PANJAB UNIVERSITY RESEARCH JOURNAL (SCIENCE)

Vol. 65[1-4] 2015

P A N J A B UNIVERSITY RESEARCH JOURNAL (SCIENCE)



VOL. 65, 2015

PANJAB UNIVERSITY RESEARCH JOURNAL (SCIENCE) VOLUME 65

Chief Patron Prof. A.K Grover, Vice Chancellor, PU, Chandigarh

Editor-in-Chief

Prof. S.K. Mehta Department of Chemistry, PU, Chandigarh

Editor

Prof. Rajat Sandhir Department of Biochemistry, PU, Chandigarh

Editorial Board:

Dr.A.K.Bhalla (Pediatrics), PGIMER, Chandigarh Prof. Rajat Sandhir (Biochemistry), PU, Chandigarh Prof. A.S. Ahluwalia (Botany), PU, Chandigarh Prof. R.K. Wanchoo (UICET), PU, Chandigarh Prof M.L. Garg (Biophysics), PU, Chandigarh Prof, Kalpana K, Mahajan (Statistics), PU, Chandigarh Prof. Jagdeep Kaur (Biotechnology), PU, Chandigarh Prof. S.K. Mehta (Chemistry), PU, Chandigarh Prof. Maniit Kaur (Physics), PU, Chandigarh Prof. A.K. Bhandari(Mathematics).PU, Chandigarh Prof. Rajinder Jindal (Zoology), PU, Chandigarh Prof. Karan Vasisht (UIPS), PU, Chandigarh Prof. R.K.Singla (DCSA), PU, Chandigarh Prof. Saniay Chhibber (Microbiology), PU, Chandigarh Prof. R.K. Pathak (Anthropology), PU, Chandigarh Prof. R.S. Loyal (Geology), PU, Chandigarh

Advisory Board :

Dr. Krishan Lal, NPL, New Delhi. Prof. A.K. Sood, Indian Institute of Science, Bangalore Dr. Amod Kumar, Acting Director, CSIO, Chandigarh Dr. Girish Sahni, Director, IMTECH, Chandigarh Prof. K.K. Mishra, Director, IGRMS, Bhopal Prof. Y.K. Chawla, Director, PGIMER, Chandigarh Dr.Vishwa Mohan Katoch, Director General, ICMR, New Delhi. Prof. A.K. Chakraborty, NIPER, Mohali Sh. Ashwagosha Ganju, Director, SASE, DRDO, Chandigarh. Dr. Manjit Singh, Director, CFSL, Chandigarh Dr. Rakesh Tuli, Executive Director, NABI, Mohali

The subscription of the journal may be sent in the form of a Bank Draft payable to **The Registrar**, **Panjab University, Chandigarh** and addressed to The Editor-in-Chief on the following address:-

Research Journal (Science) Room No. 28-29, Old Correspondence Bldg. Panjab University, Chandigarh - 160 014, India

The manuscripts for publication or any other enquiry is also to be addressed to the Editor-in-Chief.

Subscription fee:		
	Inland	Foreign
Annual Subscription	Rs.400/-	US\$ 50
Life Membership	Rs. 3000/-	US\$ 250

CONTENTS

PREPROCESSING IN AUTOMATIC VEHICLE LICENSE PLATE RECOGNITION Anuj Kumar, Anuj Sharma and R.K. Singla	1
BUSINESS SOFTWARE PATENT: A LEGAL STUDY OF INTERNATIONAL AND NATIONAL SCENARIO WITH SPECIAL REFERENCE TO INDIA Dr. (Mrs.) Jyoti Rattan	9
ONLINE SIGNATURE VERIFICATION USING FEATURES DERIVED FROM PRESSURE PROPERTY Sudhir Rohilla, Anuj Sharma, and R.K. Singla	17
LICENSE PLATE DETECTION IN AUTOMATIC VEHICLE PLATE RECOGNITION (AVPR) Anuj Kumar, Anuj Sharma and R K Singla	25
PERFORMANCE EVALUATION OF FREQUENT PATTERN MINING TECHNIQUES Rohini Sharma	33
NAMED DATA NETWORKING: AN EMERGING INTERNET PARADIGM Anjali Goyal, Anuj Sharma and R.K. Singla -2.	41
FREQUENT PATTERN MINING BASED SYSTEM FOR EFFICIENT ANOMALY DETECTION Rohini Sharma	49
FREE OPEN SOURCE IMAGE PROCESSING LIBRARIES FOR DEVELOPMENT OF ANDROID APPLICATIONS Jasleen Kaur Bains and Dr. Anuj Sharma	59
AWARENESS AND ACCEPTANCE OF THE SHIFTING TRENDS FROM OF HIGHER LEARNING TO MOBILE LEARNING: A SURVEY OF STUDENTS OF HIGHER EDUCATION IN CHANDIGARH Jasleen Kaur Bains	69
AN INTERVENTIONAL STUDY TO ASSESS THE KNOWLEDGE AND OF HIGHER ABOUT THE TRANSMISSION AND PREVENTION OF OF HIGHER OF HIGHER AMONGST THE DENTAL STUDENTS Dr Shipra Gupta, Dr Jyoti Gupta, Nandini Bhaskar and Ashish Jain	81
A SURVEY ONPARKING MANAGEMENT SYSTEM AND DESIGN OF OF HIGHER VEHICLE PARKING MANAGEMENT SYSTEM USING OF HIGHER Neeru Mago and Dr. Satish Kumar	91
TEXT FEATURE SPACE OPTIMIZATION USING ARTIFICIAL BEE COLONIZATION Pallavi Grover and Sonal Chawala	97
PROBIOTIC COCKTAIL MEDIATED SUPPRESSION OF INFLAMMATORY RESPONSE GENERATED IN Shigella dysenteriae type 1 INFECTED HUMAN INTESTINAL EPITHELIAL CACO-2 CELLS. Radhika Trikha, Naresh Sachdeva, Praveen Rishi and Rupinder Tewari	105
USING CONCEPT MAP NETWORK BASED CONSTRUCTIVIST LEARNING ENVIRONMENTS (CLE) FOR TEACHING LEARNING PROGRAMMING Minakshi Sharma and Sonal Chawla	121

PREPROCESSING IN AUTOMATIC VEHICLE LICENSE PLATE RECOGNITION

*Anuj Kumar, Anuj Sharma and R.K. Singla

Department of Computer Science & Applications, Panjab University, Chandigarh

Abstract

Automatic Vehicle Plate Recognition(AVPR) is used for identifying vehicle license plate number using image processing and pattern recognizing techniques. Automatic recognition of vehicle license plates plays an important role in traffic surveillance systems. The process of AVPR is divided into six stages. Firstly, Video or image of vehicle is taken using a camera. The image may contain impurities such as holes and dirt particles. The noise is removed from the image of the vehicle in preprocessing stage. In Plate Detection stage, vehicle plate is extracted from the preprocessed image of the vehicle. The features of vehicle plate like presence of characters, aspect ratio, color, size and rectangular shape are used to localize the plate. The characters on the vehicle plate are isolated in the plate segmentation stage. The final stage is to recognize the alphanumeric characters present on the vehicle plate. The features of the characters like shape, size and contours of characters can be used for character recognition. This paper will present the various methods of preprocessing discussed in literature.

Keywords: AVPR, Preprocessing, Plate Detection, Template Matching

INTRODUCTION

Vehicles play an important role in transportation. Use of vehicles is increasing because of population growth. Therefore, controlling of vehicles is becoming a big problem. So, there is a need to recognize the vehicles. As Vehicle number plate is unique for every vehicle, we can use vehicle registration plate for this purpose. Manual recording of vehicles is time consuming, costly and not efficient. Therefore, there is a need for automation of process of vehicle plate recognition. Automatic Vehicle Plate Recognition (AVPR) is an image processing and pattern recognition problem used to identify vehicle license plate number.

Automatic recognition of car license plates plays an important role in traffic surveillance systems. Such system which is applied in parking areas, highways, bridges and tunnels, can help a human operator and improve overall quality of a service [1]. Automatic number plate recognition is a mass surveillance method that uses optical character recognition on images to read vehicle registration plates. It is a technique which is used to identify vehicles using their license plate numbers. It is the process of extraction of vehicle plate number from an image of a vehicle or video of a moving vehicle. The main use of AVPR is Security. This technique is very helpful in toll collection, parking management, access control, radar based speed control, boarder control and road patrolling. The basic requirement for any Number Plate Recognition

*Corresponding Author: anuj_gupta108@rediffmail.com MS received: March 14, 2016; Accepted: August 29, 2016 system, for practical implementation, is real-time performance with high recognition accuracy. Thus, the following basic performance requirements of

Automatic Vehicle Plate Recognition System can be identified as:

- · High recognition speed
- High recognition accuracy (typically more than 95%)
- High level of consistency [3]

High Security Registration Plate (HSRP) is a highly secure number plate aimed to bring about a uniform pattern of displaying registration marks across the country. HSRP plates are made of aluminum featuring unique details apart from the registration number. The plates have a seven-digit unique laser code, chromiumbased chakra hologram to prevent counterfeiting, a self destructive sticker with the engine and chassis numbers of the vehicle, 'IND' inscribed in blue color, with India inscribed at a 45 degree angle in hot stamping foil across all letters and numbers on the plate. Last but not the least; it has a non removable and non reusable snap lock. The unique seven-digit laser code is the biggest safety feature. It is meant to be scanned by laser detector cameras to identify if the number plate details match the laser code and whether or not the registration plate belongs to the vehicle. However, for this to work laser detector cameras will have to be installed on important roads and intersections to capture footage of stolen vehicles. These cameras are not available locally [6]. In any case HSRP or Non-HSRP Plates, recognition system is required to match laser code or vehicle number, respectively. Therefore, there is a need for reliable Automatic Vehicle Plate Recognition system.

The main challenges in AVPR are:

- Text on plates may be written in different languages and fonts
- · Size of vehicle plates is not same
- Plate may exists in different location of image of
 Vehicle
- There may be dirt on the plates
- Plates may have different types of illumination due to environment
- Plates may have unnecessary text
- · Vehicle Plates have screws
- · Vehicles plate may be tilted
- · Blurry Images
- Poor lighting due to shadows and reflections

I. WORKING OF AVPR

Our model will include three phases. The three phases are Data Acquisition, Vehicle Plate Extraction and Vehicle Number Detection. The phases of AVPR of model is given in Figure 1:

A. Phase1: Data Acquisition

In the very first step we will form the video using a camera. We can also use CCTV camera for the purpose. The parameter of the camera such as resolution, shutter speed, orientation etc has to be considered into account while making the video of a moving car. Then, in the second stage video of moving vehicle is converted into frames The frame rate is to be considered in this stage. Then the key frame is to be selected. The key frame should be clear enough to recognize the vehicle plate number.

B. Phase II: Vehicle Plate Extraction

As the videos and images are taken in real environment under uncontrolled illumination, there may be noise in the images and low contrast. In this stage, the noise is removed from the image of the vehicle. Contrast adjustment is also performed on the image. The image is enhanced and preprocessed so that it is easy to recognize the number. In the next stage, Features of plate are extracted and vehicle plate is localized from the image of the vehicle. The input of this stage is a vehicle image, and output is the portion of the image carrying the vehicle plate.

According to the reference [2], the methods for License Plate Extraction are:

License Plate Extraction Using Boundary/Edge

Phase I	Input Video		
Data Acquisition	Video to Frame Conversion		
	<u>_</u>		
	Key Frame Selection		
		-	
Phase II	Pre-processing and noise removal		
	Feature Extraction		
Venicle Place excidention			
	Number Plate Extraction		
	Plate Segmentation		
Phase III Vehicle Number			
	Character Recognition		
Detection			
	Vehicle plate number		

Fig. 1: (Phases of AVPR)

Information

- License Plate Extraction Using Color Features
- License Plate Extraction Using Character Features
- License Plate Extraction Combining Two or More Features

Fuzzy logic is used in [17] for license plate extraction. Authors in [18] used connected component analysis for plate detection.

C. Phase III: Vehicle Number Detection

Then vehicle plate is segmented to extract the characters for recognition. Character segmentation is basically the isolation of the characters within the image component. [2] Methods used in segmentation are:

 License Plate Segmentation Using Pixel Connectivity.

- License Plate Segmentation Using Prior Knowledge of Characters.
- License Plate Segmentation Using Character Contours.
- License Plate Segmentation Using Combined Features.

The characters are then recognized and Vehicle type information is detected. The output is the vehicle plate number and vehicle type information. Methods used in character recognition are:

- Character Recognition Using Raw Data
- Character Recognition Using Extracted Features
 [2]

Template matching is used in [11], [12], [14] to recognize the characters. Reference [19] used Optical Character Recognition (OCR) for recognizing the



Fig. 2: Stepwise Description

characters. Final output of the system will be vehicle plate license number. The Stepwise description is shown in figure 2.

I. PREPROCESSING IN AVPR

Preprocessing is used to enhance the quality of the image. Preprocessing is needed to further high performance recognition [14]. Plate Detection system may fail due to low quality of image of vehicle [15]. The steps of preprocessing is shown in figure 3.





key frame is selected for further reference. The image of frames is shown in figure 4.

Extracting the correct frame with a clear vehicle plate image is another challenge.



Fig. 4: Frames of Video

The image may contain impurities such as holes and dirt particles. The image with noise is shown in figure 5.



Fig. 5: Noised image

The noise is removed from the image of the vehicle in preprocessing stage. To deal with illumination problem, good preprocessing methods should be used to remove the influence of lighting and to make the plate clear. Noise is unwanted information in digital images. Noise produces undesirable effects such as artifacts, unrealistic edges, unseen lines, corners blurred objects and disturbs background scenes [9]. Digital images are prone to a variety of types of noise. Noise is the result of errors in the image acquisition process that result in pixel values that do not reflect the true intensities of the real scene [10]. In literature, authors commonly used Mean Filter, Median Filter, Gaussian filter, Mexican Hat Filter for removing the noise from the plate. According to reference [5], Various techniques are present including Gaussian, Median, Kalman etc. that removes the noise and reduces sharp edge details present in the image. These technique creates a water color image of the real image, removing the sharp edge and discontinuities that are present within the image.

Gaussian filter has a better performance as compared to median filter in high noise image processing. The image may be of low contrast. Histogram Equalization is used in [1] for contrast enhancement.

The median filter is a nonlinear <u>digital filtering</u> technique, often used to remove <u>noise</u>. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, <u>edge detection</u> on an image). Median filtering is very widely used in digital <u>image processing</u> because, under certain conditions, it preserves edges while removing noise. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the <u>median</u> of neighboring entries [7]. According to reference [8], the mean filter is replaces the center value in the window with the average value of all the pixel values in the window. An example of mean filter of a 3x3 window of values is shown below.

unfiltered values

4	2	7
3	2	8
7	6	8

Mean = (4 + 2 + 7 + 3 + 2 + 8 + 7 + 6 + 8)/9 = 45/9 = 5

mean filtered

*	*	*
*	5	*
*	*	*

The median is less sensitive than the mean to extreme values which are called *outliers*. Therefore, Median filtering is better able to remove these outliers without reducing the sharpness of the image [10]. Median filter is used in [13], [21-23] to remove the noise. Authors [4], [24] and [25] used Gaussian filter to eliminate the noise form the image of the vehicle. The image of vehicle after noise removal is shown in figure 6.



Fig. 6: Image of vehicle after removing noise

If the colored images are processed directly, it will lower the processing speed of the AVPR system. Therefore, colored image of vehicle should be converted into gray image. This process is called Gray Processing [16]. RGB to gray conversion is used in [20] to increase the processing speed and facilitate the plate extraction. The Gray scale image is shown in figure 7.



Fig. 7: Grayscale image of the vehicle

Then to sharpen the edges, edge detection techniques can be used. The image after edge detection is shown in figure 8.



Fig. 8: Image After Edge Detection This image can be input to Plate Detection stage of AVPR

KUMAR et al.

CONCLUSION

This Paper described the process of Preprocessing of AVPR system. Preprocessing is used to enhance the quality of the image. Each step of preprocessing is discussed with practical examples in detail. The techniques and methods used in preprocessing are explained. The preprocessed image may increase the speed of AVPR system.

REFERENCES

- Gao, Da-Shan, and Jie Zhou. "Car license plates detection from complex scene." In Signal Processing Proceedings, 2000. WCCC-ICSP 2000. 5th International Conference on, vol. 2, pp. 1409-1414. IEEE, 2000.
- [2] Du, Shan, Mohammad Ibrahim, Mohamed Shehata, and Wael Badawy. "Automatic license plate recognition (ALPR): A state-ofthe-art review." *Circuits and Systems for Video Technology, IEEE Transactions on* 23, no. 2 (2013): 311-325.
- R. Lotufo and A. Morgan, "Automatic numberplate recognition," *Image Anal. Transp. Appl.*, pp. 6/1–6/6, 1990.
- [4] More, Nandan, and Bharat Tidke. "License Plate Identification Using Artificial Neural Network and Wavelet Transformed Feature Selection." In *Pervasive Computing (ICPC)*, 2015 International Conference on, pp. 1-5. IEEE, 2015.
- [5] Muzammil, Muhammad Junaid, and Syed Ali Raza Zaidi. "Application of image processing techniques for the extraction of vehicle number plates over ARM target board." In Computer, Control & Communication (IC4), 2013 3rd International Conference on, pp. 1-5. IEEE. 2013.
- [6] http://www.zigwheels.com/news-features/ news/high-security-registration-plates-all-youneed-to-know/12705.
- [7] https://en.wikipedia.org/wiki/Median_filter
- [8] http://www.markschulze.net/java/meanmed. html
- [9] Boyat, Ajay Kumar, and Brijendra Kumar Joshi. "A Review Paper: Noise Models in Digital Image Processing." *arXiv preprint arXiv:1505.03489* (2015).

- [10] http://in.mathworks.com/help/images/noiseremoval.html
- [11] M. Sarfraz, M. J. Ahmed, and S. A. Ghazi, "Saudi Arabian license plate recognition system," in Proc. Int. Conf. Geom. Model. Graph.2003, pp. 36–41.
- [12] C. A. Rahman, W. Badawy, and A. Radmanesh, "A real time vehicle's license plate recognition system," in Proc. IEEE Conf. Adv. Video Signal Based Surveillance, Jul. 2003, pp. 163–166.
- [13] Kocer, H. Erdinc, and K. Kursat Cevik. "Artificial neural networks based vehicle license plate recognition." *Procedia Computer Science* 3 (2011): 1033-1037.
- [14] Kasaei, Seyed Hamidreza Mohades, and Seyed Mohammadreza Mohades Kasaei. "Extraction and recognition of the vehicle license plate for passing under outside environment." In Intelligence and Security Informatics Conference (EISIC), 2011 European, pp. 234-237. IEEE, 2011.
- [15] Abolghasemi, Vahid, and Alireza Ahmadyfard.
 "An edge-based color-aided method for license plate detection." *Image and Vision Computing* 27, no. 8 (2009): 1134-1142.
- [16] Zhang, Cheng, Guangmin Sun, Deming Chen and Tianxue Zhao. "A rapid locating method of vehicle license plate based on characteristics of characters' connection and projection." In 2007 2nd IEEE Conference on Industrial Electronics and Applications. 2007.
- [17] Wang, Feng, Lichun Man, Bangping Wang, Yijun Xiao, Wei Pan, and Xiaochun Lu. "Fuzzybased algorithm for color recognition of license plates." Pattern Recognition Letters 29, no. 7 (2008): 1007-1020.
- [18] Rao, Yunbo. "Automatic vehicle recognition in multiple cameras for video surveillance." *The Visual Computer* 31, no. 3 (2015): 271-280.
- [19] El Khatib, Ibrahim, Yousef Sweidan, Samir-Mohamad Omar, and Ali Al Ghouwayel. "An efficient algorithm for automatic recognition of the Lebanese carlicense plate." In Technological Advances in Electrical, Electronics and Computer Engineering (TAEECE), 2015 Third International Conference on, pp. 185-139. IEEE, 2015.

- [20] Parasuraman, Kumar, and P. Vasantha Kumar.
 "An efficient method for indian vehicle license plate extraction and character segmentation."
 In IEEE International conference on computational intelligence and computing research, pp. 1475-1477. 2010.
- [21] Sarfraz, M. Saquib, Atif Shahzad, Muhammad A. Elahi, Muhammad Fraz, Iffat Zafar, and Eran A. Edirisinghe. "Real-time automatic license plate recognition for CCTV forensic applications." *Journal of real-time image processing* 8, no. 3 (2013): 285-295.
- [22] Karwal, Hanit, and Akshay Girdhar. "Vehicle Number Plate Detection System for Indian Vehicles." In *Computational Intelligence & Communication Technology (CICT), 2015 IEEE International Conference on*, pp. 8-12. IEEE, 2015.
- [23] Prabhakar, Priyanka, P. Anupama, and S. R. Resmi. "Automatic vehicle number

plate detection and recognition." In Control, Instrumentation, Communication and Computational Technologies (ICCICCT), 2014 International Conference on, pp. 185-190. IEEE, 2014.

- [24] More, Nandan, and Bharat Tidke. "License Plate Identification Using Artificial Neural Network and Wavelet Transformed Feature Selection." In *Pervasive Computing (ICPC)*, 2015 International Conference on, pp. 1-5. IEEE, 2015.
- [25] Sharma, Jaibir, Anadi Mishra, Kunal Saxena, and Sudhakar Kumar. "A hybrid technique for License Plate Recognition based on feature selection of wavelet transform and artificial neural network." In Optimization, Reliability, and Information Technology (ICROIT), 2014 International Conference on, pp. 347-352. IEEE, 2014.

BUSINESS SOFTWARE PATENT: A LEGAL STUDY OF INTERNATIONAL AND NATIONAL SCENARIO WITH SPECIAL REFERENCE TO INDIA

Dr. (Mrs.) Jyoti Rattan

Department of Laws, Panjab University, Chandigarh

Associate Professor, Department of Laws, Panjab University, Chandigarh, is a topper in Law and a Gold Medalist in LL.M, Ph.D. in Law and M.Sc. in Chemistry. Her areas of interest have been Taxation Laws, Cyber Law, Law of contract, RTI and International Law. Dr. Rattan has written books on Taxation Laws, Cyber law and RTI, International Law and several research articles on Taxation Laws, Cyber Law and International Law areas besides Inter-disciplinary Law and Administrative issues in reputed journals, presented papers and won awards at various national and international Conferences in India and abroad including the 91st Indian Science Congress; 26th International Congress of Administrative Sciences, Seoul, Korea, 2004; Third Regional International Conference; International Institute of Administrative Sciences (Belgium), Monterrey, Mexico, 2006 and 27th International Congress of Administrative Sciences, Abu Dhabi, U.A.E., 2007 and 2011 International Conference of the International Institute of Administrative Sciences (IIAS), held at Lausanne, Switzerland, 2011. In 2012, Dr. Rattan's papers have been selected for oral presentation at IASIA's Annual Conference, Bangkok, Thailand, 5th International Conference on Information Law 2012, organized by the Ionian University and the International Society for Ethics and Technology (INSEIT) (US), in Greece; 13th International Winelands Conference 2012, Research Congress Centre of the Stellenbosch Institute for Advanced Study (STIAS), Mostertsdrift, Stellenbosch, South Africa. Istanbul 9th Academic Conference organized by the International Institute of Social and Economic Sciences in 13 April 2014 to 16 April 2014 in Istanbul, Turkey, The 2014 IASIA Annual Conference on Good governance: the Position of Students, Scholars and Practitioners Port Elizabeth, South Africa, 2014 International Congress of IIAS, Ifrane, Morocco.

Abstract

The Computer Software was unknown in the 19th century and hence was not a subject matter of IPRs protection when Berne Convention and Paris Convention were adopted. The need for seeking legal protection for computer programs/software has been increasingly felt in the late 20th century due to their importance and heavy competition in this field. Under international law, the Computer Software is considered as subject matter of copyright protection and accordingly countries amended their copyright laws to provide copyright protection to it. However, a new practice was started by the US of giving patent protection to it (considering it to be strong protection) followed by the European countries. At present, debatable issue is whether copyright or patent protection must be provided to computer software. Jurists, software developers have different opinions. This paper is a humble attempt to make indepth study of international and national scenario of business software and IPR protection provided to it especially in India.

Methodology

It is theoretical study based on international and national instruments, books, reports, article and the internet.

Key Words: United Nations Millennium Summit, MDGs, wireless, broadcasting networks, EDUSAT.

INTRODUCTION

The Computer Software was unknown in the 19th century and hence was not a subject matter of IPRs protection when Berne Convention and Paris Convention were adopted. The need for seeking legal protection for computer programs/software has been increasingly felt in the 20th century due to their importance and heavy competition in this field.

Under international law, the Computer Software is considered as subject matter of copyright i.e., Article 10.1 of TRIPs Agreement, 1995 provides that computer programmes, whether in source or object code, shall be protected as literary works under the Berne Convention. Further, Article 11 of TRIPs Agreement recognizes the rental rights in respect of completed programmes and cinematographic works. Further, WIPO Copyright Treaty (WCT), 1996 is a special agreement within the meaning of Article 20 of the Berne Convention, 1886 where protection is provided to copyright therefore, computer program is covered under literary work and hence subject matter of copyright protection.

To meet the above requirements, in many countries, computer programs/ software have been made the

*Corresponding Author: *jyotirattan@gmail.com* MS received: January 16, 2016; Accepted: September 14, 2016 subject-matter of copyright protection under the Copyright law. In India, the Copyright Act of 1957 was amended in 1994 to incorporate computer program/software for registration as a literary work under the said Act. Accordingly, it is now possible to protect computer program/software in India under the Copyright Act.

Therefore, traditionally computer program/software was subject matter of copyright protection under national and international law and is considered as not falling within the definition of invention under the patent law for obtaining patents. However, with the increasing use of computers over the years, in practice the law-makers and law enforcers are being put under pressure to grant patent protection to software. The reason put forward is that computer programs indeed represent a form of applied mathematics and are full of unprecedented innovative qualities. Therefore, in recent years, several countries have been increasing the limits of patent protection, to expand the traditionally accepted area of inventions and to include more abstract areas, such as software. The United States of America is the forerunner in granting patent protection largely due to the relative flexibility granted under its patent statute. Significantly, the trend adopted by the US courts has been largely appreciated by the programming community.1

2. Computer Software as a New Subject Matter of Patent: Trend Set by the US

It is important to note that in 1972 in Grottschal v Benson,² the US Supreme Court held that a computer program whose sole objective is to generate numerical values (algorithm) would be non-patentable. The court held that algorithm is a mental act which is not patentable. Basically, software is a set of computer program which involves using algorithms to make the computer function. However, for the first time in 1978 in re Toma,³ the US Patent Office Board of Appeals deviated from the decision of Supreme Court in Benson's case and held that software translates one language into another and hence patentable. Further, in 1981 in Diamond v. Diehr,4 the US court was inspired by the decision of US patent office to grant patent to software and held that algorithm is patentable. The court defined the term algorithm as "a fixed step by step procedure for accomplishing a given result usually a simplified procedure for solving a complex problem". The court held that algorithm is a defined process or set of rule that leads and assures the development of a desired output from a given input. After this decision, the courts in US granted

patent to software in number of cases. For example, in 1992 in Arrythmia Research Technology Inc. v Carasonix Corp.,⁵ a computer process for diagnosing heart attack was given patent. Subsequently, the US patent office gave new examination guidelines for computer related inventions in 1996. In accordance with new examination guidelines, court issued patent to computer software used for conducting methods for doing business. In the case of State Street Bank and Trust Company v. Signature financial Corp., ' number of patents is issued to number of softwares such as method of advertising over internet, method of placing an order online with a single mouse click. Further, it is also possible to claim both process patent as well as product patent for computer program. When the computer is executing the computer program's instructions, patent process may be granted whereas when a computer program is recited in conjunction with a physical structure such as computer memory then product patent may be granted.

After US, Europe and Japan started granting patent to computer software. In 1985, European patent Office (EPO) issued guidelines for governing patent of software. However, many other countries provide copyright protection to computer software as is also pointed out by a jurist that "There is a divergence on views among various jurisdictions of the world as to what category of intellectual property protection may be granted for software. In the US the patent office has upheld several software patent claims whereas, this trend is not very popular in other countries. In majority of the countries including India, the intellectual property protection for software is still governed by copyright laws".⁹ Lets briefly analyse the efforts made by India for business software Patent.

Efforts made in India for business software Patent

It is important to mention that India had also made certain efforts regarding business software Patents. Prior to May 20 2003, the Indian Patents Act 1970 defined an "invention" as any new and useful article, process, method which is useful to industry. However, software developers and Stakeholders agree that stronger protection is needed for software inventions in India. Although there was no specific provision excluding the patentability of software *per se* or business methods from the interpretation of this definition, but it could be clearly ascertained that only methods for the manufacture of a tangible product were patentable. Therefore, methods implemented by software inventions and software *per se* and business methods were not patentable.

Consequently, in 2002 the Patents Act was amended to make Indian law in tune with Article 27 of the TRIPs Agreement and to make it clear that computer softwares are not covered under the definition of invention. Accordingly "invention" is redefined as "a new product or process involving an inventive step and capable of industrial application". Consequently, a new Section 3(k) was introduced, providing that mathematical and business methods are non patentatble inventions. However a positive move in this direction was, the Patents (Amendment) Ordinance 2004¹⁰ promulgated in December 2004 by which Section 3(k) was amended to exclude from patentability "a computer programme per se other than its technical application to industry or a combination with hardware". That means a computer programme having technical application to industry or a combination with hardware is patentable.

The Indian Patent Office released a Draft Manual of Patent Practice and Procedure¹¹ in 2005 providing guidelines on the types of claim allowed in respect of software-related inventions. As per the guidelines, claims to computer programs per se, computerreadable media with programs recorded thereon, methods implemented by software that lack technical effect and methods with a technical effect but lacking hardware support in the specification are not patentable. The guidelines state that in respect of a method, "the method claim should clearly define the steps involved in carrying out the invention. It should have a technical effect. In other words, it should solve a technical problem ... The claim orienting towards a 'process/method' should contain a hardware or machine limitation."¹² In India, for administrative convenience, four patent offices are located in metropolitan cities. However, the offices are inconsistent in their practice with regard to software inventions, mainly due to the lack of clear guidelines. However, The Patents (Amendment) Act 2005 repealed the ordinance and restored the earlier position. That means under Section 3(k) of the Patents Act, mathematical and business methods, computer programs per se and algorithms are not patentable. Subsequently, the government issued Draft Manual of Patent Practice and Procedure 2008.13 Significantly, under this Draft the guidelines on software inventions were more elaborate, but similar in content. However, due to pressure from different areas, the government invited various actors to deliberate upon. These meetings generated intense debate, with the open source industry opposing the guidelines set out in the manual and arguing that the manual tries to introduce software patent protection.14 Though the Indian Patent Office mainly relies on the practice followed by the European¹⁵ and UK patent offices, but due to controversy there are various examples where inventions claiming software methods with a technical effect that have been allowed by the European or UK patent office¹⁶ were rejected by Indian Patent Office due to following reasons: the term "technical effect" is not defined in the Indian Patents Act; the Draft Manual is not binding on the examiners, as it is only in draft form ;and there are no Indian precedents in respect of software inventions.

A moot question regarding business software is that initially it was a subject matter of copyright protection then why the US and other countries started giving patent protection to it? To answer this question it is utmost important to understand the difference between patent and copyright.

3. Difference between Patents and Copyright

This distinction is considered important to understand the patentability of software. A Major Distinction between Copyright and Patents is that a Patent provides protection to original ideas, whereas, the Copyright provides protection to form and not idea. The copyright works must be fixed in a tangible form. Therefore, a copyright may be available in respect of the printed text of a patent claim, whereas, a patent would be available in the ideas represented in the claim.

It is important to note that, a patent will not be granted merely for an abstract idea (such as a mathematical theorem) that is incapable of practical application but only where such an idea can be given a practical shape as an invention whereas copyright is granted for an abstract idea.

Registration is compulsory in case of patent whereas it is not so in case of copyright. Though patent is granted for 20 years but it is considered to be stronger protection as compared to copyright which is granted for 60 years.

Examples of copyright works fixed in a tangible form are printed books, drawing, painting, phonograph records, multimedia CDs, films and sheet music. Patents were granted for new inventions i.e., for industrially or commercially useful products such as new machines, articles, materials and processes for making things.

Take the example of a work entitled to copyright protection: a printed book. It is clear that a book is subject of copyright protection because it is a literary work represented by a particular arrangement of work on printed pages. Now take clear cases of inventions, entitled to patent protection: a steering wheel in a car or a new kind of electrical generator (examples of machines, which perform work).

4. Computer Software: whether patent or copyright Protection

After considering the difference between the copyright and patent, an important question is whether: software is more like a written work or a machine or process of making a machine? In other words is software a subject matter of copyright protection or patent protection?

Some jurists believe that it has qualities of both i.e., of written description as well as of a steering wheel or a process of making steering wheel. Significantly software is both a written description of a process and in a sense, the process itself. It is unique nature of software, that it is a written work which acts as a machine to perform tasks and because of which it is entitled for protection under both copyright and patent law.¹⁷

Further in order to prove a copyright violation, the copyright owner must prove that the alleged infringer had access to and copied the copyrighted material. For example, imagine a journalist who covers an event and writes a newspaper Article describing it. Another journalist covers the same event and writes an article using almost similar language as the first article the next day. Because the second journalist independently created the second article without copying the first article, no copyright violation has occurred.¹⁸

Computer software and hardware companies have taken advantage of the copyright law's lack of protection against independent creation to 'replica' *computer products through reverse engineering*. Reverse engineering is the process of recreating a device by observing how it functions, and using this binformation to create device which is its functionally equivalent.

Patent law eliminates this loophole as any use of the patented device which is prohibited by the patent laws and which is unauthorized by the patent owner is infringement, even if the infringing device was created without any knowledge of the original device. A piece of software patented cannot be reverse-engineered and sold by another company, because patent rights prevent anyone other than the patent holder from exercising the patent holder's exclusive rights without authorization. As a result of the stronger protection provided by patent law, patent protection is significantly harder and more expensive to obtain than copyright protection.¹⁹ Therefore in the present scenario, before deciding whether to patent or copyright protection to the computer software we must know what is computer software.

The term 'computer software' is a wider term and commonly used to describe computer programs and similar materials such as database, preparatory material and associated documents like manuals for users of the program and the persons maintaining the programs. According to a jurist, it may include²⁰: preparatory design materials, like flowcharts, diagrams, written specifications, form and report layouts, designs for screen displays etc.; object code and source code and other executable code; software development tools, like relational database development systems, compilers, report generators etc.; databases and data files; computer output, for example, sound, printout, computer file or data, electronic signals; screen displays; manual and guides (on paper or stored digitally) and Program languages.

Therefore, computer software is nothing but collection of items and materials associated with the development and operation of computer program, but it does not include computer hardware. Significantly, computer software is most commonly created by computer programmers using a programming language. The programmer writes commands in the programming language that are similar to what someone might use in everyday speech. These commands are called source code. Another computer program called a compiler is then used on the source code, transforming the commands into a language that the computer can understand. The result is an executable computer program, which is another name for software.²¹

It is important to note that we can either download computer software from the Internet or purchase licensed software embedded in a removable magnetic or optical storage medium. Under copyright law, computer programs are literary works. It is significant to note that some jurists are in favour of copyright protection whereas others are in favour of patent protection. Let's briefly analyse views in favour and against patent protection of computer software.

View in Favour of Patent Protection of Computer Software: This new trend has started because it is widely believed that patent protection is strong as compare to copyright protection. Because, consider for example, that for software developers and writers, who are protected under copyright law, it is the specific form and expression of the software as written in the program that is protected. But this is not a really significant degree of protection considering that any sufficiently inventive programmer would be able to achieve the similar effect as the copyrighted software by simply re-writing the code, to produce the similar software product with different (and consequently separately copyrightable) code. Therefore, if the software were to be granted Patent Protection, then the holder of the patent would be entitled to protection over the software product and could consequently take action against anyone who uses any form of code to reproduce that software product, regardless of the inventiveness of that programmer in achieving the same result by writing different lines of code.

View in Favour of Copyright protection of Computer Software: Those jurists who are in favour of copyright protection of computer program believe that both under international and national law, computer program is a subject matter of copyright protection.

Significantly, International Law is in favour of Copyright Protection of Computer Program.²²

Article 10.1 of TRIPs Agreement, 1995 provides that computer programmes, whether in source or object code, shall be protected as literary works under the Berne Convention. However, Article 11 talks about the rental rights with regard to computer programs and cinematographic work.

Further, WIPO Copyright Treaty (WCT), 1996 is a special agreement within the meaning of Article 20 of the Berne Convention therefore, computer program is covered under literary work and hence subject matter of copyright protection.

It is important to note that national laws including Indian Law is also in favour of Copyright Protection of Computer Program. For example, under Indian law, section 14 of Indian Copyright Act, which was amended by the Copyright (Amendment) Act of 1994, provides that computer program is covered under literary work under section 2(o). Section 2(ffc) defines the computer program as a set of instructions expressed in words, codes, schemes or in any other form including a machine readable medium, capable of causing a computer to perform a particular task to achieve a particular result.

Further, under section 3(k) of Indian Patent Act, 1970, computer program is considered to be a non-patentable invention which provides that a mathematical or business method or a computer program *per se* or algorithms are non patentable inventions.

No doubt granting of patent to computer software seems very convenient, both the law makers and programmer have to be careful because software does not simply fit into the traditional definition of what can be protected through the grant of a patent. For example, a computer program is, on its own, little more than a representation of the instructions issued to the computer, as to the manner in which the computer is to carry out a specific function or perform a specific task. A computer is capable of comprehending instructions issued to it in binary code and a program is nothing more than a mathematical formula expressed in binary notation (or algorithm), that serves as a process or set of instructions issued to the computer to require the computer to perform in a specific manner.

The patent laws make a specific exception in respect of the grant of patent protection to scientific discoveries, laws of nature, theories, and in general all discoveries of facts or laws of nature that were hitherto unknown, but which were discovered. Mathematical formulae and algorithms traditionally fall within this exception. Therefore, it would follow that computer programs which can be reduced to algorithms, would consequently be denied patent protection on the grounds of the same exception.

Therefore, no doubt pure algorithms have been treated as mathematical formulae that are not entitled to patent protection. But, with the passage of time, a growing trend has been towards the grant of patents in respect of inventions in which algorithms are used as an intrinsic part of the machine, in order to produce a given result.

5. Conclusion and Suggestions:

Computer software, an offshoot of e-revolution and a new subject of IPRs was initially made a subject matter of copyright protection as mentioned under various international instruments such as TRIPs, WCT, and WPPT etc. Accordingly number of countries amended their copyright laws and brought it within the purview of copyright protection by bringing it within the definition of subject matter of copyright. In India also such amendment was made by the Copyright (Amendment) Act 1994. However, the US started a new practice of granting patent protection followed by the European countries thus started a new debate whether to grant patent or copyright protection to it.

The software programmers are interested that their

programmes (software) be given the highest degree of protection because of the increasing use of the computer over the years. Further it is also believed that computer software represents a form of applied mathematics and full of innovative qualities. Therefore, law makers and enforcers were under pressure to grant patent protection to the computer software.

However, the judges and jurists do not agree that patent protection be granted to all forms of software programmes. Because if such permissions were made common, then this could lead to the grant of unnecessarily wide protection to each and every software programme, i.e., various forms of intellectual property that may not otherwise qualify for protection under the patent law.

However, there are other important criticisms also. For example:

- (1) It is significant to note that over 2000 new softwares are granted patents each year. However, Software by its nature is incapable of being separated into separate parts. In other words, the location and demarcation of each patented algorithm from the main program is often highly impossible. Therefore, programmers find it difficult to program a new code, without the fear of violating already patent protected algorithms that may be essential to their program. So software programmers might be discouraged to work for improvements in related areas due to legal restrictions.
- (2) Unlike traditional inventions, softwares generally become obsolete, old or useless in a few months or years. For example, nobody talks about "WordStar" anymore which has become useless in the modern times, and instead MS Office "Word" has now become most popular. Therefore, the grant of protection to software for a period of 20 years or more, is irrelevant in the context of software.
- (3) In fact, the grant of such a long monopoly period in respect of software would not only harm the software industry but also retard further development. Because the holders of software patents would be least interested in developing new software code until the monopoly or protection period is over. Instead they would be interested in actively preventing other persons from developing such improvements in violation of their patent rights.
- (4) Softwares, by nature are extremely complex

development of technology. For example, in some types of software, there are several million lines of code, all of which go into the making of the final saleable software product. However, this complexity has not been created by the effort of only one programmer; rather it is a group activity. In fact, software is nothing more than a string of algorithms that have been developed by previous programmers and subsequently merged together. But the moment one of algorithms has been patented, no other programmer can use that algorithms in his/her program.

It is commendable to note that there exists a third viewpoint that, the system of software patents should be completely abolished and the software industry would exist without patent protection. However, this solution is not supported by the large corporations due to their big business interests.

Therefore, for the business software patents, an acceptable via media or solution could be the development of a different system of protection, developed solely for and in respect of the software industry, that:

- (1) Defines the types of software and the extent to which such software can be protected.
- (2) Specifies a rational period of protection.

REFERENCE

- ¹ Dr. N.S. Sreenivasulunu, Intellectual Property Rights, pp. 49-56, (2011).
- ² 409 US 63, 1972.
- ³ 575 F. 2d, 872 at note 4 C.C.P.A., 1978.
- 4 450 US 175, 209 U.S.P.Q., 1997, 1982.
- ⁵ 958 F. 2d 1053, Fed Cir, 1992.
- ⁶ Federal Registrar, Vol. 61 No. 40, pp. 7478-7492. The guidelines came into force from 26.03.1996.
- ⁷ 47 U.S.P.Q. 2d, 1596 Fed. Cir., 1998 CERT, denied, US 1999.
- ⁸ Prabudha Ganguli, Intellectual Property Right: Unleashing the Knowledge Economy, pp. 397-398, (2000).
- ⁹ R.K. Suri, Cyber Crime, p. 221, (2002).
- ¹⁰ Available at http://lawmin.nic.in/Patents%20 Amendment%20Ordinance %202004.pdf (accessed on 04.12.2014).

- ¹¹ Available at http://ipindia.nic.in/ipr/patent/ manual-2052005.pdf (accessed on 30.11.2014).
- ¹² "Business method and software patent trends in India"
- Available at http://www.iam-magazine.com/Magazine/ Issue/35/Management-report/Businessmethod-and-software-patent-trends-in-India (accessed on 02.12.2014).
- ¹³ Available at http://www.indiaoppi.com/sites/default/ files/PDF%20files/DraftPatent_Manual_2008. pdfhttp://www.ind iaoppi.com/sites/default/ files/PDF%20files/DraftPatent_Manual_2008. pdf (accessed on 02.12.2014.)
- ¹⁴ Available at http://www.indiaiprights.com/newpdfs/0601116256news.pdf (accessed on 03.12.2014.)

- ¹⁵ Available at http://www.epo.org/news-issues/issues/ software.html accessed on 05.12.2014.
- ¹⁶ Available at http://webcache.googleusercontent. com/search?q=cache:sx0zdZWeOMk J:www.richardpoynder.co.uk/SP ReportFinal. DOC+&cd=4&hl=en&ct=clnk&gl=in. Also see https://www.gov.uk/apply-for-a-patent (accessed on 05.12.2014.)
- ¹⁸ Roodney D. Ryder, Guide to Cyber Laws, pp. 321-322, (2007).

¹⁹ Ibid

- ²⁰ Vakul Sharma, Information Technology Law and Practice, p. 383, (2010).
- ²¹ http://www.wisegeek.com/what-is-computersoftware.htm (accessed on 22.05.2010).

ONLINE SIGNATURE VERIFICATION USING FEATURES DERIVED FROM PRESSURE PROPERTY

*Sudhir Rohilla, Anuj Sharma, and R.K. Singla

Department of Computer Science and applications, Panjab University, Chandigarh

Absract

The signature of a person is considered as an important behavioral biometric trait for authentication purpose as these are

socially accepted and extensively used in legalizing the documents throughout world. In the present work, we proposed an online signature verification system based on features derived from pressure property along with the coordinates and time properties of the signature data point. We have used symbolic representation to represent the signatures and common threshold has been applied to get the matching score. The performance of the system is checked on the SVC2004 benchmark signature database which includes forty writers with twenty genuine and twenty forgery signature from five other writers. The initial experimental results measure a reduction of 3% in the equal error rate when the features involving pressure property are used among other features. The results of experimentation prove the efficiency of the features involved.

Keywords: biometrics, on-line signature verification, pressure features, symbolic.

INTRODUCTION

BIOMETRICS is the automation of authentication of a person using its behavioral and physical characteristics. There are several characteristics which can be used for the biometric system. These characteristics should be universal, unique, invariant, difficult to forge etc. For example, facial patterns, fingerprint patterns, speech patterns, iris patterns, signature and handwriting patterns etc. These patterns are known as the biometrics traits. Among these traits, signature is such a trait which is used throughout world and hence is socially acceptable characteristic for biometric system. It is used in legalizing the document across many organizations like universities, government offices, banking sector, courts and several such administrative and financial institutions.

The task of automation of signature verification is viewed in two modes. One mode is on-line and second is off-line mode. These two modes are distinguished for the collection of raw details about the signature. In offline mode, the signature is captured as an image after the signature is being done. In online mode, signature is captured and all the dynamic information like co-ordinates, time, pressure etc. is stored simultaneously while the signature is being done. These dynamic characteristics are difficult to forge by the imposters and therefore, online signature verification system gives more accuracy than the offline signature.

In general, a signature verification system consists

of data acquisition (signature collection), feature extraction and a Department of Computer Science and Applications, Panjab university, Chandigarh, India.



Fig. 1: Online signature as a biometric trait.

verification methodology to find out the matching score as mentioned in Fig. 2. The signature collection process takes the online information from the signature and then, the signature is represented in a mathematical form after extracting some features. These features



Fig. 2: A general Online signature verification system.

*Corresponding Author: rohilla2209@gmail.com

MS received: March 14, 2016; Accepted: September 23, 2016

are the mathematical properties derived from the raw information collected by the signature. There are mainly two kinds of features presented in the literature: parametric and functional features. In functional features, the signature is represented by a function based on time usually and the value of this function serve the purpose of features. In parametric features, value of some of the mathematical properties are stored in a vector and each of such properties is taken as a unique feature to represent the signature [12]. There are two kinds of classification for parametric features. One such classification is local and global features and another classification is static, kinematics, structural and statistical feature set [20]. These classification can be depicted in Fig. 3. In this paper, a new category of second kind of classification of parametric features has been proposed in this study and will be discussed in detail in feature extraction section. For verification techniques, there are several classifier and matching techniques like support vector machine (SVM), hidden markov model (HMM), neural network (NN), dynamic time warping (DTW) etc. In DTW technique, the matching can be found between two time sequences by minimizing the sum of square of the distances between them [17], [8], [11], [3]. The Euclidean distance based matching is one of the examples of DTW technique. The other technique is a stochastic technique HMM in which a system based on statistical markov process with latent states has been modeled to match the patterns [21], [24], [18], [4]. Though its implementation is costly due to high computational complexity yet it is considered as a potential approach for verification purpose [19]. On the other hand, the SVM is a classifier in which a hyperplane or a set of hyper-planes in a high dimensional space is constructed to distinguish the two different class data by maximizing the distance between the inter-class objects and minimizing the classification



Fig. 3: Classification of Parametric Features

error that is the intra-class variation among two classes [9], [15], [16]. The NN technique is also used in training and classifying the signatures [5], [6]. But the limitation of NN is that it requires a significant large number of data to get trained and in case of signatures it is better to minimize the size of training data set as suggested in [10]. The Kashi et al. implemented the features collected were first coordinates and their velocities, moment, integrated absolute centripetal acceleration, direction histogram, rms velocity etc and implemented HMM technique on the signatures database of 59 users (542 genuine and 325 forgeries) and measured FAR (False Acceptance Rate), the rate at which forgery signatures are accepted by the system, is 2.5% and the FRR (False Rejection Rate), the rate at which genuine signature are rejected by the system, is 2.5% [14]. Wu et al. used the split and merge mechanism on the database consisting 246 forgeries and 200 genuine signatures and reported FAR as 2.8% and FRR as 13.5% [22]. Jain et al. extracted the features like $\Delta \chi$ and $\Delta \gamma$ i.e. γ and γ coordinates differences, Y coordinates with reference to center of signature, $sin(\alpha)$ and $cos(\alpha)$ with x-axis, curvature etc and developed the verification system using the DTW technique. The FAR and FRR, for common threshold were reported as 2.7% and 3.3% respectively and for writer dependent threshold as 1.6% and 2.8%, respectively [13]. Kholmater et al. collected the features like $\Delta \chi$ and $\Delta \gamma$, χ and γ coordinates with reference to first point of trajectory and the curvature difference between two consecutive trajectory points. They have used the DTW matching technique for the verification of a system having signatures of 94 users (1134 genuine and 367 forgeries). The system based on the linear classifier along with the above features has been established to report FRR as 1.64% and FAR as 1.28% [15]. Augilar et al. implemented the HMM technique using MCYT bimodal biometric database consists of on-line signature modalities and fingerprint. They had reported the EER for skilled forgeries as 0.74% and for random forgeries as 0.05% [1]. Guru and Parkash introduced a verification technique based on the symbolic representation on ATVS MCYT database consisting of 50 signatures of each 330 users. The FAR and FRR for common threshold were reported as 4.1% and 4.3% and the same ratios for writer dependent threshold were 3.9% and 3.7% which further resulted into an average EER of 3.8% [10]. Recently, Barkoula et al. elaborated TAS (turning angle scale) and TASS (turning angle scale space) for representation of the signature and then applied variation of the longest common subsequence verification technique on two databases: SVC2004 (Task1) and SUSIG (Visual Corpus Part-1). For skilled forgeries they had reported the average EER of 5.33% for SVC2004 and 0.52% for SUSIG database [2]. Emerich et al. used Tespar based coding method, wavelet analysis and SVM as the verification classifier on the SVC2004 (Task2) database. The mean EER was reported as 6.96% [7]. Garcia reported the mean EER of 2.74% by using GMM and DTW matching techniques and MCYT database (100 users and 50 signatures for each of the 100 users) [17]. In this paper, we have presented a new feature category derived from pressure information at each data point. In the next section, we describe the system design and in third section, the features are explained in details. The symbolic technique has been described in section 4. In section 5, the experimental section has been elaborated with the discussion and conclusion will be the last section of the paper.

A. System Design

The developed system contains three stages as shown in Fig. 4.



Fig. 4: Implemented System Design

Stage I: Data acquisition is the very first step in online signature verification. The signature can be captured through various machines like tablet PCs, pen tablet and PDAs. As the signature is being done, we dynamically capture its attributes like χ - γ coordinate points, time sequence for the captured data points, pressure etc. We applied the size normalization to the captured data points of each signature.

Stage II: In the next stage, we extract the feature by using the dynamic information captured at stage 1, some of the mathematical properties, called features, has been computed and the signatures are, then, represented in terms of these features.

Stage III: In this stage, a verification technique is developed using the training data. In this study, we have implemented the symbolic matching technique in two perspective: with sub-trajectories and without sub-trajectories. After that the output is stored as if the signature is authentic or genuine.

Moreover, There are three error rates for the system

performance evaluation. One is False Acceptance Rate (FAR) which is the rate by which the system accepts the forgery signature and other one is False Rejection Rate (FRR) which is the rate by which the system rejects the system. These two kinds of rates are inversely proportional to each other because if we make our system more strict towards the forgery then the chances of the rejection of genuine signatures or FRR may get increase and if we make our system more relax towards the genuine signatures then the chances of the acceptance of false signatures or FAR may get increase. In this view, an Equal Error Rate (EER) has been considered for signature verification system evaluation which is the rate at which both of the rates, FAR and FRR, become equal.

II. FEATURE CLASSIFICATION

As mentioned in system design, the second step is the feature extraction. At this step, the signature trajectories can be represented by some behavioral characteristics which are the numeric measure of the basic mathematical properties of each data point. These characteristics are termed as features of signature trajectories. In the literature, such type of eighty features have been described and categorized into four categories based on their behavioral nature [20]. These are static, kinematics, structural and statistical feature categories. In this paper, a new feature category has been derived from the pressure property and has been named as the pressure feature category. The set of this category contains 22 features based on pressure and pressure change as described in TABLE I and all the features in other categories are shown in TABLE II.

TABLE I: Proposed Pressure Features

SN	Features	SN	Features
1	Pressure, P(X(max))	13	Pressure Change, DP(max)
2	P(X(min))	14	DP(min)
3	P(Y(max))	15	DP(1st X-Y)
4	P(Y(min))	16	DP(Last X-Y)
5	P(1st X-Y)	17	DP(Vx(max))
6	P(Last X-Y)	18	DP(Vx(min))
7	P(Vx(max))	19	DP(Vy(max))
8	P(Vx(min))	20	DP(Vy(min))
9	P(Vy(max))	21	DP(V(max))
10	P(Vy(min))	22	DP(V(min))
11	P(V(max))		
12	P(V(min))		

TABLE I shows the 22 features used to characterize the signatures. These features include pressure at various critical points like *X-min*, *X-max*, *Y-min* and *Y-max*. These form the first four features of the set. The features 5, 6, 15 and 16 are the values of pressure and pressure change at the start point and end point of the trajectory. The features 7-12 and 17-22 measures the pressure and pressure change at the minimum and maximum velocities in X-Y direction and the absolute velocities. In this way, the pressure feature category has been built by such kind of features.

SYMBOLIC MATCHING USING SUB-TRAJECTORYLEVELS

In this study, we have implemented symbolic matching without sub-trajectories and with sub-trajectories. Both are briefly discussed as below.

A. Symbolic matching without sub-trajectories:

In symbolic data matching, signatures are represented by the feature vectors. Each feature vector contains the value of all the features define to characterize the signature such as a signature can be characterized by m features as $\{ff1; f2; ...; fm\}$. Then, on the basis of the mean and standard deviation of each feature in a number of sample signatures (feature vectors) of a writer, a feature level threshold is developed. This feature level threshold is used to obtain an interval valued reference feature vector (RFV) as discussed by Guru and Prakash [10]. For example, the RFV of an ith writer for m features is given by

$$RFV_i = \{ [f_{i1}^-, f_{i1}^+], [f_{i2}^-, f_{i2}^+], \dots, [f_{im}^-, f_{im}^+] \}, \quad (1)$$

where the interval-valued m^{th} feature of i^{th} writer, $[f_{im}^-, f_{im}^+]$, is defined as

$$[f_{im}^- = \mu_{im} - T_{im}, f_{im}^+ = \mu_{im} + T_{im}], \quad (2)$$

where the $\mu_{_{inr}}$ is the mean of mth feature of $i^{\prime h}$ writen's training sample and feature-level threshold, $\tau_{_{inr}}$, is evaluated as

$$\tau_{im} = \alpha \sigma_{im} \tag{3}$$

where the is a scalar and im is the standard deviation of m^{th} feature of i^{th} writer's training sample.

Each of the feature value of a test signature of a writer is compared to its corresponding interval in the reference feature vector of the same writer and is checked whether this value lies within the interval or not. If it lies within the interval, it is accountable for the genuineness of the signature otherwise for forgery of the particular signature. Then a common threshold, empirically evaluated, is applied on the total count of accountable features for a test signature. This threshold decides if the test signature is authentic or a forgery.



Fig. 5: Concept of Sub-trajectories

B. Symbolic matching with sub-trajectories:

Symbolic matching with sub-trajectories means that we are partitioning the signatures into a number of equal parts. Each part is considered as a sub-trajectory. This partition is done on the basis of captured data points. The sub-trajectory level two means that signature is broken into two halves, the subtrajectory level three means that signature is broken into three equal parts and similarly, the sub-trajectory level m means that signature is broken into *m* equal parts. Each such parts

contain equal number of data points. After dividing into subtrajectories, the symbolic matching technique has been applied on each of the sub-trajectory. Thus, we would have a feature set comprising *m* times the extracted features from the Sub-Trajectory level, (ST)=m, and in this way, we increase the total number of features each time by increasing the subtrajectory levels. The concept of sub-trajectories can be understood with the help of Fig. 5. In this Fig. 5(b), the original signature (single sub-trajectory (ST-1) shown in Fig. 5(a)) has been divided into two sub-trajectories

RESULTS

The experiments are performed by using a publicly available database SVC-2004 (first Signature Verification Competition held in 2004). It consists of two datasets, TASK1 and TASK2. Each of the dataset contains the signatures of forty writers. For each individual writer, the set contains the twenty original genuine signatures and twenty skilled forgery signatures which are obtained from five other writers [23]. In this paper, we have used only TASK2 as it contains the pressure information whereas TASK1 does not contain pressure.

We have used five genuine signatures out of twenty genuine signatures for each writer which are randomly chosen to train the system and remaining fifteen genuine signatures along with twenty skilled forgeries are used to test the system. Two kind of experiments are conducted for both of the datasets. First kind of experiment is performed by considering the entire signature as a single trajectory i.e. when number of sub-trajectory (ST) is equal to one and the other kind of experiments are done on various sub-trajectory levels. In the latter kind of experiment, first level is chosen by dividing the signatures into two halves by taking equal number of trajectory points in each part and the level is termed as ST= 2. The next level is ST= 3, in which signature is divided into three parts, having equal number of trajectory points. In the same manner, we have considered different levels of sub-trajectory as ST= 4, ST= 5, ST= 6 and ST= 7 for verification. We have performed the experiments using features of four categories and then with the new feature category i.e. pressure feature category. The initial experimental results measure a reduction of nearly 3% in the equal error rate when the features involving pressure property are used among other features. The optimum results come from the sub-trajectory level 5 (ST5) in both the cases. This also shows that the sub-trajectories help in reducing the overall EER of the system. The reason to obtain the better accuracy with the pressure property is because while duplicating the signature, the forgers never would have thought to replicate the pressure and on that basis, we evaluate our system performance by considering these features and the results of experimentation prove the efficiency of the features involved. These features will be explored further in our future work. In addition, the present results have been

performed with limited database size and EER could be improved with increase in data for genuine and forgery signatures. The online signature verification offer useful applications in real life use such as banking, web based authentication etc. The use of large data in present study could further help to improve signature verification system in order to realize the objectives of real life applications.

REFERENCES

- [1] J. Aguilar, J. Garcia, D. Ramos, and J. Rodriguez. Hmm-based online signature verification: Feature extraction and signature modeling. *Pattern Recognition Letters*, 28(16):2325– 2334, 2007.
- [2] K. Barkoula, G. Economou, and S. Fotopoulos. Online signature verification based on signatures turning angle representation using longest common subsequence matching. International Journal on Document Analysis and Recognition (IJDAR), 16(3):1433–2833, 2013.
- [3] L. Bovino, S. Impedovo, G. Pirlo, and L. Sarcinella. Multi expert verification of handwritten signatures. Proceeding IEEE 7th International Conference Document Analysis and Recognition, pages 932–936, 2003.
- [4] J. Coetzer, B. M. Herbst, and J. A. Preez. Offline signature verification using discrete radon transform and a hidden markov model. EURASIP J. Applied Signal Processing, 4:559–571, 2004.
- [5] G. Dimauro, G. Impedevo, and G. Pirlo. Component oriented algorithms for signature verification. International Journal Pattern Recognition and Artificial Intelligence, 8:771–794, 1994.
- [6] J. P. Draouhard, R. Sabourin, and M. Godbout. A neural network approaches to on-line signature verification using directional pdf. *Pattern Recognition*, 29:415–424, 1996.
- [7] S. Emerich, E. Lupu, and C. Rusu. A new set of features for a bimodal system based on on-line signature and speech. *Digital Signal Processing*, 23(3):928–940, 2013.
- [8] P. Fang, Z. C. Wu, F. Shen, Y. J. Ge, and B. Fang. Improved dtw algorithm for online signature verification based on writing forces. *Proceedings of ICIC*, pages 631–640, 2005.

Sr No	Static Features (1-18)	Kinematic Features (19-49)		Structural Features (50-64)	Statistical Features (65- 80)
1	count(Stroke)	totalSignatureDuration	$t(Jerk_{min})/T_{pd}$	$ \begin{array}{c} \Theta_{initial} \\ tan^{-1}(V_u/V_r) \end{array} = $	avg(Jerk)
2	$count(local x_{max})$	totalPenDownTime, T_{pd}	$t(Jerk_{max})/T_{pd}$	$\Theta_{lastPenUp}$	Standard Deviation (sd) of a_{π}
3 4	$\begin{array}{l} \operatorname{count}(\operatorname{local} y_{max}) \\ ((y_{max} - y_{min}) * \\ (x_{max} - x_{min}))/(\Delta_x * \end{array}$	$T(V_x>0)/T_{pd} \ T(V_x<0)/T_{pd}$	$Jerk_{x,min} \ Jerk_{x,max}$	$\Theta_{lastPenUp} - \Theta_{initial}$ directionChainCode, S_1	$\operatorname{sd}(a_y)$ $\operatorname{sd}(v_x)$
5	$egin{array}{llllllllllllllllllllllllllllllllllll$	$T(V_y > 0)/T_{pd}$	$Jerk_{y,min}$	directionChainCode, S_2	$sd(v_y)$
6	$\frac{1}{(x_{lastPenUp})} - \frac{1}{(x_{rastPenUp})} - \frac{1}$	$T(V_y < 0)/T_{pd}$	$Jerk_{y,max}$	directionChainCode, S_3	$\operatorname{sd}(x)/\Delta_x$
7	$(y_{lastPenUp} - y_{lastPenUp})/\Delta y_{lastPenUp}$	$t(V_{x,min})/T_{pd}$	$Jerk_{min}$	directionChainCode, S_4	$\mathrm{sd}(y)/\Delta_y$
8	$(x_{lastPenUp} - x_{r})/\Delta x$	$t(V_{x,max})/T_{pd}$	$Jerk_{max}$	directionChainCode, S_5	$avg(V)/V_{x,max}$
9	$\begin{array}{ccc} x_{min} & & & \\ (y_{lastPenUp} & - & \\ y_{last} & & \\ \end{pmatrix} / \Lambda \end{array}$	$t(V_{y,min})/T_{pd}$	$t(X_{min})/T_{pd}$	directionChainCode, S_6	$\operatorname{avg}(V)/V_{y,max}$
10	$(x_{1stPenUp} - x_{y})/\Delta $	$t(V_{y,max})/T_{pd}$	$t(X_{max})/T_{pd}$	directionChainCode, S_7	$avg(V)/V_{max}$
11	$(y_{1stPenUp} - y_{max})/\Delta_y$	$t(V_{min})/T_{pd}$	$t(Y_{min})/T_{pd}$	directionChainCode, S_8	$(x_{max} - a_{max})/a_{max}(x)$
12	$(x_{1stPenUp} - x_{min})/\Delta_x$	$t(V_{max})/T_{pd}$	$t(Y_{max})/T_{pd}$	dirChangeChainCode,	$\frac{(y_{max})}{(y_{max})} - \frac{(y_{max})}{(y_{max})} - \frac{(y_{max})}{(y_$
13	$(y_{1stPenUp} - y_{min})/\Delta_y$	$t(Jerk_{x,max})/T_{pd}$	$rms(Acc_{tan})/Acc_{max}$	dirChangeChainCode,	$avg(Jerk_x)$
14	$count(V_x=0)$	$t(Jerk_{x,min})/T_{pd}$	$rms(Acc_{cent})/Acc_{max}$	dirChangeChainCode,	$avg(Jerk_y)$
15	$count(V_y=0)$	$t(Jerk_{y,min})/T_{pd}$	T((dx/dt)(dy/dt) > 0) / T((dx/dt)(dy/dt) < 0)	C_3 dirChangeChainCode, C_4	$sd(a_{tan})$
16 17 18	count(V_x changes sign) count(V_y changes sign) maxDistance/($(y_{max} - y_{min}) * (x_{max} - x_{min})$)	$t(Jerk_{y,max})/T_{pd}$,		$sd(a_{cent})$

TABLE II: A feature Set containing the eighty features under their respective categories. Here, T denotes a time interval and t specifies an instance of time.

- [9] M. Fuentes, S. G. Salicetti, and B. Dorizzi. Online signature verification: Fusion of a hidden markov model and a neural network via a support vector machine. *Eighth International Workshop on Frontiers in Handwriting Recognition*, pages 253–258, 2002.
- [10] D. S. Guru and H. N. Prakash. Online signature verification and recognition: an approach based on symbolic representation. *IEEE* transactions on pattern analysis and machine intelligence, 31(6):1059–1073, 2009.
- [11] K. Huang and H. Yan. Stability and style variation modeling for online signature verification. *Pattern Recognition*, 36(10):2253–2270, 2003.
- [12] D. Impedovo and G. Pirlo. Automatic signature verification: The state of the art. *IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews,* 38(5):609–635, 2008.
- [13] A. K. Jain, F. Griess, and S. Colonnel. Online signature verification. *Pattern Recognition*, 35:2963–2972, 2002.
- [14] R. Kashi, J. Hu, W. L. Nelson, and W. Turin. A hidden markov model approach to online handwritten signature verification. *International Journal Document Analysis and Recognition*, 1:102–109, 1998.
- [15] A. Kholmatov and B. Yanikoglu. Identity authentication using improved online signature verification method. *Pattern Recognition* Letters, 26(15):2400–2408, 2005.
- [16] H. Lv, W. Wang, C. Wang, and Q. Zhuo. Offline chinese signature verification based on support vector machines. *Pattern Recognition Letters*, 26(15):2390–2399, 2005.
- [17] L. G. Mariano, R. L. Rafael, and C. N. Enrique. Embedded system for biometric online signature verification. *IEEE Transaction on Industrial Informatics*, 10(1):491–501, 2014.

- [18] J. Ortega-Garcia, J. Fierrez-Aguilar, J. Martin-Rello, and J. Gonzalez-Rodriguez. Complete signal modeling and score normalization for function based dynamic signature verification. Lecture Notes in Computer Science in Audio and Video Based Biometric Person Authentication, 2688:658–667, 2003.
- [19] L. R. Rabiner and B. H. Juang. An introduction to hidden markov models. *IEEE ASSp Magazine*, 1986.
- [20] S. Rohilla, A. Sharma, and R. Singla. Online signature verification at sub-trajectory level. Springer International Publishing, Smart Innovation, Systems and Technologies: Advanced Computing, Networking and Informatics- Volume 2, 28:369–374, 2014.
- [21] M. M. Shafiei and H. R. Rabiee. A new online signature verification algorithm using variable length segmentation and hidden markov models. Seventh International Conference on Document Analysis and Recognition, 1:443–446, 2003.
- [22] Q. Wu, S. Lee, and I. Jou. On-line signature verification based on split and merge matching mechanism. *Pattern Recognition Letters*, 18:655–673, 1997.
- [23] D. Yeung, H. Chang, Y. Xiong, S. George, R. Kashi, T. Matsumoto, and G. Rigoll. SVC2004: First international signature verification competition. *Proceedings of the International Conference* on Biometric Authentication (ICBA), Hong Kong, pages 16–22, July 2004.
- [24] H. S. Yoon, J. Y. Lee, and H. S. Yang. An online signature verification system using hidden markov model in polar space. *Proceedings of* the Eighth International Workshop on Frontiers in Handwriting Recognition (IWFHR), pages 329–333, 2002.

LICENSE PLATE DETECTION IN AUTOMATIC VEHICLE PLATE RECOGNITION (AVPR)

*Anuj Kumar, Anuj Sharma and R K Singla

Department of Computer Science & Applications, Panjab University, Chandigarh

Abstract

License Plate Detection or Localization is the second stage of Automatic Vehicle Plate Recognition (AVPR) System. AVPR is an image processing and pattern recognizing technique for the detection of vehicle license plate number from an image or video of a moving vehicle. A license plate recognition system employs image processing techniques, which helps to identify the vehicles through their plates. AVPR Model consists of four main stages. The four stages are Preprocessing, Vehicle Plate Detection, Character Segmentation and Character Recognition. Firstly, Video or image of vehicle is taken using a camera. The image may contain impurities such as holes and dirt particles. The noise is removed from the image of the vehicle. The features of vehicle plate like presence of characters, aspect ratio, color, size and rectangular shape are used to localize the plate. The characters present on the vehicle plate are isolated in the Plate Segmentation stage. The final stage is to recognize the alphanumeric characters present on the vehicle plate. The features of the characters like shape, size and contours of characters can be used for character recognition. This paper presents the various methods and techniques of License Plate Detection stage.

Keywords: AVPR, Feature Extraction, Preprocessing, License Plate Detection (LPD), Template Matching, Character Segmentation, Optical Character Recognition (OCR)

INTRODUCTION

Vehicles play an important role in transportation. Use of vehicles is increasing because of population growth. Monitoring vehicles for law enforcement and security purposes is a difficult problem due to number of automobiles on the road [6]. Therefore, controlling of vehicles is very important and crucial. So, there is a need to recognize the vehicles. As number plate is unique for every vehicle, we can use vehicle license registration plate for this purpose. Manual recording of vehicles is time consuming, costly and not efficient. Therefore there is a need for automation of process of vehicle plate recognition. Automatic Vehicle Plate Recognition (AVPR) is image processing technique for the extraction of vehicle license plate number from an image or video of a vehicle. A license plate recognition system employs image processing techniques which helps to identify the vehicles through their plates [2]. According to reference [15], AVPR is important for traffic control in restricted areas, automatic payment of tolls on highways or bridges and general security system to identify vehicles. The working of AVPR System is shown diagrammatically in Figure 1:



Fig. 1 : AVPR System

The input to AVPR system is video or image of a moving vehicle and output is the license vehicle plate number. License plate recognition is one of the most important types of intelligent transport system and is of considerable interest because of its potential applications to many areas such as highway electronic toll collection, traffic monitoring systems and so on [6].

I. AVPR MODEL

AVPR Model consists of four stages. The four stages are Preprocessing, Vehicle Plate Detection, Character Segmentation and Character Recognition. The stages of AVPR are shown in figure 2.

A. Stage 1: Preprocessing

Data consisting of Videos of moving vehicles is input in the first stage. After converting video into frames, key frame is selected for further reference. As the videos and images are taken in real environment under uncontrolled illumination, there may be noise and low contrast. The image may contain impurities such as holes, dirt particles and the background which must be removed [4]. The image with noise is shown in figure 3.

*Corresponding Author: anuj_gupta108@rediffmail.com MS received: September 14, 2016; Accepted: September 26, 2016



Vehicle Plate number

Fig. 2 : Stages of AVPR System



Fig. 3: Noised image

In this stage, the noise is removed from the image of the vehicle. Contrast adjustment is also performed on the image. The image is enhanced and preprocessed so that it is easy to recognize the number. The image of vehicle after noise removal is shown in figure 4.



Fig. 4: Image of vehicle after removing noise

Authors in [1], [5] used Gaussian filter to remove noise. Bottom Hat Filter is used to remove noise in [2]. Authors [3], [19] used Unwanted Line Elimination Algorithm (ULEA) to remove noise. Median Filter is used in reference [4], [21-22], [26] to get rid of noise. Gaussian Filter has a better performance in high noise image processing as compared to median filter [7]. Histogram equalization is used for contrast enhancement in [8]. Authors in reference [20] applied Mexican Hat Filter to remove noise from image of vehicle.

A. Stage II: License Plate Detection/Localization

In this stage. Features of plate are extracted and vehicle plate is localized from the image of the vehicle. The input of this stage is a vehicle image, and output is the portion of the image carrying the vehicle plate. The features of vehicle plate like presence of characters, aspect ratio, color, size and rectangular shape are used to localize the plate. A number of techniques, such as connected component analysis, neural networks, genetic algorithms, morphology, were implemented for vehicle license plate detection in literature. Two or more techniques can be combined to give more efficient and accurate results. The success of AVPR system depends upon the accuracy of plate detection stage. The image after plate localization is as shown in figure 5.



Fig. 5: Extracted Plate

A. Stage III: Character Segmentation

Character segmentation is basically the isolation of the characters within the image component. The vehicle plate is segmented to extract the characters for recognition. The features like color, size, shape and position of characters on plate can be considered to extract the characters. The input to this stage is license plate of vehicle and output is the characters present on the vehicle plate. Column Sum Vector is applied in [2] for character segmentation. Authors [4] used Otsu's method for extracting the characters from license plate. Bounding Box Technique is implemented in [20] to segments the characters. Authors [21] applied Horizontal Projection for character segmentation. Reference [28] used Shift Filtering for segmenting the characters.

B. Stage IV: Character Recognition

The final stage is to recognize the alphanumeric numbers present on the vehicle plate. The features of the characters like shape, size and contours of characters can be used for character recognition. The Authors in reference [23][29][31-32][34] applied Optical Character Recognition (OCR) for recognizing the characters present on the license plates. Probabilistic Neural Network [2] is implemented to recognize characters in [2]. Authors [15] [28] [30][36] used Neural Networks for Character recognition. Genetic Algorithm is employed for Character Recognition in reference [16]. Authors [20] [27] [33] applied Template Matching for recognition of characters. Statistical correlation method is used in [35] for matching.

Methods and techniques used in four stages of AVPR are summarized in Table 1.

LICENSE PLATE DETECTION IN AVPR

In Plate Detection stage, Vehicle plate is extracted from the preprocessed image of the vehicle. The features of vehicle plate like presence of characters, aspect ratio, color, size and rectangular shape are used to localize the plate. The input to this stage is preprocessed image and output is the license plate of the vehicle. Features of plate are extracted and vehicle plate is localized from the image of the vehicle.

Stages	Techniques			
Preprocessing	Median Filter [4], [21-22], [26] Gaussian Filter [1] [5], Bottom Hat filter [2], ULEA [3] [19], Mexican Hat Filter [20]			
License Plate Extraction	Connected Component Analysis [9] [16] [28], VEDA [3] [19], SVM [39] [43], ANN[[6], Horizontal and Vertical Edge Detection [37], OCS [10], BLOB Analysis [13], Edge.Clustering [14], Hough Transformation [21], OAC [24], Graph Grammar [25], DWT [41]			
Character Segmentation	Column Sum Vector [2], Otsu's method [4],Bounding Box Technique [20], Horizontal Projection [21], Shift Filtering [28]			
Character Recognition	Template Matching [20],[27][33], OCR [23], [29] [31-32][34], Probabilistic Neural Network [2], Neural Network [15] [28] [30] [36], Genetic Algorithm [16]			

According to reference [9], Extraction of plate is difficult task due to following reasons.

- License Plates occupy a small portion of the whole image.
- b) The difference of license plates in formats, styles and colors from country to others.
- c) Location of plate is not known in advance
- Blurry image, low illumination, vehicle motion, dirty plates and distorted characters could influence the efficiency of extraction.

Detecting the accurate location of a license plate from a vehicle image is considered to be most crucial step of an ALPR system, which greatly affects the recognition rate and speed of the whole system [17]. Features of plate like aspect ratio, rectangular shape, size, presence of characters and color of plate can be used to localized plates. Vertical Edge Detection Algorithm (VEDA) is applied in [3], [19] for license plate detection. Authors [6] used Artificial Neural Network (ANN) for license plate detection. Reference [9], 16], [28] implemented Connected component Analysis for

Table 1

extracting plate from image of a vehicle. Giannoukos et. al [10] used Operator Context Scanning(OCS) for license plate detection. Sobel edge detector [11] is applied to detect vertical edges. Sobel edge detector uses a 3 * 3 mask, which is applied to input image to give the resultant edged image. If two vertical edges are detected correctly, the four corners of the License Plate can be located. Reference [12] proposed tophat transform method for license plate localization. BLOB analysis is used in [13] for character location and grouping to identify them from other objects without ambiguity. Authors [14] used Edge clustering for License Plate Detection. Authors [17] proposed a region based method for accurate plate detection. The algorithm firstly generates candidates region using mean shift segmentation, then decides if a region of interest really contains plate based on final analysis of candidate regions. Morphological processing and color analysis is used in [18] for license plate extraction. Authors [21] used Hough Transformation for plate recognition. Yazdian et. al [24] focused on incorporation of local normalization with Optimal Adaptive Correlation to detect the license plate on video sequences. Research [25] introduced Graph Grammar based algorithm of license plate recognition. Horizontal and Vertical Edge Detection is used in [37] for LPD. Authors [38] applied standard morphological operations such as median filter and labeling to coarsely find the LP region. Reference [39] employed Support Vector machine (SVM) as a classification tool to distinguish a license plate from other objects. The trained SVM Model is applied on ROIs in order to identify the license plate. Authors [40] introduced a method for discovering the candidate car license plate locations. Firstly, the image is decomposed using a wavelet to get the HL bandwidth vertical edges. Then, the HL band is binaries using an Otsu threshold. Next a black top hat algorithm applied to reduce the effects of interfering large continuous features other than the license plate. This work correctly locate the license plate regions with a success rate of about 98.2%. Reference [41] proposed License Plate Localization algorithm based on Discrete Wavelet Transform (DWT). The proposed algorithm can be applied in complex environments and different size of LP images. Authors [42] presented a feature based license plate localization algorithm that copes with multi object problem. This algorithm is robust against illumination, shadow, scale and weather conditions. It extracts license plate candidates using edge statistics and morphological operations and removes incorrect candidates according to the determined features of license plates.

CHALLENGES IN PLATE DETECTION

Detecting the accurate location of a license plate from a vehicle image is considered to be most crucial step of an AVPR system, which greatly affects the recognition rate and speed of the whole system [17]. License plates come in different sizes and in different width-height ratio, different color, the fonts used for digits on license plates are not same for all license plates [6]. Plate may exist in different location of image of vehicle. There may be dirt on the plates. Plates may have different types of illumination due to environment. Plates may have unnecessary text. Vehicle Plates have screws. Vehicles plate may be tilted. These challenges make the license plate detection stage very crucial.

CONCLUSION

This Paper described the methods and techniques used in literature for License Plate Detection stage of AVPR system. Features of plate like aspect ratio, rectangular shape, size, presence of characters and color of plate are used to localized plates. This paper also highlighted the challenges in License Plate Detection/Localization. Authors has used Connected Component Analysis [9] [16] [28], VEDA [3] [19], SVM [39][43], ANN[[6], Horizontal and Vertical Edge Detection [37], OCS [10], BLOB Analysis [13], Edge clustering [14], Hough Transformation [21], OAC [24], Graph Grammar [25], and DWT [41] for extracting the plate from image of a vehicle. VEDA has lesser complexity as compare to canny and sobel edge detection mechanism [19]. Detecting the accurate location of a license plate from a vehicle image is considered to be most crucial step of and ALPR system, which greatly affects the recognition rate and speed of the whole system [17]. Two or more techniques can be combined to give more efficient and accurate results. The success of AVPR system depends upon the accuracy of plate detection stage.

REFERENCES

- Mousa, Allam. "Canny edge-detection based vehicle plate recognition." International Journal of Signal Processing, Image Processing and Pattern Recognition 5, no. 3 (2012): 1-8.
- [2] Öztürk, Fikriye, and Figen Özen. "A new license plate recognition system based on probabilistic neural networks." *Procedia Technology* 1 (2012): 124-128.
- [3] Al-Ghaili, Abbas M., Syamsiah Mashohor, Alyani Ismail, and Abdul Rahman Ramli. "A new vertical edge detection algorithm and its

application." In *Computer Engineering & Systems, 2008. ICCES 2008. International Conference on*, pp. 204-209. IEEE, 2008.

- [4] Karwal, Hanit, and Akshay Girdhar. "Vehicle number plate detection system for indian vehicles." In Computational Intelligence & Communication Technology (CICT), 2015 IEEE International Conference on, pp. 8-12. IEEE, 2015..
- [5] Sharma, Jitendra, Amit Mishra, Khushboo Saxena, and Shiv Kumar. "A hybrid technique for license plate recognition based on feature selection of wavelet transform and artificial neural network." In Optimization, Reliability, and Information Technology (ICROIT), 2014 International Conference on, pp. 347-352. IEEE, 2014.
- [6] Rashid, Amr E. "A fast algorithm for license plate detection." In Signal Processing Image Processing & Pattern Recognition (ICSIPR), 2013 International Conference on, pp. 44-48. IEEE, 2013.
- [7] Muzammil, Muhammad Junaid, and Sajjad Zaidi. "Application of image processing techniques for the extraction of vehicle number plates over ARM target board." In Computer, Control & Communication (IC4), 2013 3rd International Conference on, pp. 1-5. IEEE, 2013.
- [8] Gao, Da-Shan, and Jie Zhou. "Car license plates detection from complex scene." In Signal Processing Proceedings, 2000. WCCC-ICSP 2000. 5th International Conference on, vol. 2, pp. 1409-1414. IEEE, 2000.
- [9] Parasuraman, Kumar, and P. Vasantha Kumar.
 "An efficient method for indian vehicle license plate extraction and character segmentation." In IEEE International Conference on Computational Intelligence and Computing Research, pp. 1475-1477. 2010.
- [10] Giannoukos, Ioannis, Christos-Nikolaos Anagnostopoulos, Vassili Loumos, and Eleftherios Kayafas. "Operator context scanning to support high segmentation rates for real time license plate recognition." *Pattern Recognition* 43, no. 11 (2010): 3866-3878.
- [11] El-Said, Shaimaa Ahmed. "Shadow aware license plate recognition system." Soft Computing 19, no. 1 (2015): 225-235.

- [12] Arulmozhi, K., S. Arumuga Perumal, P. Sanooj, and Krishan Nallaperumal. "Application of Top Hat transform technique on Indian license plate image localization." In Computational Intelligence & Computing Research (ICCIC), 2012 IEEE International Conference on, pp. 1-4. IEEE, 2012.
- [13] Aguileta-Mendoza, Armando, and Jorge Rivera-Rovelo. "Plate Location and Recognition Using Blob Analisys." In International Conference on Ubiquitous Computing and Ambient Intelligence, pp. 319-325. Springer International Publishing, 2013.
- [14] Hsu, Gee-Sern, Jiun-Chang Chen, and Yu-Zu Chung. "Application-oriented license plate recognition." *IEEE transactions on vehicular technology* 62, no. 2 (2013): 552-561.
- [15] Parisi, R., E. D. Di Claudio, G. Lucarelli, and G. Orlandi. "Car plate recognition by neural networks and image processing." In *Circuits* and Systems, 1998. ISCAS'98. Proceedings of the 1998 IEEE International Symposium on, vol. 3, pp. 195-198. IEEE, 1998.
- [16] Vijayalakshmi, P., and M. Sumathi. "Design of algorithm for vehicle identification by number plate recognition." In 2012 Fourth International Conference on Advanced Computing (ICoAC), pp. 1-6. IEEE, 2012.
- [17] Jia, Wenjing, Huaifeng Zhang, and Xiangjian He. "Region-based license plate detection." *Journal of Network and computer Applications* 30, no. 4 (2007): 1324-1333.
- [18] Abolghasemi, Vahid, and Alireza Ahmadyfard. "An edge-based color-aided method for license plate detection." *Image and Vision Computing* 27, no. 8 (2009): 1134-1142.
- [19] Davis, Amritha Mary, and C. Arunvinodh. "Automatic license plate detection using vertical edge detection method." In *Innovations* in Information, Embedded and Communication Systems (ICIIECS), 2015 International Conference on, pp. 1-6. IEEE, 2015.
- [20] Sulaiman, Norizam, Sri Nor Hafidah Mohammad Jalani, Mahfuzah Mustafa, and Kamarul Hawari. "Development of automatic vehicle plate detection system." In System Engineering and Technology (ICSET), 2013 IEEE 3rd

International Conference on, pp. 130-135. IEEE, 2013.

- [21] Prabhakar, Priyanka, P. Anupama, and S. R. Resmi. "Automatic vehicle number plate detection and recognition." In Control, Instrumentation, Communication and Computational Technologies (ICCICCT), 2014 International Conference on, pp. 185-190. IEEE, 2014.
- [22] Sarfraz, M. Saquib, Atif Shahzad, Muhammad A. Elahi, Muhammad Fraz, Iffat Zafar, and Eran A. Edirisinghe. "Real-time automatic license plate recognition for CCTV forensic applications." *Journal of real-time image processing* 8, no. 3 (2013): 285-295.
- [23] Sen, E. Judith, K. Deepa Merlin Dixon, Ansy Anto, M. V. Anumary, Daine Mieheal, Finey Jose, and K. J. Jinesh. "Advanced license plate recognition system for car parking." In *Embedded Systems (ICES), 2014 International Conference on*, pp. 162-165. IEEE, 2014.
- [24] Yazdian, Nazanin, Yun Tie, Anastasios Venetsanopoulos, and Ling Guan. "Automatic Ontario license plate recognition using local normalization and intelligent character classification." In *Electrical and Computer Engineering (CCECE), 2014 IEEE 27th Canadian Conference on*, pp. 1-6. IEEE, 2014.
- [25] Song, Yuqing, Jianqing Liu, and Dianwei Li. "Graph grammar based license plate recognition." In Intelligent Networks and Intelligent Systems (ICINIS), 2012 Fifth International Conference on, pp. 37-40. IEEE, 2012.
- [26] Kocer, H. Erdinc, and K. Kursat Cevik. "Artificial neural networks based vehicle license plate recognition." *Procedia Computer Science* 3 (2011): 1033-1037.
- [27] Kasaei, Seyed Hamidreza Mohades, and Seyed Mohammadreza Mohades Kasaei. "Extraction and recognition of the vehicle license plate for passing under outside environment." In Intelligence and Security Informatics Conference (EISIC), 2011 European, pp. 234-237. IEEE, 2011.
- [28] Rao, Yunbo. "Automatic vehicle recognition in multiple cameras for video surveillance." *The Visual Computer* 31, no. 3 (2015): 271-280.

- [29] El Khatib, Ibrahim, Yousef Sweidan, Samir-Mohamad Omar, and Ali Al Ghouwayel. "An efficient algorithm for automatic recognition of the Lebanese carlicense plate." In *Technological Advances in Electrical, Electronics and Computer Engineering (TAEECE), 2015 Third International Conference on*, pp. 185-189. IEEE, 2015.
- [30] Jiao, Jianbin, Qixiang Ye, and Qingming Huang. "A configurable method for multi-style license plate recognition." *Pattern Recognition* 42, no. 3 (2009): 358-369.
- [31] Bhutta, M. Usman Maqbool, Hasan Mahmood, and Hafiz Malik. "An intelligent approach for robust detection and recognition of multiple color and font styles automobiles license plates: A feature-based algorithm." In Audio, Language and Image Processing (ICALIP), 2014 International Conference on, pp. 956-961. IEEE, 2014.
- [32] Beibut, Amirgaliyev, Kairanbay Magzhan, and Kenshimov Chingiz. "Effective algorithms and methods for automatic number plate recognition." In Application of Information and Communication Technologies (AICT), 2014 IEEE 8th International Conference on, pp. 1-4. IEEE, 2014.
- [33] Lee, Eun Ryung, Pyeoung Kee Kim, and Hang Joon Kim. "Automatic recognition of a car license plate using color image processing." In *Image Processing*, 1994. Proceedings. *ICIP-94.*, *IEEE International Conference*, vol. 2, pp. 301-305. IEEE, 1994.
- [34] Yousef, Khalil M. Ahmad, Maha Al-Tabanjah, Esraa Hudaib, and Maymona Ikrai. "SIFT based automatic number plate recognition." In Information and Communication Systems (ICICS), 2015 6th International Conference on, pp. 124-129. IEEE, 2015.
- [35] Massoud, M. A., M. Sabee, M. Gergais, and R. Bakhit. "Automated new license plate recognition in Egypt." *Alexandria Engineering Journal* 52, no. 3 (2013): 319-326.
- [36] Chuang, Chi-Hung, Luo-Wei Tsai, Ming-Shan Deng, Jun-Wei Hsieh, and Kuo-Chin Fan.
 "Vehicle licence plate recognition using superresolution technique." In Advanced Video and Signal Based Surveillance (AVSS), 2014

11th IEEE International Conference on, pp. 411-416. IEEE, 2014.

- [37] Makaoui, Khalid, Zouhair Guennoun, and Mounir Ghogho. "Improved license plate localization." In 2016 International Conference on Electrical and Information Technologies (ICEIT), pp. 402-405. IEEE, 2016.
- [38] Tan, Jinn-Li, Syed AR Abu-Bakar, and Musa M. Mokji. "License plate localization based on edge-geometrical features using morphological approach." In 2013 IEEE International Conference on Image Processing, pp. 4549-4553. IEEE, 2013.
- [39] Kusakunniran, Worapan, Kornthep Ngamaschariyakul, Chaiyanan Chantaraviwat, Kanon Janvittayanuchit, and Kittikhun Thongkanchorn. "A Thai license plate localization using SVM." In International Computer Science and Engineering Conference (ICSEC), pp. 163-167. 2014.

- [40] Pang, Jing. "Variance Window Based Car License Plate Localization." Journal of Computer and Communications 2, no. 09 (2014): 61.
- [41] Wang, Yuh-Rau, Wei-Hung Lin, and Shi-Jinni Horng. "A sliding window technique for efficient license plate localization based on discrete wavelet transform." *Expert Systems with Applications* 38, no. 4 (2011): 3142-3146.
- [42] i, Hamid, Shohreh Kasaei, and Faezeh Dorri. "An efficient features-based license plate localization method." In 18th International" Conference on Pattern Recognition (ICPR'06), vol. 2, pp. 841-844. IEEE, 2006.
- [43] Kim, Kwang In, Keechul Jung, and Jin Hyung Kim. "Color texture-based object detection: an application to license plate localization." In Pattern Recognition with Support Vector Machines, pp. 293-309. Springer Berlin Heidelberg, 2002.

PERFORMANCE EVALUATION OF FREQUENT PATTERN MINING TECHNIQUES

Rohini Sharma

Department of Computer Science and Applications, Panjab University, Chandigarh-160014

Abstract

In the very beginning, when computing devices were not around, data was stored by noting down facts and figures manually. For processing the data, again manual analysis was the only option. With the advent of computing device which can store data, things became quite easy. Later on Database Management Systems were used to store data and analyze it using Query Languages. As the size of data became large, the concept of data warehouse arrived which can hold a large amount of data. To extract useful information from data warehouse, data mining techniques were used. Various data mining techniques are being used for extracting information from large data sets. In this paper, I have reviewed three data mining algorithms: Apriori, FP-Growth and CATS/Feline and discussed their suitability for large dataset. Comparison is done on the basis of Simplicity, Transaction Representation, Dataset Scans, Execution Time and Memory Consumption. It has been found that no algorithm is best for all the five parameters. FP-Growth is working in best way as far as Transaction Representation and memory consumption is concerned. CATS/Feline is best for Dataset Scans and Execution Time and Apriori is the simplest of all.

Keywords: Data Mining, Apriori, FP-Growth, CATS/Feline

INTRODUCTION

Frequent pattern mining (FPM) is used to find frequent patterns from a given dataset. Famous traditional example of FPM is market basket analysis in which various items placed on shelves in a shop can be placed in such a way that customer can find them quickly according to their needs. The customer behavior is studied and using FPM techniques useful patterns are extracted that represent the shopping behavior of customer. For eg. a customer who bought bread, is buying jam also 90% of times. So if bread and jam are placed on a shelf close to each other, customer will surely buy jam even if he has not thought of buying it before. FPM has been used in diverse areas including intrusion detection (Lee et. al., 2000), web usage mining (Brin et. al., 1997) etc.

Many algorithms are proposed for frequent pattern mining, out of which Apriori Algorithm proposed by Agrawal et.al. (1993, 1994), was widely accepted. Many other algorithms are also proposed like FP-Growth (Han et. al., 2000), Eclat (Zaki et. al., 1997) and dEclat (Zaki et. al., 2003), Tree Projection (Agrawal et. al., 2001), CATS/Feline (Cheung et. al., 2003), CanTree (Leung et. al.,), SaM (Borgelt, 2010) and RElim (Borgelt, 2005). Many algorithms are proposed for maximal frequent patterns and closed frequent patterns also. In this paper, we will review three algorithms, Apriori, FP-Growth, and CATS/Feline, selected according to their popularity in data mining fraternity. The algorithms have been compared theoretically on following parameters: Simplicity, Transaction Representation and Dataset Scans. The selected algorithms are also executed on a large dataset containing 1 million transactions and comparison is based on execution time and memory consumption parameters. It has been observer that Apriori algorithm is the simplest one. However, Transaction Representation and Memory Consumption is best in FP-Growth. CATS/Feline is best as far as Dataset Scan and Execution Time is concerned.

Section 2 gives problem definition. In Section 3, related work is given. The selected algorithms are revisited briefly and theoretical comparison is made in Section 4. In Section 5, Experimental Evaluation of the algorithms is presented and finally conclusion is drawn in Section 6.

PROBLEM DEFINITION

In Frequent Pattern Mining, if T is a set of transactions and I is a set of unique items in the transactions, then frequent patters are subsets of set I which occur in at least m transactions in set T·m is the minimum support that gives lower bound on the number of transactions having that frequent pattern. Mathematically if F is a set of frequent patterns then $F = \{P \mid P \subseteq I, P \in \{Transactions in S\}, S \subseteq T, |S| \ge m\}.$

*Corresponding Author: *rohini@pu.ac.in* MS received: September 9, 2016; Accepted: November 3, 2016

SHARMA

In this paper, the suitability of frequent pattern mining algorithms for large dataset having 1 million transactions is studied. Three algorithms have been selected for the study: Apriori, FP-Growth and CATS/ Feline. The parameters selected for theoretical comparison are:

- Simplicity
- Transaction Representation
- Memory Scans

The parameters selected for experimental evaluation are:

Execution Time

Memory Consumption

The purpose of the review is to select the best out of the three selected algorithms for above mentioned parameters and to check whether any of these techniques is best of all on all the parameters collectively.

RELATED WORK

Various frequent pattern mining techniques are compared by different authors in literature. The work related to ours is shown in the form of a table in Table 1.

Author	Year	Dataset	Techniques	Parameters	Results
Shukla, R. et. al.	2015	Medical Data	Apriori, Eclat	Execution Time	Eclat gives better performance
Sharma, M. et. al.	2015	Kosarak, Mushroom	Genetic Algorithm	Time Efficiency	Genetic Algorithm proposed.
Mythili, M. S. et. al.	2013	Mushroom, Super Market	Apriori, FP-Growth	 Storage Structure Search Type Technique Database Scans Memory Utilization Database Runtime 	FP-Growth is better than Apriori
Vanitha, K. et. al.	2011	Super Market	Apriori, FP-Growth	 Scalability Execution Time 	FP-Growth is better than Apriori
Solanki, S. et. al.	2014		Apriori, Eclat, FP-Growth	 Database Scan Data Structure used 	Eclat and FP- Growth are better than Apriori
Modak, S. et. al.	2015	Chess, Mushroom	Apriori, FP-Growth, H-Mine	 Memory Execution Time 	Apriori outperforms FP-Growth for Sparse dataset. FP-Growth and H-Mine give same performance for higher value of support.
Garg, K. et. al.	213	Synthetic Dataset	Apriori, FP-Growth, Eclat	· Execution Time	FP-Growth works the best and Apriori works the worst.

Table 1: Related Work

No Study has considered CATS-FELINE algorithm for comparison with other well known algorithms. In this study, Apriori and FP-Growth algorithms are compared with CATS-FELINE for parameters that include Simplicity, Transaction representation, Dataset Scans, Execution Time and Memory consumption.

34

FREQUENT PATTERN MINING ALGORITHMS

1 Apriori Algorithm

Apriori Algorithm was proposed by Aggrawal et. al.(1993, 1994). It is first widely accepted algorithm for Frequent Pattern Mining. In Apriori technique, bottom up approach is used in which candidate patterns are extended by one item in each step and it is checked if new pattern is also frequent. It works on downward closure property which states that if {A, B} is frequent then {A} and {B} are also frequent. The working of Apriori Algorithm is shown in the flowchart given in Figure 1.

2 FP-Growth Algorithm

FP-Growth algorithm was proposed by Han et. al. (2000). In this approach, first all frequent items are found and arranged in decreasing order of their

frequency. This list is called Frequent-1 list. Items in transactions are arranged in the order of frequent-1 list. All the transactions are brought into memory in the form of a prefix tree called FP-Tree, such that each transaction contains only frequent items pruning infrequent ones. The transactions which share prefix of items also share part of the branch in prefix tree having those items. Using FP-Tree, frequent patterns are generated by traversing the tree in upward direction for each frequent item starting from the last item in Frequent-1 list. Downward Closure Property is being used for generating frequent patterns. The working of FP-Growth is shown in Figure 2. Conditional pattern for an item in FP-Tree are generated by considering the whole branch starting from that item till root node and taking minimum count through all the nodes in the branch.



Fig. 1: Apriori Algorithm

3 CATS/Feline Algorithm

William Cheung et.al. (2003) proposed Compressed and Arranged Transaction Sequences (CATS) Tree which is an extension of FP-tree in which header table and links between same items are used as it is. For CATS tree construction, database is scanned only once. As the items in a transaction are encountered, they are inserted into the tree along a single path. If some items in a transaction are same as the items in other transaction already inserted in the tree, the common items are merged at the highest frequency level so that the constraints on the structure of the tree are met.

The constraints are that item count of an item should never be greater than its parent's item count and parent's item count should be greater than sum of children item's count. Nodes along a path can be swapped if frequency of descendent becomes greater than frequency of antecedent in the course of merging. Frequent-1 items list is also created side by side along with the item's count. Frequent/Large Pattern Mining with CATS tree (Feline) technique is used to extract frequent patterns. It employs divide and conquer technique as in FP-Growth to generate conditional CATS tree for each frequent item starting from the bottom of Frequent-1 list. Using these conditional CATS tree, maximal frequent patterns can be generated. However to generate conditional CATS tree, CATS tree needs to be traversed in both upward and downward direction as there is no ordering between items. If on one path, one item is above the other item, in another path that item may be below the other item.

CATS tree does not provide full compression. The level of compression depends on the ordering of items in the transactions and ordering of transactions in the database. Working of CATS/Feline algorithm is shown in Figure 3.

4 Comparison of Apriori, FP-Growth and CATS/ Feline

Comparison of the algorithms has been made on the basis of Simplicity, Transactions Representation in Memory and Dataset Scans:

- Simplicity: Apriori algorithm is the simplest of all to understand as the most obvious approach is used in it to generate frequent patterns. It does not use any kind of complex data structure to store the transactions as in other two algorithms.
- Transactions Representation: In Apriori, transactions are not brought into memory and stored in some complex data structure. So, transactions are not represented as such in memory. In FP-Growth, Transactions are represented in memory in the form of a tree in which only frequent items are included. Moreover, items in transactions are ordered according to their frequency in Frequent-1 list in descending order. In CATS/Feline, transactions are represented in memory in the form of a tree which includes all the items. Moreover, items are not arranged in the order of their frequencies as frequency of each item is not calculated before making CATS tree.
- Dataset Scans: Apriori Algorithm requires dataset scans for each candidate. If there are n unique items in the dataset, 2ⁿ-1 unique patterns are possible. Hence O(2ⁿ) dataset scans are required. FP-Growth requires two dataset scans, one is for creating Frequent-1 list and the other for creating FP-Tree. CATS/Feline algorithm requires only one dataset scan for creating CATS tree and Frequent-1 items list simultaneously.

FREQUENT PATTERN MINING



Fig. 2: FP-Growth Algorithm


Fig. 3: CATS/Feline Algorithm

EXPERIMENTAL EVALUATION

For experimental evaluation, synthetic dataset T10I4D1000K has been selected. This dataset is available at http://fimi.ua.ac.be/data/. This dataset has 1000,000 variable size records which are created by copying each transaction in dataset T10I4D100K ten times. Algorithms are implemented in C++ and executed using GNU C++ Compiler. Support value taken for conducting the experiments is 3. Experiments are performed on a system with Intel Core i7 processor @2.4 GHz with 8 GB RAM. We have taken two parameters for evaluation, one is total execution time and the other is memory consumption. For Finding out memory usage, we have counted number of memory spaces required to store candidates in case of Apriori, number of nodes created in FP tree in case of FP-Growth and number of nodes in CATS tree in case of CATS/Feline algorithm.

Experimental results are depicted with the help of graphs shown in Figure 4 and 5 where it is quite



Fig. 4: Execution Time for FPM Algorithms



Fig. 5: Memory Consumption for FPM Algorithms

39

clear that large dataset having one million or more transactions, CATS/Feline performs better than Apriori and FP-Growth algorithms in terms of execution time. In terms of memory usage, FP-Growth clearly performs better than other two algorithms.

CONCLUSIONS AND FUTURE WORK

Three algorithms: Apriori, FP-Growth and CATS/ Feline have been evaluated for a large dataset on five parameters: Simplicity, Transactions Representation, Dataset Scans, Execution Time and Memory Consumption. Apriori is the best algorithm as far as simplicity is concerned but execution time is quite high as it requires multiple dataset scans. FP-Growth algorithm is best as far as Transaction Representation and Memory Consumption is concerned. CATS/Feline is best as far as Dataset Scan and Execution Time is concerned. Work in this paper will be extended by increasing the size of dataset further. Moreover, memory consumption is limited by number of items in transactions. Memory consumption can by reduced by combining items in some way.

REFERENCES

- Agrawal, R., T. Imielinski and A. Swami. 1993. Mining association rules between sets of items in large databases, SIGMOD Rec. 22 (2) : 207-216.
- Agrawal, R. and Srikant. 1994. Fast algorithms for mining association rules, Proc. 20th International Conference on very large data bases, VLDB 1215 : 487-499.
- Agarwal, R. C., C. C. Aggarwal and V. Prasad. 2001 A tree projection algorithm for generation of frequent item sets, Journal of Parallel and Distributed Computing 61 (3) : 350-371.
- Borgelt, C. 2005. Keeping things simple: Finding frequent item sets by recursive elimination, Proceedings of the 1st International Workshop on Open Source Data Mining: Frequent Pattern Mining Implementations : 66-70.
- Borgelt, C. 2010, Simple algorithms for frequent item set mining, Advances in Machine Learning II 263 : 351-369.
- Brin, S., R. Motwani, J. D. Ullman and S. Tsur. 1997. Dynamic itemset counting and implication rules for market basket data, SIGMOD Rec. 26 (2) : 255-264
- Cheung, Wand O. Zaiane. 2003. Incremental mining of

frequent patterns without candidate generation or support constraint, Proceedings of Seventh International Symposium on Database Engineering and Applications : 111-116.

- Garg, K. and D. Kumar. 2013. International Journal of Computer Applications 69(25) : 29-32
- Han, J, J. Pei and Y. Yin. 2000. Mining frequent patterns without candidate generation, SIGMOD Rec. 29 (2) : 1-12.
- Lee, W., S. Stolfo and K. Mok. 2000. Adaptive intrusion detection: A data mining approach, Artificial Intelligence Review 14 (6) : 533-567.
- Leung, C. S., Q. Khan and T. Hogue. 2005. CanTree: A tree structure for efficient incremental mining of frequent patterns, Fifth IEEE International Conference on Data Mining.
- Modak, S., S. Vikmani and L. D'mello. 2015. Frequent Pattern Mining Algorithms: A Comparative Study, International Journal of Innovations and Advancement in Computer Science 4(9)
- Mythili, M. S. and A. M. Shanavas. 2013. Performance Evaluation of Apriori and FP-Growth Algorithms, International Journal of Computer Applications 79(10).
- Sharma, M. and S. Kumar. 2015. Performance Evaluation of Frequent Pattern Mining using Genetic Algorithm: The Review, Performance Evaluation (2): 58-61.
- Shukla, R. and A. K. Solanki. 2015. Performance Evaluation for Frequent Pattern Mining Algorithm, International Journal of Engineering Research and General Science 3(5): 910-15
- Solanki, S. and N. Soni. 2014. A Survey on Frequent Pattern Mining Methods Apriori, Eclat, FP growth, International Journal of Computer Techniques.
- Vanitha, K. and R. Santhi. 2011. Evaluating the performance of association rule mining algorithms, Journal of Global Research in Computer Science 2.6 : 101-103.
- Zaki, M. J., S. Parthasarathy, M. Ogihara and W. Li. 1997. New algorithms for fast discovery of association rules, KDD 97 : 283-286.
- Zaki, M. J. and K. Gouda. 2003. Fast vertical mining using diffsets, Proceedings of the Ninth ACM SIGKDD International Conference on Knowledge Discovery and Data Mining : 326-335.

NAMED DATA NETWORKING: AN EMERGING INTERNET PARADIGM

*Anjali^SGoyal, Anuj Sharma and R.K. Singla

Department of Computer Science and Applications, Panjab University, Chandigarh

Abstract

This paper introduces Named Data Networking (NDN) a.k.a Content Centric Networking (CCN) or Information Centric Networking (ICN) which is a new architecture for transferring information on Internet. This new paradigm changes the host-centric network architecture to data-centric network architecture. NDN focuses on what content the user wants i.e. named content rather than the position where it resides i.e. named hosts. In conventional architecture, IP Packets are used to find the information whereas in NDN Data/Interest Packets are used for same. NDN has various components i.e. Naming, Caching, Security, Routing and Forwarding etc. It uses hierarchical scheme for naming. In caching, IP handles same type of traffic conversely NDN caches heterogeneous type of traffic in one place which further improves content dissemination. Instead of securing the location/server where content resides, the security is embedded in the content itself. For Routing and Forwarding Interest Packet, router checks the content store (CS); if not available then maintains the state of all pending interest in Pending Interest Table (PIT), which is used to guide the data packets back to the consumer. Then the request comes to Forwarding Information Base (FIB), through this request goes to multiple routes with the help of Named-Data Link State Routing Protocol (NLSR). The new architecture has several benefits over conventional IP Architecture like in-network caching, enhanced security, fast data retrieval process and less latency.

Keywords: Architecture, Caching, Comparison, Future Internet Architecture (FIA), Routing and Forwarding, Named Data Networking (NDN), Named Data Object (NDO)

INTRODUCTION

In 1960's and 70's when architecture of current Internet was developed, an example of successful communication was Telephony which was based on TCP/IP protocol (which is basically point to point conversation between two entities). This model established communication pipes between the hosts through which they could communicate to each other, means conventional architecture was designed to centre around communication between hosts in the network. IP-Based network has some limitations i.e. Security, Caching, Scalability, Twostep mapping overhead, Content Mobility.In order to satisfy these needs, some overlay network architecture takes initiative to improve users information access like peer to peer (P2P) system (Bit Torrent), Content Delivery Networks (CDN) but as traffic is increasing for content distribution, more efficient solutions are needed. Thus NDN has been proposed for the Future Internet Architecture (FIA). NDN is based on 'What' rather than 'Where'; means Internet users will care more about what content they want rather than where the content resides (location independent). NDN is named content data ; and it has no idea of source and destination address. It changes the meaning of the network by delivering the packet based on the name rather than determining the destination address. NDN project aims to develop FIA that can capitalize on strengths and address weakness of the current host based network (point to point communication architecture) in order to naturally accommodate emerging pattern of communication [1]. In the subsequent section, we will study about the Architecture and details of two different packets (Interest and Data/Content Packet) handled in NDN. After that the main components of NDN like Caching, Routing and Forwarding and Also the Comparisons between the IP and NDN will discuss; which will aid the reader to find out the fundamental differences between the two.

NDN OVERVIEW

NDN (a.k.a ICN/CCN) is an alternative to the Current IP model or Current Internet Architecture. The NDN includes 16 NSF (National Science Foundation) funded principal investigators at 12 campuses and growing interest from the industrial and academic research communities [2]. It is based on Named content and each content name is composed of one or more variable length components [3]. Hour Glass Architecture : Both NDN and IP Architecture have hour glass shape shown in Figure [1] but content chunks replaces IP at the network layer, which means packet can name object rather than addresses. The hour glass architecture centres on a universal network layer (IP) which implements the minimal functionality for global interconnectivity [1]. Two more advancement in the Architecture of NDN: Routing and Forwarding Strategy and Security. Every chunk of data is uniquely named so that Interest packet can be forwarded using multiple path, removing the IP single best path forwarding strategy. Security must be built in to the architecture; NDN provides security by signing all named data in the data packet whereas in Conventional architecture security is provided to the Location/server and not to the content.



Fig. 1: Hour Glass Architecture

ARCHITECTURE OF NDN

Communication in NDN works on Pull Model. In NDN, the communication is started by the receiver (consumer) through the interchange of two types of packet: Content/Data Packet and Interest Packet. Both types of packet have name that can identify a piece of data [4]. A consumer puts the name i.e. Named data object (NDO) of the content in the Interest packet and sends it to the network [5]. Router sees the Interest Packet and forward in network. Once Interest Packet reaches the router that contains the NDO, then it will return content in Data packet that contains both the name, as well as signature too. A name can be human readable or a binary object. The signature attached to data object shows the name data integrity and authenticity for the security measures.

1) Detail Regarding Interest Packet and Data Packet:

Interest Packet: When a consumer wants some data then they send the name in the interest packet. Each interest packet has field name, selectors, nonce and Guiders/InterestLifetime. See Figure [2]

Name: NDN Name is a hierarchical name of variable length, which contains a sequence of name components. Selectors: It is an optional field which include Exclude filter (specify the component, when requested content come in Data Packet, the specified component exclude from the data packet), MinSuffixComponents(allows a data consumer to indicate the minimum number of component in the name), Max Suffix Components (allows a data consumer to indicate the maximum number of component in the name)[9], Publisher Public Key Locator (contain the hash of the producers public key for the requested content) [3] etc.

Nonce: It carries a randomly-generated 4-octet long bytestring [9]. The Name and Nonce combination should uniquely identify an Interest packet. For discarding the same data Nonce are useful.

Interest Lifetime: It is also optional field which includes

Interest Lifetime (time for the life of interest packet) and scope (limit the number of hops an interest can propagate)

Data Packet:When sources send content to the consumer, it sends the data in Data packet. Each Data packet has field

Interest Packet

Data Packet



Fig. 2: Different Fields of Packet

Name, MetaInfo, Content and Signature[10].See Figure [2]

Name: Same as the name in the Interest Packet. MetaInfo: MetaInfo contained the information like Content type, Freshness period etc.

Content: Content field include the data. With each name there is some data associated.

Signature: Signature computed over the entire content packet and through the signature receiver assured that the data is correct. Security feature is directly related with this field. It includes key locator (the key needed to verify the Content Signature).

2) Detail Regarding Componenets of NDN: See Figure[3]



Fig. 3: Different Components in NDN Router

Content Store (CS): Used for fast data retrieval and data caching.

Pending Interest Table (PIT): Store the information regarding the incoming interfaces of Interest Packet that are not satisfied yet [6]. It stores the information so that Data Packet can be delivered back to same path.

Forwarding Information Base (FIB): FIB is a table which consists of name prefixes and corresponding outgoing interfaces. Similarly in case of IP-Based Network, FIB also exists but in that IP address and next hop are specified.

WORKING OF PACKETS

1) Working of Interest Packet: When the request is coming from the requester (consumer) the request coming in the Interest Packet, it goes to the router. NDN router first checks the Content Store (CS) [6] if the data is present in the Content Store then it inserts the content in the Data packet and sends it to the Table (PIT). If the content is already requested by other consumer, then PIT table adds only the incoming interface in front of existing named content and request is not sent further because for this name content one



Fig. 4: Flowchart of Interest Packet

request has already gone in the network. With reduction in network traffic performance is increases. If data is not found in the PIT table then add the new entry in the PIT table i.e. insert the new row (content name and incoming interface) in the table and send request to the Forwarding Information Base (FIB). When the request comes to FIB, then depending upon the network, it decides whether to send request further or not. If the network is congested at that time or interest is suspected to be the part of Denial of service (DoS)[2] then the router will not send the interest packet further, i.e. it drops the interest packet. If the network is not congested at that time then it matches the name prefix with the longest name in the FIB table. On the basis of forwarding strategy, it is decided when and where to forward the request. It also sends the interest packet to multipath through which router suspect that the request can be fulfilled speedily. Figure [4] show the flowchart of the Interest Packet.

2) Working of Data Packet: The Data packet coming from one of the interfaces, router firstly finds the matching PIT entry with respect to named content. If the named content is not available in PIT table then



Fig. 5: Flowchart of Data Packet

the content is stored in content store and drop the data packet otherwise forward data to the incoming interfaces and remove the PIT entry respectively. Also save the data in the Content Store for increasing performance (response time less), so that if further the same request is coming from another requestor then there is no need to find the data from the producer. Figure [5] show the flowchart of the Data Packet.

The Interest Packet is forwarded hop by hop and Data Packet is also coming via the same path. There is more redundancy in NDN because it copies the content at each intermediate interface and for every request generated there is always one response. Overall NDN not only avoids network congestion and conflicts, it deals with content authenticity and integrity, get rid of dependence of end to end connection, Multihoming, mobility, flow balance/load balancing, security which improve performance and efficiency of larger scale content distribution.

 Example of NDN Message Flow: Suppose a consumer wants the data having name /obj1/obj2/wrd



Fig. 6: Example of NDN Message Flow

in Figure [6], it sends the Interest Packet having the name of the content to the Router A and router checks the Content Store. When the data is not available in CS then the entry(Name +Incoming Interface) are put in to the PIT and also searched for name in FIB (Name + Outgoing Interface) in which router finds the longest prefix match, then sent the request to next router B[7], same process is done by router B and then request is sent to Router C. When C checks its content store and data is available then it sends the Data Packet to the reverse path from where the packet is received with the help of PIT. When reverse path is followed by the Data Packet, then data saved at each intermediate router and PIT entry is removed. So the copy of data is saved at the router A and B also. When any requestor wants the same data then there is no need to go to C, the data is given directly from the Router A, so from this performance increases and also network traffic reduces [8].

NAMING SCHEME

Information/Data can be of any kind like video,



Fig. 7: Naming Scheme: Human readable content name

image, webpage etc. Everything in the Internet have some name. NDN uses unique name to pull content irrespective of host entity (address). It uses hierarchical naming scheme and that are application specific and also allow routing to scale. It allow user to fetch and distribute content directly using their names. NDN names are non-transparent to network i.e. router doesnt know the meaning on the names but they know the boundary between the components in the name. NDN name is human readable (Figure [7]) and may contain several components arranged in hierarchy that is delimited by '/' where IP uses fixed length[11].Similar to the current Internet lookup, users

in NDN will enter keywords with respect to some content they are looking for example: Figure [7] shows, if someone want to extract the content from Prof. Raj Jain, which belongs to the Washington University in St. Louis and want to extract the data about Computer Networks and the Internet and then this hierarchical name is used for this particular request. "cse:wustl:edu / ~ 'jain=cse473 - 11/i Icni", cse.wustl. edu is the globally routable name and $/\sim$ *jain=cse473* - 11 = is the organizational specified name and i 1cni is the segment of the name. In NDN architecture naming system is most important key component and still under active research area and the first open challenge is how to define and allocate the name, and, the second issue is that storing variable length name consumes high memory rather than IP addresses of fixed length. Example: If we have 6 components and each component have 5 character, then total memory consumed is 30 bytes which is more than IP address. So for resolving these issue, some researcher gives the solution for this: "Name Component Encoding" (NCE) Scheme It is a code allocation mechanism developed to achieve memory efficient encoding for the name components and State Transistion Arrays used to accelerate the longest name prefix matching criteria.

CACHING

To enhance the transmission efficiency of content dissemination, NDN offers caching mechanism. In

conventional IP-Based network, caching concept is also used but when multiple replica of the similar object are located in different servers then multiple URLs will be used to access the content owned by different content providers. So in that it will treat them as different object. But in NDN, no concept of IP address is used, so this problem is being solved. When any Interest Packet is coming, the NDN router first analyses the Content Store [2]. If the data is present in the CS, then data will be sent back to the consumer. Here content store acts like a buffer memory. The in-network Caching concept is used.

Some new features of NDN caching are Transparency, Ubiguity and Fine Granularity: Firstly Transparency, Conventional cache system is designed for only a particular traffic class but NDN provides cache infrastructure which are shared by different traffic class. Each application manages the cache space independently. The name content i.e. NDO is unified and Persistent. On the basis of unified content name, NDN make its decision of routing and caching. Secondly Ubiquity, in NDN cache is ubiquitous and the point where cache is done is no longer fixed. And lastly, Fine Granularity NDN technique is to divide large file into small self identifiable chunks. Instead of performing the caching to the large file, perform the cache on these units of chunks. First issue: there is neither experimental study nor analytical modelling of chunk level object popularity. By using, Caching and substituting at small level instead of large file with unified name, it is feasible to fetch distinct parts of same file from distinct nodes. This improves performance and maximizes space utilization.

Techniques for NDN Performance Optimization: Firstly, Caching Sharing Mechanism, distinct type of traffic shares the storage space of single cache node. If diverse type of traffic occurs then how to share limited resources efficiently?[12] Cache share mechanism can be fixed or dynamic. If we use fixed partition then two issues arise, first if distinct traffic class occur, then how to divide the space? Second, whether the similar partition ratio or distinct partition ratio should follow by each node, for different traffic the nodes can have changed partition ratio? For the former issue, dynamic feedback control theory used. For the latter, it is observed that VoD application requires less space than file sharing to achieve the hit ratio. Dynamic cache sharing: At particular time if the whole space of cache is not used by one traffic class, then any other traffic class can use it. Two strategies used: Priority based sharing and weighted fair sharing. In the first, it gives higher service priority to some applications. When any high priority object comes and wants some space in cache but there is no free space for that, then at that time the low priority objects from cache are abolished. If the traffic of high priority application enters at a constant rate, then it degrades the performance of low priority application. Weighted fair sharing increases space utilization. One traffic class share the cache space of other, if that space is not used at that instant. Secondly Policy for Cache Decision: it explains the object orientation in different cache nodes. In traditional web cache, it is possible to optimize object placement due to prior awareness of traffic requirement and network topology. NDN does not use the concept of permanent cache nodes. Also the traffic classes are distinct and line-rate operation occurs. One simplest approach is Leave Copy Everywhere (LCE) means at each intermediate node copy the object but this causes cache redundancy i.e. at multiple nodes similar object is copied. For increasing the value of cache system a) High Popularity contents are immediately pushed to the edge of the network, so that latency decreases and utilization of network resource increases. b) For reducing inter-domain traffic in the same ISP, we have to improve the entire network cache diversity; some schemes rather than LCE put the data in cache nodes. Move Copy Down (MCD): Remove the object from the hit node, where cache hit occurs and shift the object from the hit node to the straight downstream node and it reduces object redundancy. Leave Copy Down (LCD): This scheme only cache the object to direct downstream node, does not remove the object from the hit node. To pull the object down, several requests will do. Randomly Copy One (RCone): It copies the object at any one random node along the returning path, when cache hit occurs. Probabilistic Cache: with some probability the requested object copied at every node. Probability is inversely proportional to the distance from this node and the requestor node. Timing of Cache decision: The decision of cache need not to be taken only when a new object comes but also taken during cache replacement. Recent studies show that, the performance of simple random replacement algorithm and LRU are similar

ROUTING AND FORWARDING

In the conventional IP architecture, the whole concept of routing and forwarding depend upon IP address. But in NDN, the packets are forwarded and routed on the basis of name rather than address. So the problem of address space exhaustion, scalable address management, mobility and NAT traversal are eliminated. In NDN, router exchange routing update with other routers and make FIB based upon receiving routing announcement. Router forwards the Interest Packet following the FIB. Routing security is an improvisation in NDN. First, data which is coming from the producer is all signed which shows that it prevents from intruder interception. Second, Prefix hijacking reduces with Multipath routing because router may identify the anomaly caused by prefix hijacking [2] and retrieve the data using other path. Third, its very difficult to forward a malicious data to a particular target because it talks only about data not the address of the host. In this the main issue is to make high-speed forwarding engine and scalable routing that can handle the traffic efficiently.

For the Scalable Routing, two main issues are a) how multipath Forwarding should be enabled to spread interest more efficiently? b) While allowing an unbounded name space in NDN, how bounding the amount of routing state (for scaling purpose)? So for solving the former issue, to prevent loops IP Router find the best way but NDN Router send an Interest Packet to multiple interfaces and cannot make loop, since the name plus nonce (randomly generated number) in the interest packet efficiently identify duplicated. Also Data packet does not loop because they take reverse path of Interest Packet. For the latter issue, extending existing routing protocol (OSPF, BGP) so that they also work on name prefixes (rather than IP) and multipath forwarding of interest[13]. For the Fast Forwarding Engine, the three mandatory requirements are: [14] a) Variable length, hierarchical name: NDN finds the longest matching name prefix (variable length) in the FIB and sends the Interest to the next router. B) Fast update to prefix table: Prefix table (PIT, FIB, CS) must support quick insertion, deletion and modification when Interest/Data packet arrives. C) Very High Capacity: the capacity of content store should be high with respect to the size of packet. OSPFN is one of the Routing Protocol which works on name Prefix rather than IP address but it only find the single best path for forwarding. A new Protocol introduces Named-Data Link State Routing(NLSR) protocol which basically works on name Prefix as well as finding the multipath with the help of Dijkstras algorithm. With this Intradomain Routing Protocol, transmission efficiency of content dissemination increases.

COMPARISON BETWEEN IP AND NDN

Both architecture using hour glass shape for the architecture, but in the NDN IP is replaced by Content

NAMED DATA NETWORKING

NAMED DATA	CONVENTIONAL	
NETWORKING(NDN)	ARCHITECTURE(IP)	
Future Internet Architecture	Current Internet Architecture	
Data Centric Network Architecture	Host Centric network Architecture	
"What"	"Where"	
Router Content Cache	No Router Content Cache	
Address Space and NAT Demolish	Address Space and NAT used	
3 Entities Maintained	1 Entity Maintained	
FIB,PIT,CS	FIB	
FIB Stores multiple hop Status information	FIB Store only next hop Status information	
New Routing Protocol NLSR based on name prefix	Existing Routing Protocols based on IP Address	
Name prefixes are of variable length arranged in hierarchy delimited by '/'	IP address is of fixed length	
Secure the data	Secure the container	
In-network Caching and Cache shared infrastructure	No Concept of In-network Caching and Cache shared infrastructure	
Optimization of bandwidth, congestion reduction with improved throughput	No Optimization of bandwidth, congestion often occur	

Fig. 8: Comparison between NDN and IP

Chunks[15]. IP address is of fixed length (32bits in IPv4 and 128 bits in IPv6), but in NDN the Name prefixes used which are of variable length arranged in hierarchy delimited by '/'. NDN routers are able to reuse the data since they are identified by persistent name but IP router cannot reuse the data after forwarding them i.e. IP has stateless data plane and but NDN has stateful data plane. Figure 8, Differeniate these two Architectures.

CONCLUSION

The recently proposed Named Data Networking (NDN) architecture highlights number of advantages in support of "What" not "Where" compared to the existing Internet infrastructure. It enhances the security feature. The data in the packet sent by the content provider is signed and this shows that the received data is correct. NDN removes the overhead of address and also increase the Performance with In-Network Caching mechanism. But instead of this, large number of open challenges in NDN are the following; Removing Redundancy in the router instead of using Leave Copy Everywhere (LCE) method for Caching; the methods used for hierarchical naming scheme; Size of cache and many more. So in the future, we will work on these challenges and find justifiable solutions for these issues.

REFERENCES

- [1] "Named Data Networking: Executive Summary," Named Data Networking. Available: http:// named-data.net/project/execsummary/. [Accessed: February 28, 2016].
- [2] Zhang, Lixia, et al. "Named data networking." ACM SIGCOMM Computer Communication Review 44.3 (2014): 66-73.
- [3] Gasti, Paolo, et al. "DoS and DDoS in named data networking." Computer Communications and Networks (ICCCN), 2013 22nd International Conference on. IEEE, 2013.
- [4] Yi, Cheng, et al. "Adaptive forwarding in named data networking." ACM SIGCOMM computer communication review 42.3 (2012): 62-67. Fig. 8. Comparison between NDN and IP
- [5] Yi, Cheng, et al. "A case for stateful forwarding plane." Computer Communications 36.7 (2013): 779-791.
- [6] L. Zhang, A. Afanasyev, J. Burke, V. Jacobson, K. Claffy, P. Crowley, C. Papadopoulos, L. Wang, and B. Zhang, "Named Data Networking," Available: http://named-data. net/publications/techreports/tr001ndnproj/. [Accessed: February 28, 2016].
- [7] Tong, Junjie, Renjie Pi, and Ke Xu. "Cloud computing infrastructure based on named content." Pervasive Computing and Applications (ICPCA), 2011 6th International Conference on. IEEE, 2011.
- [8] Dolvara Gunatilaka, "Recent Information-Centric Networking Approaches," Available: http:// www.cse.wustl.edu/ jain/cse570-13/ftp/icn/. [Accessed: February 28, 2016].
- [9] "NDN Packet Format Specification, Interest Packet, Named Data Networking. Available: http:// named-data.net/doc/ndn-tlv/interest.html. [Accessed: February 28, 2016].

- [10] "NDN Packet Format Specification, Data Packet, Named Data Networking. Available: http://named-data.net/doc/ndn-tlv/data.html. [Accessed: February 28, 2016].
- [11] Saxena, Divya, and Vaskar Raychoudhury. "Radient: Scalable, Memory Efficient Name Lookup Algorithm for Named Data Networking." Journal of Network and Computer Applications (2016).
- [12] Zhang, Guoqiang, Yang Li, and Tao Lin. "Caching in information centric networking: a survey." Computer Networks 57.16 (2013): 3128-3141.48 Proceedings of CHASCON-2016, DCSA, PU Chandigarh.
- [13] Bari, Md Faizul, et al. "A survey of naming and routing in informationcentric networks." Communications Magazine, IEEE 50.12 (2012):44-53.
- [14] Mohan Li, "Recent Advances in Named Data Caching and Routing," Available: http://www. cse.wustl.edu/jain/cse570-13/ftp/ndnrc/index. html. [Accessed: February 28, 2016].
- [15] Choi, Jaeyoung, et al. "A survey on contentoriented networking for efficient content delivery." Communications Magazine, IEEE 49.3(2011): 121-127.

FREQUENT PATTERN MINING BASED SYSTEM FOR EFFICIENT ANOMALY DETECTION

Rohini Sharma

Department of Computer Science and Applications, Panjab University, Chandigarh-160014

Abstract

Frequent Pattern Mining is a widely used approach for detecting associations between attributes and these associations can be analysed to find out anomalous behaviour in network traffic data. The traffic data is quite voluminous which requires high processing time as well as storage space for storing the data. Moreover the frequent patterns generated are also very large in number. The whole process can be made efficient if somehow it is possible to decrease the volume of data before applying frequent pattern mining and also the volume of generated rules obtained by the mining process. In this paper, a system has been proposed to increase the efficiency by introducing the concept of pre-mining and post-mining. Pre-mining can decrease the volume of data captured by reducing it vertically through feature selection and horizontally through sampling. Similarly the rules generated after mining can be pruned to retain only those rules which are significant enough to detect anomalies. Different approaches proposed and used by authors for vertical reduction, horizontal reduction, mining, pruning and how these approaches can increase the efficiency of the system, have been discussed.

Keywords: Frequent Pattern Mining, Anomaly Detection, Associations, Pruning.

INTRODUCTION

In the fast growing world and technology, almost each and everything is connected by some kind of network. It was started from ARPANET and moving towards Internet of Things. Networking is something which is going to stay forever probably. Initially it was network of computer systems now it is networking of things be it a computer system, a vehicle or a stick. Things include virtually everything. In any kind of network, security is an important issue. Dictionary definition of Network Security is protection of the access to files and directories in a computer network against hacking, misuse and unauthorized changes to the system. Various intrusions in the form of attacks and threats initiated by hackers and unauthorized users can decrease the utility of networking. Such intrusions are taken care of by commercial Intrusion Detection Systems. Intrusion Detection Systems can be divided into two categories: Signature based IDS (SIDS) and Anomaly based IDS (AIDS). In SIDS, signatures of known intrusions are maintained in a database and these signatures are used to detect attacks in the data. Slight variations from the signatures can also be detected by employing machine learning techniques. These systems produce very low false positives but cannot detect novice attacks. In AIDS, user's/network's normal behaviour is modelled and any variation from the normal behaviour is treated as an intrusion. Various machine learning techniques are used to model the normal behaviour.

In this paper, focus is on Anomaly based Intrusion Detection. To model the normal behaviour of the user/network, various data mining techniques are employed in literature. Frequent Pattern Mining (FPM) is an important technique widely used in varied fields of computer science and allied subjects for generating attributes having associations. Various authors have applied Frequent Pattern Mining over network traffic data to generate frequent patterns which represent anomalous flows. But a complete framework is missing. Network traffic data generated by a network is continuous and voluminous. To handle large volume of continuous data some kind of preprocessing is mandatory which should decrease the volume but at the same time the resultant data should be a representative of the whole traffic data. The reduction of data is possible horizontally as well as vertically which decreases the resource requirements as well as the time required to process data. Vertical Reduction is possible by selecting significant features out of the complete feature set. Horizontal Reduction is possible by selecting significant records out of the complete traffic data records. Sampling is an important and widely used technique for horizontal reduction which decreases processing as well as storage cost. However it is a tradeoff between cost in terms of resources and time and accuracy. As we decrease the volume using preprocessing the cost in terms of resources and time will also decrease but it may affect

*Corresponding Author: *rohini@pu.ac.in* MS received: November 10, 2016; Accepted: November 23, 2016

the accuracy of results obtained. If no preprocessing is applied, the accuracy will be maximum but it will also maximize the cost. After preprocessing and getting the representative data, frequent pattern mining can be applied to generate frequent patterns on the basis of which the normal behaviour of the user/network can be modelled. The framework can be constrained to detect anomalies by generating frequent patterns for normal data and comparing the frequent patterns generated for testing data with the frequent patterns of normal data. The frequent patterns which are not found in the normal data represents anomalous flows which can be studied further to extract anomalies. The frequent patterns generated by FIM technique are also very large in number in which some patterns may be significant and some may not. To decrease the cost of processing further these patterns can be pruned and only significant patterns can be taken further for comparison with the patterns generated for normal data. A framework is proposed in this paper which uses pre-mining before applying FIM and post mining after the FIM generated patterns in order to decrease the overall cost of generating and processing frequent patterns. The architecture proposed employs FPM effectively and efficiently for anomaly detection which focuses on extracting traffic records and meaningful features from highly voluminous data before applying FPM and again applying pruning techniques to the generated rules for extracting significant rules from large number of rules generated. It is advocated that by decreasing the volume of data in the beginning and the volume of rules at the end will increase the efficiency of anomaly detection.

In this paper, Section 2 will give an overview of related concepts required to understand the framework. Section 3 discusses various phases of the proposed framework and analysis of the techniques used in these phases. Section 4 draws the conclusion of the paper.

RELATED CONCEPTS

2.1 Feature Selection

Feature Selection is the process of selecting a subset of relevant features or attributes for further analysis. It helps in simplifying the process and decreasing the processing cost as well as storage requirements. The motivation behind feature selection is that some of the features are irrelevant or redundant and removing such features which are having little effect on the output will keep the size of the dataset small. Irrelevant features are not of any use for the process under study and redundant features give the same information content given by other features. Feature Extraction is a different process which focuses on creation of new features as a function of existing original features. Feature extraction, if required, is to be done before feature selection. It depends on the data to work upon. Feature selection techniques are categorised into three classes (Guyon et. al., 2003):

- Filter Methods: These methods apply statistical measures to the features and rank them according to the score obtained. According to the score, some features are kept and some are removed. These methods do not depend on the model chosen for classification. Chi-Square test, Information gain are some of the filter methods used.
- Wrapper Methods: These methods treat features selection as a search space problem. Different combinations of features are created, evaluated and then compared. High computation cost is involved in these methods.
- Embedded Methods: These methods are coupled with the classification model as the model is being created. LASSO is an example of embedded methods.

The methods which are based on linear models are not suitable for traffic data as it contains mixed type of attributes: numerical, categorical as well as hierarchical. (Iglesias et. al., 2014).

2.2 Sampling

Sampling is the process of choosing elements from the total population in such a way that the results obtained for the chosen sample generalizes back to the total population. Various traditional approaches which are used to sample network traffic data:

 Systematic Sampling: In this technique the elements in the population can be arranged systematically and first element is picked at random. After the first element all the other elements are picked automatically in a definite sequence at equal spacing from each other.

• •

 Random Sampling: In this technique each element in the population has equal probability of being selected. It is the most suitable approach of sampling which eliminates any kind of biasing but this technique requires the population to be complete. For real time data this method may not be suitable.

Stratified Sampling: This technique is suitable for heterogeneous kind of population. The population is divided into subgroups called strata and elements are chosen from these stratums in such a way that number of elements chosen from each stratum may or may not be proportional to the size of the stratum. Moreover the strata are made in such a way that all the elements in a stratum are quite similar to each other but are quite different from elements of other stratums. Similarity is measured on the basis of variability of interest.

The traditional approaches of sampling are not suitable for network traffic data with an exception of stratified sampling due to following reasons (Mahmood et. al., 2010):

- The traffic data is skewed. It may contain large number of data records for one type of attack where as for another type of anomaly it may contain comparatively less number of records
- Network traffic data is continuous real time data.
- 2.3 Frequent Pattern Mining (FPM)

The basis of FPM is to find frequent itemsets from the given database in order to conclude the associations between the items. A famous example is market basket analysis. Customers are buying number of items from market and certain items are having associations with other items. For eg. Whenever a customer buys Jam, he normally buys bread also. If this is the case then an itemset containing two items: Jam and Bread will be frequent in the database. Various algorithms are proposed in literature for frequent pattern mining and many of these are applied over network traffic data for extracting useful frequent patterns among the traffic data attributes. The algorithms Apriori, FP-Growth, Eclat, SaM and RElim(Ignasi et. al., 2013) are the bechmark algorithms used for frequent pattern mining.

In Apriori Algorithm (Agrawal et. al., 1993), two concepts are used to include or exclude a frequent pattern: Support and Confidence. Support is the number of transactions containing the frequent pattern. It can be modelled as the formula given for S which keeps the value of S between 0 and 1. Confidence is the measure that how many transactions which contain first item also contain second item in the itemset. It can also be measured as the formula given for C which again keeps the value of Confidence between 0 and 1.

S = number of transactions containing frequent pattern

Total number of transactions

C = Number of transactions containing both the items in the itemset: Antecedent as well as Consequent

Number of transactions containing only first item ie. Antecedent of the rule

In this algorithm, the whole database is traversed first to find out all the frequent-1 patterns ie. those patterns containing only one item and these patterns are frequent which means the support (S) of those patters is greater than minimum support (MinSup) of the system. Now frequent-i+1 patterns are created from frequent-i patterns by combining those frequent-i patterns which are having same items at position 1 to i-1. Frequent-i+1 pattern is created by including all the items in frequent-i patterns at position 1 to i-1 then including ith item in first frequent-i pattern at ith position in new frequent-i+1 pattern and ith item in second frequent-i pattern at i+1th position in new frequent-i+1 pattern. The support of the new frequent-i+1 pattern is generated by traversing the database again looking for i+1 items in each transaction. If total n unique items are there in the database with m transactions then in the worst case it requires 2ⁿ scans of the database.

In FP-Growth (Han et. al., 2000), FP-tree is used for storing information about frequent patterns in a very compact way so multiple scans of the database are avoided. First all the items are arranged in an order of their respective frequencies and an FP-tree is built with root labelled as null, item prefix subtrees as children at first level and a frequent item header table. Item prefix subtrees contain item name, count and node link which points to the next node in the tree containing same item name or null. Frequent item header table contains item name and head of node link. Then frequent pattern growth method is used which avoids candidate generation but applies a partitioning based divide and conquer method which subsequently decreases the size of the conditional patterns and FP-trees. Conditional pattern base is generated by analysing the paths in the FP-tree corresponding to the item whose conditional pattern is to be found. Conditional FP-tree is made and the process is repeated until all the frequent patterns are found. This method avoids scanning the whole database again and again but space requirement is quite high for storing all the conditional FP-trees.

In EcLat (Zaki et. al., 1997), vertical layout is supported. TransactionIds of the transactions, in which the elements occur, are made associated with those elements by scanning the whole database. Now no more scanning of database is required as to get (k+1) frequent pattern, the transactionId lists associated with k frequent pattern and the new element are to be intersected.

SaM (Borgelt et. al., 2010) technique is based on the concept of Split and Merge. Horizontal representation of transactions is sufficient for finding frequent patterns. In this technique first all the items in each transaction are ordered according to their frequency in the database and then all the transactions are sorted and represented in the form of a tree. Now all the transactions with same leading item are separated from the rest of the list. The leading item is removed and reported if it is frequent and the other elements are again made to go through the same procedure in order to find out all the frequent patterns containing the leading element. The procedure is again called for the rest of the list which was obtained by deleting the items containing same leading element and process goes on until all the frequent patterns are found. Certain optimizations are also proposed by the authors to improve its performance compared to Apriori, FP-Growth and Eclat. SaM uses very simple data structures and processing scheme and is faster than other algorithms but for sparse transaction database it may not perform well.

RElim (Borgelt, et. al., 2005) uses the concept of conditional patterns used in FP-Growth but does not use frequent pattern tree. The method also starts with finding frequencies of various items, arranging all the items in all the transactions in increasing order and then the transactions are arranged in increasing order. A leading items list is created with each item pointing to a sub-list containing other elements in the transactions having same leading element. The method starts from the last element in the list which is also the least frequent one. The last element in the leading items list is deleted with all the records in its sub-list (which do not contain the leading item) assigned to an empty list and also combined with the rest of the leading items list. The removed leading element is reported if it is frequent and the sub-list which acts as a conditional database for the removed leading element is made to go through the same process until all the frequent item sets containing the leading element are found. The updated leading element list is also processed in the same way again in order to find all the frequent patterns available in the transaction database.

2.4 Pruning

Association rules generated are quite large in number. Pruning these rules and keeping only significant ones will reduce false positives to a great extent. When a frequent pattern is not representing an anomaly but it is misclassified as an anomaly, it is called a false positive. Similarly when an anomalous pattern is misclassified as a normal pattern, it is called false negative. Similarly true positive and true negatives are also defined. Pruning of association rules or frequent patterns has not been studied in literature extensively specially in Network Traffic applications but it can be of great help in improving the efficiency of an anomaly detection system.

PROPOSED SYSTEM FOR ANOMALY DETECTION

The proposed system for anomaly detection consists of three layers: Pre-mining, Mining and Post-mining. Diagrammatic version is shown in Figure 1 and Figure 2. Pre-mining and post mining are normally not used while generating patterns for anomaly detection but these steps certainly increases the efficiency of the system. Pre-mining decreases the amount of data to be handled in the next layer. The voluminous data can be reduced horizontally as well as vertically. Horizontal reduction means to reduce the number of records and it can be achieved by applying sampling techniques. Vertical reduction deals with removing certain attributes or adding some useful attributes which are statistical functions of existing attributes. Vertical reduction can be achieved by applying feature selection techniques. After the pre-processing step is over, refined dataset is given to the Mining layer for generating useful frequent patterns. In this layer one or more mining algorithms are applied to generate patterns. Various frequent pattern mining algorithms are proposed and used in literature. Five popular and widely used algorithms are: Apriori, FP- Growth, Eclat, SaM and RElim as discussed in Section 2.3. The frequent patterns generated by the mining layer can be very large in volume. In the Post-mining step pruning technique is applied to the generated frequent pattern set for pruning insignificant rules which results in only significant rules on the basis of which anomalies can be detected.



Fig. 1: Anomaly Detection

3.1 Pre-Mining

It can also be termed as pre-processing which is not given due importance in existing literature for frequent pattern mining. In data reduction, curse of dimensionality is handled by selecting relevant features or deriving new features from existing ones. Number of records is also reduced in the data reduction step.



Fig.2: System Design

3.1.1 Vertical Data Reduction

Existing relevant features are selected along with new relevant features which can be derived from the existing ones. A traffic record obtained can be termed as an n-feature tuple. These n-feature tuples may be representing packet header attributes extracted from packet headers passing through the network or flow records where each flow record represents a connection. Flows are sequence of packets in one direction sharing certain attributes like SourceIP, DestinationIP, SourcePort, DestinationPort, Protocol. Onut et. al. (2007) have identified three categories of features: Basic features extracted from packet header or payload, Single Connection Derived (SCD) features related to a particular connection and Multiple Connection Derived (MCD) features which are related to multiple connections. Netflow is a common standard used to capture flow information. IPFIX (IP Flow Information Export) (Claise et. al., 2013) is the future standard for capturing flow information. The flow records can be monitored over a period of time and applying statistical measures, new features can be created like average inter-packet arrival time, mean packet length etc. Ramadas et. al. (2003) derived various new features for detecting anomalies in the network. Among the derived features important ones are session has valid start?, connection closed properly?, number of gueries per second, average size of gueries, average size of answers, duration of connection etc. Self Organizing maps (SOM) are used to create models for each data segment where data segments are created by segmenting the original data according to service type and application protocols. Iglesias et. al. (2014) stressed upon removing strongly correlated, redundant and irrelevant features as it improves detection guality. NSL-KDD 2009 (tavallaee et. al., 2009) dataset is used and out of 41 original feature vectors, only 16 are selected for further analysis without anomaly detection power degradation. This is achieved by ranking and selecting network traffic features using WMR, MRMR, SAM, LASSO, Stability Selection and stepwise regression filter techniques. Then refinement of the selected features set is done using brute force search using backward elimination and forward selection. The results obtained are evaluated using various classifiers and Accuracy, Precision, Recall and AVC features are used to measure the performance of selected features set for the classifiers used. Cost associated with feature generation is used to show costly features which can be eliminated.

Syarif et. al. (2012) implemented feature extraction using Principal Component Analysis and Independent Component Analysis; feaure selection using Genetic Algorithm and Particle Swarm Optimization. Authors have also implemented four machine learning algorithms (Naive Bayes, Decision Tree, Nearest Neighbout and Rule Induction) for misuse detection and applied ensemble algorithms (bagging, boosting and stacking) for improving the performance. For anomaly detection four unsupervised clustering algorithms (K-Means, K-Medoids, EM clustering and distance-based outlier detection) are implemented. It is concluded that Nearest Neighbour classifier with Particle Swarm Optimization give best results for misuse detection and distance based outlier detection gives best results for anomaly detection. Imran et. al. (2012) proposed a system for Intrusion Detection in which Linear Discriminant Analysis is combined with Genetic Algorithm to make a hybrid approach for transforming features into a new feature space called linear feature space and selecting optimum set of features then RBF technique is applied for classifying the traffic data into two classes: normal and intrusive. NSL-KDD dataset is used for experimentation. Davis et. al. (2011) provided a comprehensive review of the techniques used for preprocessing the traffic data used by anomaly based Network Intrusion Detection Systems (NIDS).

Various techniques like Statistical features, Entropy, Association Mining, Protocol specific preprocessing, z-score normalization, wrapper based feature selection, Markov blanket feature selection etc are used by various authors for selecting and extracting features from traffic data set. Features derived from packet payload rather than from packet header are more suitable for detecting anomalies but they are computationally expensive. Moreover the context of anomaly detection should be limited which stimulates deeper network traffic inspection. Principal Component Analysis (PCA) is a widely used technique for KDD Cup 99 dataset. Feature selection has not been used for pattern extraction using association rule mining but it does offer advantages in terms of reduced volume which leads to reduced processing.

3.1.2 Horizontal Data Reduction

The traffic dataset which is very large in volume can be reduced horizontally which means selecting records from the complete dataset. Sampling is used to select a subset of records which should be a representative of the whole traffic records ie. information inferred

from this subset of records should stand correct for the whole traffic data. Zesby et.al. (2009) have discussed various sampling techniques which are used to sample packet records which includes Systematic Sampling, Random Sampling, Stratified Sampling etc. Out of these sampling techniques stratified sampling is the most representative sampling technique as far as network traffic data is concerned as it first divides the whole data into stratas according to the stratification attribute and then samples are taken from these stratas but is guite time consuming and complex as stratas are needed before sampling records. Various researchers have proposed and tested number of techniques for decreasing the volume of dataset in a way which does not affect the information content. Fernandes et. al. (2008) used two approaches for applying stratified sampling to decrease the volume of dataset. In the first approach limits for stratifying are defined manually and in the other approach Cluster Analysis using CLARA and K-means techniques is used to create clusters or stratas with limits set automatically. Flow duration is used as stratifying variable for classifying flows. Records are extracted from these stratas according to Neyman method and results are checked using stratification gain metric.

Silva et.al. (2013) have proposed MuST-a multiadaptive sampling technique based on linear prediction. Sample size and Interval between samples are self adjustable parameters which are adjusted according to the behaviour of the packets belonging to previously collected samples instead of the whole network traffic. Next sample size and the next interval between samples is increased or decreased depending upon the increase or decrease in the network activity for detecting new traffic patterns which increases efficiency. The adjustable parameters are also bounded by thresholds for preventing them from increasing or decreasing indefinitely. Mahmood et.al. (2010). proposed and tested a two stage sampling scheme which can identify rare patterns in the traffic in an effective manner. Most of the sampling techniques ignore rare traffic patterns as the traffic data is skewed containing large number of traffic records representing few common attacks. These rare patterns are important as many problems are started small and with time it increase. If these problems can be found in the start only it will increase the effectiveness of the system. In the first stage, traffic records are sampled with a probability p1. The sampled records are matched with the previous frequent patterns which are stored in a buffer. If a record does not matches with the buffer

records then it is a new pattern and is passed to clustering process. If the record matches with a buffer record then it is sampled with second probability p2 in the second stage. If at second stage again that record is sampled then it is passed to the clustering process otherwise it is ignored. Second probability depends on the number of records which match with the buffer. If large number of records matches, p2 is to be kept small otherwise it is kept large in order to include more records. Therefore, as far as network traffic data is concerned which is a skewed distribution, stratified sampling or its variant is more suitable. Moreover the sampling size and sampling interval should be dynamic and varying in order to get a more representative set.

3.2 Mining

This is the central phase of the system which does the mining part and produces frequent patterns which can further be represented as association rules. After reducing the highly voluminous data vertically and horizontally, association rule mining can be applied to the sampled data for finding frequent patterns in the traffic data. These frequent patterns can be very useful. to find out anomalies in the traffic. Paredes-Oliva et.al. (2013) proposed and tested a traffic profiling system FaRNET which is based on Frequent Itemset mining for discovering traffic heavy hard hitters more efficiently than AutoFocus as more dimensions of Netflow data are used. First the Netflow data is randomly sampled and then any of the two techniques: Flat FIM and Hierarchical FIM can be applied according to the results required. In Flat FIM five algorithms: Apriori, FP-Growth, Eclat, SaM and RElim are used and evaluated to find out frequent patterns. In Hierarchical FIM, three expansion techniques: Full Expansion, Progressive Expansion and Progressive Expansion k-by-k are implemented and evaluated. In these expansions, a hierarchical attribute is expanded either fully with items expanded with its corresponding ancestors or an attribute is expanded progressively. This expansion helps in finding out a subnet under attack rather than a specific IP address.

Li et.al. (2010) designed a sliding window model to process stream network traffic data generated using NetFlow. Each sliding window has multiple basic windows. A tree structure is used to store the frequent patterns level by level. As a new basic window arrives, its frequent patterns are found out and appended to the tree structure deleting the entry for first basic window which is the oldest one in the sliding window. Four algorithms based on vertical mining are proposed and implemented for finding frequent patterns. The authors have supposed that new multi-patterns combining all old frequent-1 patterns and combining old and new frequent-1 patterns will not happen, otherwise list of Transaction ids is required for all frequent-1 patterns and rest of the patterns will have to be generated from these frequent-1 patterns which are quite time and space consuming.

Brauckhoff et. al. (2012) proposed an approach for extracting anomalies in which five histogram based anomaly detection techniques are used to generate metadata like range of IP addresses or ports. The metadata generated by these five techniques are combined using union operator. This combined metadata is used to filter anomalous flows or records from testing data and then association rule mining is applied on this filtered data to generate summarized item-sets. Anomalous flows are not only detected but particular anomalies are also extracted manually. Five types of anomalies: flooding, backscatter, network experiment, DDoS, scanning and spam are handled. Wang et.al. (2004) proposed Mining Maximal frequent itemsets for Intrusion Detection (MMID) which works on topdump data. In this system, maximal frequent itemset technique is used over attack free training data to set profile of system's and user's normal behaviour. Same technique is used for training data containing attacks to model the attacks. Then the same technique is used for the testing data stream and the patterns generated are labelled as normal, intrusive, suspicious or infrequent. Whatever technique is to be used it should be well adapted to streaming data as network traffic data is continuous voluminous data and sliding window is a common way used to handle streaming data. The features of traffic data are mixed which includes numerical, categorical as well as hierarchical. The underlying structure of categorical and hierarchical features can be used and elaborated further for generating generalized rules.

3.3 Post Mining

After the mining phase is over, the last phase or postmining further reduces the generated patterns by keeping only the significant ones.

3.3.1 Pruning

After the frequent patterns are generated, the insignificant patterns can be pruned in order to decrease the number of patterns finally used for anomaly detection. This increases the efficiency of the

system as fewer patterns need to be analysed now. The volume of patterns generated can also be decreased by summarizing rules to an abstract level or rules can be clustered on the basis of different dimensions in order to generalize them further. Namik et.al. (2011) studied the use of Chi-Square computation techniques for pruning the insignificant association rules. Using Chi-Square techniques the statistical significance of association rules are determined and this statistical significance of a rule or the degree of dependence between two variables determine the inclusion or exclusion of a rule. More pruning techniques are available in literature but as far as our knowledge, these have not been applied on network traffic data generated association rules as yet. Pruning can definitely decrease the cases of false positives and also decreases the processing cost and hence increases the efficiency.

CONCLUSION AND FUTURE WORK

This paper has proposed a system for anomaly detection which is based upon frequent pattern mining. The efficiency of the system is increased by reducing the captured data using feature selection and sampling ie. the data is reduced vertically and horizontally before applying mining. For feature selection, correlation and dependencies between attributes can be used to select significant features ignoring the irrelevant ones. For horizontal reduction, stratified sampling or its variant is a suitable technique for network traffic data because of its skewed nature. Sliding window model makes the handling of streaming data easier. Five benchmark algorithms Apriori, FP-Growth, Eclat, SaM and RElim have their own advantages and disadvantages and are suitable for network traffic data. Other Frequent Pattern Mining algorithms are there which can be used and tested for mining phase. Pruning is not much used in literature for selecting significant rules but it definitely increases the efficiency of the system by selecting only significant patters which can be analysed for anomaly detection. Different other techniques can be applied and tested for pruning insignificant rules.

REFERENCES

- Agrawal, R., T. Imieliñski and A. Swami. 1993. Mining association rules between sets of items in large databases. In ACM sigmod record 22(2): 207-216.
- Borgelt, C. 2010. Simple algorithms for frequent item set mining. In Advances in machine learning II, Springer Berlin Heidelberg: 351-369.
- Brauckhoff, D., X. Dimitropoulos, A. Wagner and K. Salamatian. 2012. Anomaly extraction in backbone networks using association rules. IEEE/ACM Transactions on Networking (TON) 20(6): 1788-1799.
- Brin, S., R. Motwani, J. D. Ullman and S. Tsur. 1997. Dynamic itemset counting and implication rules for market basket data. In ACM SIGMOD Record 26(2): 255-264.
- Claise, B., B. Trammell and P. Aitken. 2013. Specification of the ip flow information export (ipfix) protocol for the exchange of flow information (No. RFC 7011).
- Davis, J. J. and A. J. Clark. 2011. Data preprocessing for anomaly based network intrusion detection: A review. Computers & Security 30(6): 353-375.
- Fernandes, S., C. Kamienski, J. Kelner, D. Mariz and D. Sadok. 2008. A stratified traffic sampling methodology for seeing the big picture. Computer Networks 52(14): 2677-2689.
- Guyon, I. and A. Elisseeff. 2003. An introduction to variable and feature selection. Journal of machine learning research 3: 1157-1182.
- Han, J., J. Pei and Y. Yin. 2000. Mining frequent patterns without candidate generation. In ACM Sigmod Record 29(2): 1-12.
- Iglesias, F. and T. Zseby, T. 2015. Analysis of network traffic features for anomaly detection. Machine Learning 101(1-3): 59-84.
- Imran, H. M., A.B. Abdullah, M. Hussain, S. Palaniappan and I. Ahmad. 2012. Intrusions detection based on optimum features subset and efficient dataset selection. International Journal of Engineering and Innovative Technology 2(6): 265-270.

- Li, X. and Z. H. Deng. 2010. Mining frequent patterns from network flows for monitoring network. Expert Systems with Applications 37(12): 8850-8860.
- Mahmood, A. N., J. Hu, Z. Tari, and C. Leckie. 2010. Critical infrastructure protection: Resource efficient sampling to improve detection of less frequent patterns in network traffic. Journal of Network and Computer Applications 33(4): 1491-502.
- Marnerides, A. K., A. Schaeffer-Filho and A. Mauthe. 2014. Traffic anomaly diagnosis in internet backbone networks: a survey. Computer Networks 73: 224-243.
- Namik, A. F. and Z. A. Othman. 2011. Reducing network intrusion detection association rules using Chi-Squared pruning technique. 3rd Conference in Data Mining and Optimization, IEEE: 122-127.
- Onut, I. V. and A. A. Ghorbani. 2007. A Feature Classification Scheme For Network Intrusion Detection, IJ Network Security 5(1): 1-15.
- Paredes-Oliva, I., P. Barlet-Ros and X. Dimitropoulos. 2013. FaRNet: Fast recognition of highdimensional patterns from big network traffic data. Computer Networks 57(18): 3897-3913.
- Ramadas, M., S. Ostermann and B. Tjaden. 2003. Detecting anomalous network traffic with self-organizing maps. International

Workshop on Recent Advances in Intrusion Detection, Springer Berlin Heidelberg: 36-54

- Syarif, I., A. Prugel-Bennett and G. Wills. 2012. Data mining approaches for network intrusion detection: From dimensionality reduction to misuse and anomaly detection. Journal of Information Technology Review 3(2): 70-83.
- Silva, J. M. C., P. Carvalho and S. R. Lima. 2013. A multiadaptive sampling technique for costeffective network measurements. Computer Networks 57(17): 3357-3369.
- Tavallaee, M., E. Bagheri, W. Lu and A. A. Ghorbani. 2009. A detailed analysis of the KDD CUP 99 data set. In Proceedings of the Second IEEE Symposium on Computational Intelligence for Security and Defence Applications.
- Wang, H., Q. H. Li, H. Xiong and S. Y. Jiang. 2004. Mining maximal frequent itemsets for intrusion detection. International Conference on Grid and Cooperative Computing, Springer Berlin Heidelberg: 422-429.
- Zaki, M. J., S. Parthasarathy, M. Ogihara and W. Li. 1997. New Algorithms for Fast Discovery of Association Rules. In KDD 97: 283-286.
- Zseby, T., M. Molina, N. Duffield, S. Niccolini and F. Raspall. 2009. Sampling and Filtering Techniques for IP Packet Selection, RFC 5475.

FREE OPEN SOURCE IMAGE PROCESSING LIBRARIES FOR DEVELOPMENT OF ANDROID APPLICATIONS

*Jasleen Kaur Bains¹ and Dr. Anuj Sharma²

Department of Computer Science and Applications, Panjab University, Chandigarh.

Abstract

The massive upsurge in the number of active Android devices all around the world has motivated programmers to use open source technologies for Android application development. The usage of mobile camera gives opportunities to develop varied image processing applications. There are free open source image processing libraries like OpenCV, JavaCV, BoofCV which help the Android programmer to make image processing applications for Android Phones. When dealing with images, it is necessary to perform image pre-processing tasks which can transform the images to facilitate faster and efficient image processing. This paper focuses on performing basic image pre-processing tasks. Experiment have been conducted to find out whether pre-processing of images speeds up the performance and minimizes storage requirements, especially in case of mobile applications. OpenCV image processing library has been used to conduct experiments, as it is considered one of the richest free open source image processing library compatible with Android OS. The free open source image processing libraries can be used to develop low cost yet technologically promising Android image processing based applications which can facilitate users in number of ways like Book readers, Language translators, Text readers for blind, object trackers, Face detectors, Real time Image based search, and industries like agriculture and healthcare in significant way.

Keyword: Android, Image Processing Library, Image Pre-processing, OpenCV, BoofCV, Open Source.

INTRODUCTION

In the past decade we have seen a rapid change in the telecom industry and its services- right from using telephones to pagers to mobile devices and now smart phones. Smart phones are often referred to as pocket computer as they have an advanced mobile operating system like Android, iOS, Windows Phone and are capable of performing most of the task performed by a PDA or Laptop. All this is possible through use of number of softwares available as third party applications (apps) on online portals like Google Play store, Apple Store etc. These apps fulfil most of the basic needs of a common user like chatting, Internet browsing, GPS navigation, social networking, working with documents, listening to music, clicking images and many more. The varied amount of services provided by smart phone have provided a plethora of opportunities to programmers to design and develop mobile apps, which can cater to needs of specific group of individuals or community as a whole. This is guite evident from the fact, that the number of available applications in the leading apps store Google Play Store, formerly known as Android Market, had 1.8 million apps in November 2015 according to Statista¹, whereas Apple's App Store remained the secondlargest app store with 1.5 million available apps in July 2015, according to Statista².

As per IDC, the Android dominated the market with 82.8% share in 2015 Q2. This reflects the popularity and affordability of smart phones powered with Android OS. These encouraging figures motivates the programmers to work in the area of Android Application development- as its popular, caters to more number of users because the devices' are affordable as compared to Apple smart phones or Windows based smart phones. Android Operating System was initially developed by Android, Inc. It was bought by Google in 2005, Android was unveiled in 2007, along with the founding of the Open Handset Alliance - a consortium of hardware, software, and telecommunication companies devoted to advancing open standards for mobile devices. It is based on the Linux kernel and designed primarily for touch screen devices. Google provides major incremental upgrades to Android every six to nine months, with confectionery-themed names, which most devices are capable of receiving through updates. The latest major release is Android 6.0 Marshmallow.

The Android developer community can gain knowledge and practice Android application development from the extensive documentation and downloads available on Android development website http://developer.android. com/. Android Studio is the official Android IDE from Google. It can be used to design and develop Android Applications.

The smart phones support inbuilt camera devices, this smart phone feature is one of the extensively used feature after calling and texting. Many apps have been developed which make use of images in one or the other way. This motivates the programmer to use free open source(F/OSS) image processing libraries which can be used along with Android OS to develop such apps. Some of the F/OSS image processing libraries compatible with Android OS are OpenCV, BoofCV, and JavaCV.

According to Kari Pulli, the demand for computervision applications is increasing with advent of mobile technology. More energy and time efficient algorithms are required to perform computer vision tasks on mobiles. Often, it is possible to trade off quality for speed. OpenCV(Open Source Computer Vision) is an open source computer vision and machine learning software library. It provides high computational efficiency for real time applications, with its vast set of computer vision and machine learning algorithms. Written in optimized C/C++, the library can take advantage of multi-core processing. Therefore one does not have to tradeoff between quality off speed using OpenCV.

It supports number of wrappers in other programming languages like Java. One of its wrappers is JavaCV. According to opency org website, OpenCV is enabled with OpenCL, it can take advantage of the hardware acceleration of the underlying heterogeneous computing platform. Its usage ranges from interactive art, to mines inspection, stitching maps on the web or advanced robotics. It is quiet promising in terms of its functionality and performance. It works efficiently on Android platform. A developer who has good knowledge of C,C++ and Java programming language can comfortably understand and use OpenCV. Not all the functions of OpenCV are available in OpenCV Java API, which is mostly used for android development but this problem can be resolved by developing code using Android NDK (Native Development Kit). In this approach, the OpenCV vision pipeline code is written entirely in C++, with direct calls to OpenCV. But this is requires programmer to have good amount of technical expertise in C++ and Android.

According to Sappan Thakker, embedded vision based system can be developed using OpenCV with Android .Such a system reduces the size of the system and provide many cost effective solution for industries.

According to information gathered from boofCV. org, BoofCV is an open source Java library for realtime computer vision and robotics applications. Its functionality covers a wide range of subjects including, optimized low-level image processing routines, camera calibration, feature detection/tracking, structure-frommotion and recognition.

According to BoofCV comparison with OpenCV, both OpenCV and BoofCV are available free of cost for academic as well as commercial use. Experiments for performing operations like GaussianBlur, Sobel gradient, Harris Corner detector, Canny with basic contour extraction, Hough line detection using polar coordinates and SURF detect have been conducted using OpenCV and BoofCV. It has been seen that OpenCV performed very well for low level image processing routines while BoofCV performed better with high level algorithms like SURF, Hough Line and Harris Corner. Table 1 show brief comparison of the various F/OSS image processing library In this paper

Library	Programming Language	License	OS Supported	*Popularity (no. of downloads)	Documentation
OpenCV	C/C++, Python, Java	BSD	Linux, Windows, Mac Os X, iOS, Android Os	12,081,957	Highly Extensive
BoofCV	Java	Apache 2.0	Linux, Windows, Mac Os X, iOS, Android Os	20,269	Extensive
JavaCV	Java	BSD	Linux, Windows, Mac Os X, iOS, Android Os	-	Limited

Table 1 Comparison of F/OSS Image Processing Library

* As per data on sourceforge.net on 25 February 2016

focus is on performing basic image pre-processing tasks. The experiments have been conducted to find out whether pre-processing of images speeds up the performance and minimizes storage requirements, especially in case of mobile apps.

SYSTEM DESIGN

The experimental work has been carried in form of two different processes.

1. PROCESS A: The first process is referred to as 'Process A', which is designed for mobile devices. In this the image is captured through smart phone inbuilt camera, then this image is passed to an android app available on smart phone which performs image pre-processing tasks and saves the pre-processed image to the sdcard of smart phone. Figure 1 shows the system design of the process A.

IMAGE CAPTURED USING SMART PHONE CAMERA IMAGE PRE-PROCESSING sdcard

PROCESS A

Fig. 1: SYSTEM DESIGN FOR PROCESS A

2. PROCESS B

The second process is referred to as 'Process B', which is designed for desktop/laptop windows based

devices. In this process, the images are captured using a digital camera and copied to the local disk drive of desktop/laptop. These images are read by windows application which performs image pre-processing tasks and saves the pre-processed images back to the local disk drive. Figure 2 below shows the System design of the process B.



PROCESS B

Fig. 2: SYSTEM DESIGN FOR PROCESS B

The configuration of various components used in Process A and B are as follows:

PROCESS A

Software used:

- IDE: Android Studio 1.4
- Image Processing Library: OpenCV4 Android 3.0

BAINS AND SHARMA

Hardware used:

- Device : Samsung Galaxy Note 4
- RAM: 3 GB
- Memory : 32 GB internal
- Operating System- Android 5.0 Lollipop
- Camera: 16 Megapixel
- Processor : 4 Cores @ 1.9GHz ARM Cortex-A57 & Low Power 4 Cores @ 1.3 GHz Cortex-A53
- Display Size: 5.7 inches

PROCESS B

Software used:

- IDE: Eclipse Java EE ,Luna Version
- Image Processing Library: OpenCV for Windows 3.0

Hardware used:

- Device : HP Envy 15 Laptop
- RAM:16 GB
- Storage: 1 TB
- Operating System : Windows 8.1
- Processor: Intel(R) Core(TM) i7-5500U CPU@2.40GHz
- Display Size: 15.6 inches
- Digital Camera: Sony CyberShot with 10x optical zoom, 16 megapixel with 3inches display.

IMAGE PRE-PROCESSING

A digital image should be pre processed before it is used for computational purpose. Image pre-processing helps to remove background noise, resize the image, correcting orientation, removing effects of blur, image binarization, removing reflections, determining edges marking portions of images and many more.

According to M. S. Sarfraz et al, the pre-processing task helps in minimization of noise and sharpening edge information. This improves detection efficiency. According to Muhammad Fraz et al, the low level image processing operations benefits the main image processing function like text detection or object detection.

According to Savitha G. et al, very few publishes literature is available in which image processing algorithms like object detection are implemented on Android. It is an emerging concept, most of the available literature concentrates on desktop applications. According to Tudor Dumitra et al., there are many challenges faced when designing phone based text detection system. Similarly according to Maurizio Pilu, while developing applications for mobile devices, major challenges faced are limited CPU capability i.e. slow processors, limited storage (mostly extended up to 128GB for high end smart phones) and low camera quality(as compared to professional digital cameras).

The slow processors on mobile devices require apps which should use lightweight libraries which can perform faster. The images should be of smaller size (preferably in bytes or kilobytes) so that they can be easily stored on the limited mobile storage. Camera quality of smart phones vary a lot due to a large number of companies competing for providing smart phones at cheaper price. All these factors stress on the importance of performing image pre-processing tasks on images intended to be used for mobile apps.

Figure 3 show the image pre-processing steps carried out for the experiments.



Fig. 3: Image Pre-processing Steps

1. *Image Size Normalisation*: It is the first step in image pre-processing. In this step, image is resized keeping its aspect ratio same as that of original image. This step is performed in order to get images of smaller dimensions and size, which takes up lesser memory for storage and can be processed faster.

2. *Image Color Conversion*: The next step is of converting the color RGB image to Greyscale image. This step is performed in order to simplify the image so that it can be represented using one channel of color with each pixel taking 8 bits to get stored. The intensity of each pixel can range from 0 to 255. This enhances the computation speed and simplifies the coding process. Moreover, most of the images processing functions work with Greyscale images.

62

3. *Image Smoothening:* This is the last step in image pre-processing. It refers to removal of noise from image. Noise in images is referred to as random variation in intensity value of pixels due to image sensors, lens, sunlight etc. Noise can degrade your image therefore it is quiet essential to remove noise before processing the original image, as it may lead to false results.

Figure 4 shows the stepwise image results, while performing the above image preprocessing steps on RGB real image.



Fig. 4: Stepwise results showing effect of each Image preprocessing steps on real image

EXPERIMENTS AND RESULTS

Two applications were developed for conducting experiments for Process A and Process B explained in Section III:

- PROCESS A: The image pre-processing android app was developed for checking the importance of image pre-processing on mobile devices. The motivation for conducting this experiment was to deal with the hardware challenges of mobile devices.
- PROCESS B: The image pre-processing desktop application was developed in order to compare the performance of OpenCV library packages available for desktop and android mobile device.

DATASET

- PROCESS A: 56 images were captured during day time using inbuilt camera of smart phone. Images were of dimension 5312 X 2988. The total memory occupied by these images was 252 MB. The mobile camera images were used as input in Android image pre-processing app.
- PROCESS B: 41 images were captured with digital camera. Images were of dimension 4608 X 3456. The total memory occupied by these images was 154 MB. The digital camera images were used as input in Windows based application developed for desktop/laptop.

IMAGE PRE-PROCESSING OPERATIONS

- For performing the image size normalisation, the bitmap image captured through mobile camera was resized to minimum size of 400 pixels keeping the aspect ratio same as that of original image. This bitmap was converted to Mat object for further processing.
- For changing the color image to grayscale image cvtColor() function of Imgproc library of OpenCV was used.
- 3. For image smoothening GaussianBlur() function was used with kernel size of 13. This function blurs the image using a Gaussian filter.

RESULT I

Following results were found when the image size normalisation was not performed in both the applications. Only two operations image color conversion and image smoothening were performed.

Desktop Application: It was found that Average processing time was equivalent to 137.3415 milliseconds. The processing time of the first image is greater (ranging from 2300-2400milliseconds). This is due to the fact that it takes a considerable time to load

the OpenCV library on desktop.

If the time taken to load the OpenCV library is ignored then the average processing time drops to 80.825 milliseconds. The size of images range from 3.9 MB to 4.5 MB.

Android App: It was found that Average processing time was equivalent to 574.166 milliseconds. If the time taken to load the OpenCV library is ignored then the average processing time drops to 538 milliseconds.

It is seen above that the average processing time taken by Desktop Application is lower than Android App. It shows that larger images can be handled faster by desktop application than mobile application. One reason is the use of faster processor and greater RAM of desktop/laptop as compared to mobile devices.

RESULT II

Following results were found when the *complete image pre-processing* steps were implemented.

Desktop Application: It was found that Average processing time was equivalent to 58.34146 milliseconds. The processing time of the first image is greater (ranging from 2300-2400 milliseconds). If the time taken to load the OpenCV library is ignored then the average processing time drops to 2.75 milliseconds.

Android app: It was found that Average processing time was equivalent to 9.2 milliseconds. The processing time of the first image is greater (ranging from 23-24 milliseconds). If the time taken to load the OpenCV library is ignored then the average processing time drops to 8.94 milliseconds.

It has been seen that the average processing time of performing *complete image pre-processing operations* on Android app is less than Desktop Application as shown in Table 2 and Figure 5. This is majorly due to following reasons:

- The Image size normalisation step enables the application to work on lesser number of pixels of an image. If the resizing is not performed then the processing time of both application increases.
- The OpenCV4Android library loads faster as compared to OpenCV for Windows. The time taken to process first image in Android App is 23 milliseconds while it's 2305 milliseconds in Desktop Application.

On the contrary, it was seen that in case of Android App, if the image size normalisation is not performed the processing time of image is exceptionally higher i.e. 538ms for Android app as compared to 80.825ms for desktop application.

Hence, it is essential to perform image size normalisation on mobile applications in order to get good performance of image pre processing tasks in terms of speed. As, it will highly impact the overall processing time of an image. The process of size normalisation may compromise with quality of image as some information is lost, but it considerably improves the performance.

	Android App	Desktop App	
Average Processing time of Image without performing Image Size Normalisation step	574.166 ms	137.3415 ms	
Average Processing time of Image by performing complete Image Pre-processing steps	9.2ms	58.34146 ms	

Table 2 : Comparison of Android app and Desktop Application average processing time.

Another interesting fact was seen through experiments that, whenever for first time application runs on desktop or mobile device it takes considerable time to load the library.

In case when image size normalisation process is not performed ,when the application is run for first time(for processing first image), the OpenCV4Android library takes 770 ms to process an image where as OpenCV for Windows library takes 2300 -2400 ms.

If the processing time taken for processing first image is ignored, then in both cases the desktop application using OpenCV windows package works faster. As. shown in Table 3 and Figure 6.

FOSS IMAGE PROCESSING LIBRARY FOR ANDROID APPS



Fig. 5: Performance Comparison of Android App and Desktop Application in terms of average processing time

Table 3 Performance comparison of Android App and Desktop Application, ignoring the processing time of first image processed

	Android App	Desktop App
Average Processing time of Image without performing Image Size Normalisation step	538 ms	80.825 ms
Average Processing time of Image by performing complete Image Pre-processing steps	8.94ms	2.75 ms



Fig. 6: Performance comparison of Android App and Desktop Application, ignoring the processing time of first image processed.

Figure 6 Performance comparison of Android App and Desktop Application, ignoring the processing time of first image processed.

Figure 7 shows the various images which have been pre-processed using OpenCV Windows library and Figure 8 shows the various images which have been pre-processed using OpenCV4Android library.



Fig. 7: Images Pre-processed on Desktop application

CONCLUSION

This paper provides brief introduction and comparison of various free open source image processing library available like OpenCV and BoofCV. The experimental work focuses on the importance of image pre processing tasks (especially for mobile devices). It was seen that these tasks improves the performance of the application in terms of lower processing time and saving considerable memory. Keeping in view the challenges of mobile devices due its small size and limited hardware, we need to focus on efficient programming practices while developing mobile applications.



Fig. 8: Images Pre-processed on Android Smartphone using OpenCV4Android library

The future scope of image processing based Android apps is tremendous. The free open source image processing libraries can be used to develop low cost yet technologically promising Android image processing based applications which can facilitate users in number of ways like Book readers, Language translators, Sign board readers for blind, object trackers, Face detectors, Real time Image based search, and industries like agriculture and healthcare in significant way.

REFERENCES

- Kari pulli, Anatoly Baksheev, Kirill Kornyakov, Victor Eruhimov, "Realtime Computer Vision with OpenCV" in Communications of the ACM, June 2012.
- M. S. Sarfraz, A. Shahzad , Muhammad A. Elahi ,M. Fraz, I. Zafar, E. A. Edirisinghe, Real-time automatic license plate recognition for CCTV forensic applications, 2011, J Real-Time Image Proc (2013) 8:285–295

- Maurizio Pilu Stephen Pollard, A light-weight text image processing method for handheld embedded cameras,2002,BMVC 2002
- Muhammad Fraz," Exploiting colour information for better scene text detection and recognition", International Journal on Document Analysis and Recognition (IJDAR), June 2015, Volume 18,Issue 2 pp 153-167
- Sapan Thakker1, Prof. Harsh Kapadia2, Image Processing on Embedded Platform Android,2015, IEEE International Conference on Computer, Communication and Control (IC4-2015).
- Savitha G, Venugopal P S, Dr. Sarojadevi, Dr. Niranjan Chiplunkar, An Approach for Object Detection in Android Device, 2014, Fifth International Conference on Signals and Image Processing
- Tudor Dumitra^o, Matthew Lee, Pablo Quinones, Asim Smailagic, Dan Siewiorek and Priya Narasimhan ,Eye of the Beholder: Phone-Based Text-Recognition for the Visually-Impaired, 2006, 10th IEEE International Symposium on Wearable Computers

Online resources referred:

Boofcv, "Performance: OpenCV:BoofCV". Available : http://boofcv.orgindex.php?title=Performance: OpenCV:BoofCV, Last accessed: 25th February 2016

IDC, Smartphone OS Markèt Share, 2015 Q2. Available: http://www.idc.com/prodserv/smartphoneos-market-share.jsp, Last accessed: 25th February 2016

Statista¹, Number of available applications in the Google Play Store from December 2009 to November 2015, Available: http://www.statista.com/statistics/266210/ number-of-available-applications-in-the-google-playstore/, Last accessed: 25th February 2016

Statista², Number of apps available in leading app stores as of July 2015, Available: http://www.statista. com/statistics/276623/number-of-apps-available-inleading-app-stores/, Last accessed: 25th February 2016

AWARENESS AND ACCEPTANCE OF THE SHIFTING TRENDS FROM ELECTRONIC LEARNING TO MOBILE LEARNING: A SURVEY OF STUDENTS OF HIGHER EDUCATION IN CHANDIGARH

Jasleen Kaur Bains

Department of Computer Science and Applications, Panjab University, Chandigarh

Abstract

The trend of mobile telecommunications is soaring with recent splendid developments in mobile technology. With passage of time the features and affordability of mobile phones has also increased massively. Gone are the days when personal computers or laptops were the only way of accessing internet. With gigantic increase in the number of mobile internet users all over the world, mobile phones are emerging as preferred and convenient device for accessing internet nowadays. This has led to next generation of Electronic learning (Elearning) known as mobile learning or M-Learning. M-Learning is the way of acquiring information, learning or knowledge through use of wireless handheld device like mobile phones, tablets etc. It gives user flexibility to learn anytime, anywhere at his or her own pace. To many of us M-Learning is all about viewing Elearning contents on mobile, but technically there are many differences between Elearning and M-Learning. This survey paper explores the level of awareness and acceptance of M-Learning among computer science students pursuing higher education.

Keywords: M-Learning, Elearning, mobile learning, social networking, mobile learners

INTRODUCTION

Learning is the mechanism of acquiring knowledge through experience, study or being taught. Teaching in school or colleges is the primary mechanism used for imparting knowledge to individuals in their early years of life. Now a day's learning among students is no more acquired only through traditional classroom teaching. Most of the schools/colleges have adopted the use of Information and Communication Technology (ICT) for E-Learning in their curriculum. It has been in existence since 20 years. E-Learning gives students the flexibility to learn and acquire knowledge through the use of hypermedia and multimedia. The main devices to impart E-Learning are personal computers (PC's) and laptops.

With the advancement of technology, market is being flooded by many low cost (as compared to PC's and laptops), handheld and technologically competent devices like smart phones and tablets. The advent of these mobile devices has led to transition of learning from E-Learning to Mobile Learning (M-Learning).M-Learning is the latest branch of ICT in education. It emphasizes on acquiring learning either alone or in combination with other ICT techniques, through the use of mobile devices like smart phones, tablets etc. It provides a lot of flexibility to the learner to learn anywhere, anytime and at any pace.

M-Learning provides a user with brief yet complete

knowledge in small chunks and lesser time. The content of M-Learning tutorials requires lot of introspection as to what is to be included and how it has to be presented using multimedia and hypermedia. M-Learning apps focus on imparting interesting quality learning via the use of gaming, small quizzes, videos, audio for quality content development.

A user may take on an average 20 to 30 minutes to go through one E-Learning tutorial as E-Learning tutorials provide detailed knowledge about a topic, whereas in M-Learning the time varies from 3 to 5 minutes only, as the knowledge imparted is very crisp, imperative and in small chunks. Shifting from E-Learning to M-Learning is not only upgrading your E-Learning tutorial to mobile app or mobile website, it rather involves careful selection of material and designing of apps which provide brief yet complete knowledge to learner. The hardware required for E-Learning material is expensive, fragile, heavy and immobile (as compared to handheld devices). Table 1 highlight the key differences between E-Learning and M-Learning.

M-Learning has gained importance for its usage on low cost mobile devices as compared to PC's, enhancement of network infrastructure in developed and developing nations, decrease in the mobile app development or deployment cost, less effort or cost of training, benefit of personalized learning, a large scale

Table 1: Key differences between Mobile Learning (M-Learning) and Electronic Learning (E-Learning)

	Categories	M-Learning	E-Learning
1	Definition	According to Jodi B. Roberts M-Learning is defined as "learning across multiple contexts, through social and content interactions, using personal electronic devices." Mobile Learners can use mobile device educational technology in many locations at their time convenience.	E-learning (or elearning) is the use of electronic media, educational technology and information and communication echnologies (ICT) in education. E-learning includes technology applications and processes such as audio or video tape, satellite TV, CD-ROM, and computer-
			based learning, as well as local intranet or extranet and web- based learning.
2	Nature of learning	Un tethered, informal and opportunistic	Tethered, formal and structured
3	Place of learning	Anywhere	Restricted to placement of desktop or laptop.
4	Flexibility in learning	More	Less
5	Duration of Learning	Shorter (3 to 5 minutes)	Longer (15-30 minutes)
6	Screen Size(of device used)	Very small (up to 10 inches approx), variety of multiple screen size	Much larger (10 inches onwards)
7	Devices used	Mobile devices like smart phones, tablets.	Desktop Computers, Laptops
8	Cost of devices	Less	More
9	Proliferation and usage of devices	Very high	Lower than Mobile Devices.
10	Popularity	More due to tremendous usage of mobile devices	Lesser
11	Size of Information	In small chunks (brief) ,easy and convenient.(Just in time)	Detailed information, focus on comprehension and retention
12	Nature of Information	Significant	Both significant and insignificant.
13	Assessment Duration	Short	Long
14	Support for Personalised Learning	More	Less
15	Example	E.g. : A quick reference guide for any kind of training	E.g. : A detailed comprehensive training.

surge in smart phone adoption and its widespread usage even in remotest areas around world.

M-Learning is creative use of mobile technology and is strongly supported by UNESCO, as an innovation in education which focuses on improving learning and access to quality education for the hardest to reach children. With more than six billion mobile subscriptions worldwide and twice as many people accessing the Internet from a mobile device as from a desktop computer, the potential for mobile learning to empower individuals is clearly huge. Mobile learning had been playing a key role towards achieving UNESCO's "Education for All" goal.

REVIEW OF LITERATURE

A few core M-Learning surveys are available, but the ones which are there emphasize on the growing acceptance and preference for M-Learning all around the world.

According to Molood Barati, the students are eager to shift to the M-Learning only if available free of cost, but were positive that it would make their life much easier and save their time. The most of academician in his survey felt that M-Learning will not save their teaching time and it would not make their life tough.

According to Nima Hunter Inc. Report, New York survey which concentrated on video and mobile learning preference and knowhow of their features among people. How organisations can build and cope up with the increasing demand of learning from interactive videos? The results showed that in near future more demand for M-Learning modules and interactive video would be there, which the learning and development professionals will have to cater to.

According to Douglas MCCONATHA, M-Learning through use of their software was beneficial for the students who accompanied the M-Learning with their classroom learning for increased effect. The authors state that convenient availability of information and resources promise the success of M-Learning. Further, the authors recommend that "more college courses utilize a mobile-learning ready framework. If instructors begin experimenting with mobile learning, the field will experience a rapid growth in the quality and quantity of studies about the effectiveness of these tools and technique."

According to Daesang Kim et al, M-Learning has enough potential to provide new learning experiences. In course of their survey they found that students actually perform better if they integrate the mobile learning with their classroom learning. According to them the students engage more effectively and willingly in M-Learning modules. M-Learning increases interaction, engagement and communication among peers and instructors.

Despite of all these encouraging results, in India we are yet to reap the benefits of M-Learning. Some of the M-Learning initiatives taken up in India are described in the following section.

M-LEARNING INITIATIVES IN INDIA

There are almost no Governmental educational policies focused exclusively on M-Learning in India. In the session 2012-2013 Government of India launched a tablet Akash, as part of an initiative to link 25,000 colleges and 400 universities in an E-Learning program. Although it got a lot of hype during its launching year but due to non availability of this tablet now (after initial distribution of 100,000 tablets till March 2013) this project has failed to achieve its desired goal.

An after school program was conducted by **Mathhew Kam** in North India in a private village school to investigate the learning impacts of English as second language(ESL) games have on lower income rural children.

Amrita Vishwa Vidyapeetham University ,India is carrying out research which is focused on a cloudbased adaptive learning system that incorporates mobile devices into a classroom setting. Some of its ongoing research projects are Amrita RITE – Rural India Tablet Education, Intelligent Tutoring Systems for School Education, eGovernance Systems for Schools, Big Data Analytics in Education.

"English on Mobile" is a product launched by British Council to bring English learning to masses of India in 2013. It has already been used by around 3000 people and allows people to learn spoken English over just voice and SMS – from any phone, anywhere in India. The product is available for Beginner, Intermediate and Advanced levels.

Gorakh Nath Sharma, a math teacher at a school in Ranchi, represented India as a Microsoft Innovative Educator at the annual 'Partners in Learning Global Forum' in 2014. He had developed a mobile assessment tool that allows students to send answers to an online test stored on a server and compete with thousands of students nationally and get their score and rank instantly.

The Biju Patnaik University of Technology, India started a service in collaboration with SMSGupShup called the **BPUTALERT in 2013**, which distributed information, academic notices and calendars through SMS to students. **Tutor On Mobile (M-Learning Platform)**, developed by Applied Mobile Labs is a mobile learning product that offers premium educational content and access to a knowledge marketplace. Tutor On Mobile is currently available to only Tata DoCoMo users. Tutor On Mobile was nominated for Best Innovation for Mobile Learning at GSMA Global Mobile Awards in 2012.

Most of the mobile learning solutions are being adopted by corporate world, they have been developing mobile learning solutions for organizations that seek to deliver training, performance support and job-aided tools through mobile handheld devices to their employees. Some of companies which provide mobile learning solutions in India are CommLab India, Applied Mobile labs Private Limited (AMLPL), Upside Learning, ExcelSoft, Tata Interactive Systems etc. Besides this last two years have seen an increase in number of many start up companies who are big time players in the market of developing android and ios based apps. These apps are mostly customised as per the personal or business requirements of company, or general information based apps. Still the number of effective apps designed for mobile learning specifically is not just enough for large number of learners.

Mobile learning is revolutionizing the concept of distance education by playing a significant role through the approaches like flipped classrooms and Massive Open Online courses (MOOCs). In flipped classroom approach the students uses combination of self and face to face learning. Initially the concepts are mastered by students through the use of videos, online tutorials etc and later for doubts or practice sessions face to face learning through a teacher is provided to student. MOOCs are specialized online courses designed by experts from mostly universities and few from corporate to impart effective, latest knowledge about the specific field to large number of learners across the world. Its key features are that these courses are generally free of cost(some universities charge the learner for offering the certification for the successful course completion), they offer highly specialised and qualitative content, largely self paced, available worldwide. Indian students form the second largest pool of learners in the world, who take these MOOCs.

The field of mobile learning is in its infancy in India. Hence lot of scope of research is there. A lot of research needs to be done to explore the benefits of this new way of learning in India and use it practically to enhance the education system in areas of school, higher education, adult and life -long learning. The organisations like CBSE and UGC after considering the unique benefits of M-Learning may take it up as a new endeavour in the field of education.

METHODOLOGY

To explore the level of awareness and acceptance of M-Learning among computer science students pursuing higher education, a survey of 85 students has been conducted for this paper. All the students who took this survey are pursuing a post graduate degree in computer science from Panjab University Chandigarh which has all modern facilities like ICT enabled classrooms, well equipped computer labs and free Internet connection through wifi for registered students. All the students belong to families of decent income group and hence own smart phone or mobile phone and laptop.

The survey was divided into two parts. The first part had six questions which were framed to capture the data regarding the device based learning preference of students, as computer students mainly use mobiles, laptops and desktops for learning purpose during course of their study. The motive was to know whether mobile device is preferred for learning or not.

The second part consisted of nine questions which were framed to capture the knowhow or popularity or preference of M-Learning apps among these students. A common view was taken by students to determine whether M-Learning initiatives are welcomed by the students or not.

RESULTS AND ANALYSIS

The results were analysed using Microsoft Excel software. Through the results it was found that 93% students were actually using smart phones with an Internet connection (as shown in Figure 1). This encouraging figure contemplates the ways to enhance the use of mobile devices for learning in coming years.



Fig. 1: A pie chart of various activities by students using Smart Phone



Fig 2: A pie chart showing the preferred device for learning in general by the surveyed students.

Most likely, the computer science students make extensive use of devices like laptop, mobile, and desktop for learning other than books. According to this survey (as shown in Figure 2), in general the computer students gave the preference to Laptop or tablet (52%) the most for learning, second preferred device was mobile phone and least preference was given to desktops.



Fig. 3: A pie chart showing device preference by students for supporting ubiquitous learning and sharing information among peers.

Although laptops were given preference by students in general for learning, but they preferred use of Mobile phones (as shown in Figure 3) for ubiquitous learning(i.e. learning anywhere ,anytime). The main reason is that mobile phones are very handy, convenient to carry and can be used for purpose of learning, interacting and sharing information with peers. This figure motivates us to look for ways in which we can exploit these benefits of mobile phones and its preference by students for betterment of imparting education.



Fig. 4: A pie chart showing percentage of students which are part of one or other learning group on mobile social networking apps.

At personal level students are already reaping the benefits of this technology as 70% students (as shown in Figure 4) agreed to being a part of one or the other learner's group formed on mobile apps like watsapp, HIKE, LINE, Vine, SnapChat, WeChat etc. The students learn by interacting with their peers on their topic of interest, sharing information and finding solutions to their queries. Students generally form a group of their own class, or group of people interested in particular subject or technology. They interact with each other on the topics related to the technology, share notes through images and pdf files and also asks queries to each other on the group. They benefit from multiple opinions about things from their peers which can expand their knowledge manifolds. Normally in traditional classroom teaching students get less time to discuss among each other due to time or any other constraint. There are no such barrier in these mobile groups. This is yet another aspect of M-Learning which can reap great benefits to education community.

The second part of survey carried questions that captured the amount of know how or popularity

or preference of M-Learning among the student sample(i.e. 85 computer science students pursuing higher education). Elearning is quiet prevalent and popular older method of learning among the students. Almost 99% students were familiar with Elearning.



Fig. 5: A pie chart showing how often students refer to Elearning course material for learning on Internet

Almost 96% (as shown in figure 5) students agreed to referring Elearning materials for learning purpose. Out of which 54% students access Elearning course material very often and 42% students access it less often.



Fig. 6: A pie chart depicting the know how of M-Learning among students
BAINS

In contrast the students are less familiar with the upcoming concept of M-Learning, which is emerging as the next big thing after Elearning. Only 42% (as shown in Figure 6) students agreed to know it completely i.e. What is M-Learning all about? How it is technically

different from Elearning. In general, 57% students just think it's same as viewing the E-Learning contents on mobile phone, which is not exactly M-Learning. So, it's clear that the technical knowhow of M-Learning among the computer students is comparatively less.



Fig. 7: The pie chart showing the understanding of the difference between M-Learning and E-Learning among students.

This is evident from the fact that according to data collected in this survey only 36% (as shown in Figure 7) students said they are sure about the difference between M-Learning and E-Learning. While 64% are unsure. These figures are of computer students while it may be lesser for non technical students or students studying in remote or rural areas where even ICT is not properly used.

If a good M-Learning app is used along with traditional form of learning it might give a boost to students grades. But these low figures can hinder the potential of using the M-Learning apps effectively for benefitting the students. As a poorly designed app which does not confer to any standards may be used by students for learning, which might not benefit them as much as a properly designed M-Learning app with appropriate and crisp material. Therefore, awareness has to created among students via presentations or courses about the technicalities of M-Learning to help them differentiate among E-Learning and M-Learning. Proper measures have to be followed to popularize the concept of M-Learning among students in the form of mobile ICT (mICT).





As, most of the students are using Android smart phones therefore they have got access to many free mobile learning apps which are used by them. Almost 78% (as shown in Figure 8) students have used these apps, but very less percentage of students i.e. only 18% use it quiet often for learning purpose. This is quiet discouraging. One main reason for this is, that in India M-Learning concept is still not popular and teachers don't encourage the students to learn from these along with traditional learning as these apps don't confer to any standards. It is difficult to access the authenticity of the learning material in the M-Learning app and moreover how much it can benefit the learner is hard to determine.



Fig. 9: Bar chart showing difficulties faced by students for accessing information or learning content on mobile

There are certain other drawbacks related to mobile phones which can hamper the usage of M-Learning apps. According to the data collected from students (as shown in Figure 9), it has been seen the biggest drawback is the smaller screen size of mobile phone which discourages the students to it for learning over stretch of hours. The next main problem is of limited battery and maybe a slow internet connection on phone.

All these drawbacks can still be worked upon as know a days, with advent of technology telecom companies are launching mobile phones with quiet bigger screens and good processors as well as long lasting batteries. If M-Learning apps are properly designed then it might take only 5-10 minutes to complete one module by learner in general. Thus, for shorter periods if mobile phones is used then all these drawbacks can be ignored.

Besides the drawbacks, the 95% students are in favor of a mobile learning management system for their respective courses, using which course contents like lecture ppts, assignments and reference materials can be made available by teachers to students on their mobile phones. This largely due to fact that students carry their mobile devices all the time with them and they want prompt access to all information related to them.



Fig. 10: The pie chart showing the general opinion of students regarding MLearning as next big thing after Elearning for learners.

BAINS

With growing number of people carrying smart phones, the potential of M-Learning is immense if properly used.

Therefore, 89% (as shown in Figure 10) students feel positive that M-Learning is the next big thing after Elearning for learners.



Fig. 11: The pie chart showing opinion of students regarding whether M-Learning along with traditional learning techniques improve grades of students.

According to survey data, 61% (as shown in Figure 11) students feel that M-Learning can help to improve the grades of students if it is used along with traditional mode of learning. While rest 39% are skeptical as they feel it largely depends on the course for which the M-Learning module is designed, its learning content, design and correct usage by students

Poorly designed M-Learning modules with inappropriate and insufficient contents cannot benefit the learner. Like Elearning, for developing M-Learning modules certain standards and methodology has to be followed to come with highly efficient modules.

CONCLUSION AND FUTURE SCOPE OF MLEARNING

M-Learning has a lot potential benefits if its meticulously used along with traditional form of learning. In order to increase the popularity and correct awareness about M-Learning among the students higher learning, we need to encourage the teachers use the concept of flipped classroom. In this approach Every teacher can make an effort to develop a M-Learning module for some part of the course like crisp notes, presentation, audio or video lectures, quiz or games related to a particular topic. As and when topic is covered the student should be encouraged for using the M-Learning app for quick revisions. This way the teacher may persuade the students to switch to M-Learning.

In addition to this, the government should also form some good policies at various levels of education to support M-Learning at large scale. M-Learning is a cheaper mode of learning as compared to traditional ICT setup. It can be quiet beneficial for very remote rural students where it is difficult to manage and implement ICT fully. India has worked in this direction by becoming one of the leading countries in the world who deliver massive open online courses (MOOCs) for learning. Many leading universities have joined this move and contributed towards it.

Effective M-Learning modules can be developed for imparting skill based training to students. For e.g.: A short course for plumber, electrician, gardener, factory worker, driver etc. They can always use this M-Learning app at their convenience to learn and progress. Likewise it can be implemented in many fields to enhance convenience of the learner or students.

It is evident from the survey data, that most of the students consider M-Learning as the next big thing after E-Learning. But there is still need to educate them regarding its proper usage to get maximum benefit. With the growing trends in technology, in no matter of

time we will see the sharp switch from E-learning to M-learning among students and learners. M-Learning has promising benefits if used with traditional form of learning. We just need to embrace it with positivity and implement it to reap its benefits.

BIBLIOGRAPHY

Avgoustos Tsinatos, "Global mobile learning implementation and trends." Available online: http:// ade.ouchn.edu.cn/?action-viewnews-itemid-200 ,Last accessed 13-11-2016.

Jodi B. Roberts, "Handbook of Mobile Learning " Print publication date: April 2013, ...

Online publication date: June 2013, Print ISBN: 9780415503693, eBook ISBN: 9780203118764

REFERENCES

- Daesang Kim, Daniel Rueckert, Dong-Joong Kim, Daeryong Seo, Students' perceptions and experiences of mobile learning,2013, Language Learning & Technology, Volume 17, Number 3 pp. 52–73 .ISSN 1094-3501
- Douglas MCCONATHA, Matt PRAUL, Michael J. LYNCH, Mobile learning in higher education: an empirical assessment of a new educational tool, 2008, The Turkish Online Journal of Educational Technology – TOJET July 2008 ISSN: 1303-6521 volume 7 Issue 3 Article 2
- Matthew Kam, Anuj Kumar, Shirley Jain, Akhil Mathur, and John Canny,2009, Improving Literacy in Rural India: Cellphone Games in an After-School Program, ICTD 2009
- Molood Barati and Seyedjamal Zolhavarieh, Mobile Learning and Multi Mobile Service in Higher Education,2012, International Journal of Information and Education Technology, Vol. 2, No. 4.
- Nima Hunter Inc., Going the Distance: The Video & Mobile Learning Survey
- E-Learning, M-Learning & Interactive Video in the Age of the Digital Workplace, 2015, Available Online: http://info.viddler.com/hubfs/ docs/Video_and_Mobile_Learning_Survey_ Summary.pdf, Last accessed 20-10-2016

Online Resources referred:

Aakash: The World's Cheapest Tablet and the Cost of the 'Made in India' Tag, Available online: http:// asiasociety.org/india/events/aakash-worlds-cheapesttablet-and-cost-made-india-tag, Last accessed 9-09-2016

Amrita RITE – Rural India Tablet enhanced Education", Available online : https://www.amrita.edu/center/ amrita-rite, Last accessed 23-09-2016

Bharti Airtel joins the m-learning bandwagon", Available online: http://www.cxotoday.com/story/bharti-airteljoins-the-m-learning-bandwagon/, Last accessed 15-09-2016

Difference between elearning and mlearning, Available online: http://fusedlearning.com/differences-betweenelearning-and-mlearning/, Last accessed 18-08-2016

English Digital Initiatives - English to the Indian masses, Available online: https://www.britishcouncil. in/about/press/english-digital-initiatives-english-indian-masses, Last accessed 9-09-2016

ICT in education-Mobile Learning, Available online : http://www.unesco.org/new/en/unesco/themes/icts/ m4ed/, Last accessed 8-08-2016

M-learning vs. E-learning – Is There a Difference?, Available online: http://elearningfeeds.com/mlearning-vs-e-learning-is-there-a-difference/, Last accessed 18-08-2016

mlearning VS elearning key differences, Chris Ballman, Available online: http://meetings-conventions.com/ blogs/guest-stars/post/2014/03/28/mlearning-vselearning-key-differences, Last accessed 19-08-2016

Mobile Learning, Available online : http://timesofindia. indiatimes.com/home/education/news/Mobile-learning/ articleshow/30927186.cms, Last accessed 14-09-2016

VoiceTap, Available online : https://en.wikipedia. org/wiki/Voicetap, Last accessed 20-09-2016

AN INTERVENTIONAL STUDY TO ASSESS THE KNOWLEDGE AND AWARENESS ABOUT THE TRANSMISSION AND PREVENTION OF HEPATITIS B INFECTION AMONGST THE DENTAL STUDENTS

*Dr Shipra Gupta, Dr Jyoti Gupta, Nandini Bhaskar and Ashish Jain

Department of Periodontics Dr. Harvansh Singh Judge Institute of Dental Sciences and Hospital, Panjab University, Chandigarh, India

Abstract

Aim: To assess the impact of an interactive lecture session on the knowledge and awareness of the dental students of different academic years.

Materials and Methods: A cross sectional questionnaire based study was conducted among 200 students 50 each from 1st, 3rd, 4th year and interns. After recording the baseline knowledge and awareness, a lecture and an interactive session was conducted by medical specialists. Comparisons were done between pre-session and post-session questionnaire results of the groups. The data was collected and statistically analyzed.

Results: There was significant gain in the knowledge and awareness about hepatitis amongst all the groups after the interactive session. Out of all the groups, first year participants had the least and the interns had the highest levels of knowledge. 3rd year students had significantly higher levels of knowledge and awareness as compared to final year.

Conclusion: One time knowledge alone is not sufficient to bring about behavioral changes that are needed in clinical settings. There is a constant need for health education to remove misconceptions or inadequacies in knowledge. This can be brought about by well structured health education programs, quiz competitions or interactive sessions with the students.

Keywords: Knowledge, Hepatitis B transmission, Interactive Lecture, Dental Students

INTRODUCTION

Hepatitis B is a blood borne viral infection caused by Hepatitis B virus (HBV) that attacks liver and causes both acute and chronic diseases. HBV infection is associated with life threatening conditions such as fulminant viral hepatitis and hepatocellular carcinoma. Most cases of hepatocellular carcinoma have hepatitis virus associated liver disease (HB EI-Serag, 2012)⁹. Based on the prevalence of Hepatitis B carrier state in the general populations, countries are classified as having high (8% or more), intermediate (2-7%), or low (less than 2%) HBV endemicity. India harbors 10–15% of the entire pool of HBV carriers of the world. It has been estimated that India has around 40 million HBV carriers. (Dutta S, 2008)⁵

An alarming fact about the hepatitis B virus is that it is more infectious than HIV, scoring 30% on an infectivity rate scale against HIV's 0.3% (McCarthy GM, 2000)¹³. Though there is an effective vaccination program available against hepatitis B since 1982, the current level of immune status and the carrier state of the patients visiting the dental settings is seldom known. The majority of the infections are subclinical, so approximately 80% of all HBV infections are undiagnosed (Goebel WM, 1979)⁷. So, all the patients should therefore be regarded as potential HBV carriers. At the same time, the infection can be transmitted from the dentist to the patient also. Various studies in the literature have shown transmission of HBV from dental health care professionals to their patients (Levin M et al, 1974)¹² (Hardler SC et al, 1981)⁸ (Reingold AL et al, 1982)¹⁵. A study by Spijkerman et al in 2002²⁰, on transmission of HBV from a surgeon to his patients, revealed that a total of nearly 28 patients may have been infected during surgical procedures.

It is important to consider that Hepatitis is preventable if awareness is promoted among people. The risk of transmission of blood borne infection arises due to lapses in sterilization techniques of the instruments, non compliance with the universal precautions or improper hospital waste management. All this leads to the continuity of the chain of infection from an infected person to the non infected person. Studies have shown that risk of exposure for general dentists is about three to four times greater than that of general population (Cattone JA and Molinari JA, 1989)³. Since the dental students attending to the patients are also exposed to the same environment, a thorough awareness and knowledge should be there to prevent the risk of acquiring infections for themselves as well as for their patients. A sound understanding about infectious diseases including Hepatitis B is essential for the budding dentists to turn them into well trained clinicians who would provide their patients with oral health care of the highest standards, follow strict infection control measures in dental practice and minimize any risk of transmission of the virus. At the same time, medical ethics makes it essential for clinicians as well as the students to keep themselves updated with the latest information regarding these diseases.

The present study was designed to assess the awareness about Hepatitis B amongst the dental students in Panjab University. Though there are various studies showing the baseline data in terms of knowledge of the students, professionals or paramedical staff, this study is unique as it reassesses the awareness levels after an interactive lecture was conducted to see any changes in the level of knowledge and awareness of students.

Aims of the Study

- To assess the impact of interactive lecture session on the knowledge and awareness of the participants.
- To evaluate the difference of knowledge, if any, amongst the dental students of different academic years for both pre and post interactive session.

MATERIALS AND METHODS

Study population

50 students each from 1st, 3rd, 4th year and interns among the students of the Dr Harvansh Singh Judge Institute of Dental Sciences and Hospital, Panjab University, Chandigarh were included in the study. First year students represented the group which were not exposed to the dental clinical set-up and they were taken as the Control Group whereas the third and final year students and interns all work in the clinics and hence formed the Test group.

Exclusion criteria

- 1. Students of 2nd year.
- 2. Students on leave on the specific days.
- 3. Students unwilling to participate.

Study design

Prior to study, ethical clearance from Institutional Ethical Committee was taken. A cross sectional questionnaire based study design was used. The students were fully informed about the design and purpose of the study. A written informed consent was obtained from the study participants and the anonymity of participants was maintained throughout the study. The questionnaire was pre-tested among 10 undergraduate trainees each of different years at the same hospital and further modifications were incorporated. The dental students were asked to fill a validated pretested questionnaire in one hour time. The variables assessed were knowledge of disease regarding etiology, mode of transmission, diagnosis, universal precautions, prevention and post exposure prophylaxis (PEP). Later on a lecture and an interactive session was conducted by a medical specialist (MD Medicine personnel). After that the same questionnaire was again filled by the participants.

Data Collection

The questionnaire forms were checked for the correct responses and the data was tabulated in MS Excel. The data were compiled and analyzed using the Statistical Package for Social Sciences (SPSS) version 15. Comparisons were done between presession and post-session questionnaire results of the groups; between control and test groups; and between subgroups within the test group.

RESULTS

The intergroup comparisons for knowledge of interns, first year, third year and the final year regarding HBV, is given in **Table 1**. The difference for pre-session and post session values comes out to be statistically highly significant for all the groups, meaning thereby that there was a significant gain in the knowledge after the lecture.

The intragroup comparison of participants for their awareness regarding hepatitis B, in terms of different

Group	Pairs		df	Significance (2-tailed)
Interns		Percent knowledge before-percent knowledge after	49	<0.0001**
First year		Percent knowledge before-percent knowledge after	49	<0.0001**
Third year		Percent knowledge before-percent knowledge after	49	<0.0001**
Final year		Percent knowledge before-percent knowledge after	49	<0.0001**

Table 1: Comparison of Knowledge and awareness amongst the respondents regarding	g HBV, before and after the
lecture series	

p e" 0.05 signifies non-significant results, p < 0.05 signifies statistically significant results (*), p< 0.001 signifies statistically highly significant results (**)

parameters, is shown in **Table 2.** It has been seen that the difference amongst the participants is statistically highly significant for etiology (p=0.001), mode of transmission (p=0.003), vaccination (p=0.001) and diagnosis (p=0.035) but was non-significant as far as the questions for PEP (p=5.584) were evaluated. This shows that all of them had the same level of awareness for PEP. Similarly when the values are assessed post session, the awareness of participants varied highly significantly from each other for all the parameters but for etiology where the comparative values were non-significant (p=0.086). A very large variation in the awareness of the participants even after a lecture session could be suitably explained when the intergroup comparisons for individual parameters (**Table 3, 4, 5, 6, and 7**) are studied.

Table 3 shows the intergroup comparisons of participants for their awareness regarding the etiology of Hepatitis B. It was seen that first year students show highly significant difference as compared to interns (p=0.001), third year (p=0.001) and final year (p=0.001) students pre-session but there was no significant difference post session except for the third year (p=0.047). Furthermore, third year participants had a significant difference of awareness vis-a-vis final year (p=0.047) post session.

Table 2: Comparison of Knowledge and awareness amongst the respondents regarding etiology, modes of transmission, vaccination, diagnosis and post exposure prophylaxis for HBV, before and after the lecture series

		Before		After	
	df	Chi-Square	p-value	Chi-Square	p-value
Etiology	3	32.355	<0.001**	6.597	0.086
Mode of transmission	3	13.639	0.003**	16.054	0.001**
Vaccination	3	20.910	<0.001**	11.950	0.008**
Diagnosis	3	8.589	0.035*	8.804	0.032*
PEP	3	5.584	0.134	32.578	<0.001**

p e" 0.05 signifies non-significant results, p < 0.05 signifies statistically significant results (*), p < 0.001 signifies statistically highly significant results (**)

	vs. 1 st yr			vs. 3 rd yr					vs. Final yr			
	Before		After		Before		After		Before		After	
Group	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value
Interns	-4.948	<0.001**	-1.615	0.106	-0.057	0.955	-0.237	0.813	-1.386	0.166	-1.615	0.106
l⁵tyr	-	-	•	-	-5. 100 ·	<0.001**	-1.990	0.047*	-3.839	<0.001**	0.000	1.000
3 rd yr	-	-	-	-	-	21	-	-	-1.407	0.159	-1.990	0.047*

p e" 0.05 signifies non-significant results, p < 0.05 signifies statistically significant results (*), p< 0.001 signifies statistically highly significant results (**)

	vs. 1 st yr			vs. 3 rd yr					vs. Final yr			
	Before		After		Before		After		Before		After	
Group	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value
Interns	-2.880	.004**	-3.099	.002**	-1.638	.101	-0.595	0.552	-1.160	0.246	-3.099	.002**
lstyr	-	-	-	-	-1.220	.223	-2.491	.013*	-3.681	<0.001**	0.000	1.000
3 rd yr	•	-	-	-	-	-	-	-	-2.845	0.004**	-2.491	.013*

Comparison of awareness amongst the respondents regarding modes of transmission for HBV is shown in **Table 4**. Again there was a statistically highly significant difference of first year students with interns (p=0.004) and final year (p=0.001) pre-session and with interns (p=0.002) and third year post session (p=0.013). Interestingly, there was a statistically significant difference of values for interns and third year students vis a vis final year (p=0.002 and p=0.013 respectively) post session also.

Table 5 presents a comparison of awareness amongst the respondents regarding vaccination for HBV. A significant difference was seen for first year students when compared with interns (p=0.019), third year (p=0.035) and final year (p=0.001) students presession and statistically highly significantly with interns (p=0.002) post session also. There was a significant difference of awareness when interns and third year students were compared to final year students (p=0.019and p=0.008 respectively) pre-session. Furthermore, interns had a significant difference of awareness visa-vis final year (p=0.002) post session also.

Table 6 shows the intergroup comparisons of participants for their awareness regarding the diagnosis of Hepatitis B. Again a statistically significant difference was seen for first year students as compared to all other groups pre-session and with interns (p=0.013) post session also. Except in case of interns and final year where there is significant difference post session (p=0.013), it was seen that a statistically non-significant difference is there pre-session and post session for all other intergroup comparisons.

Comparison of awareness amongst the respondents regarding post exposure prophylaxis for HBV is shown in **Table 7**. It was seen that none of the groups differ from each other regarding their awareness about PEP pre-session as well as post session except for interns who have a highly significant difference when compared to first year (p=0.001), third year (p=0.001) and final year (p=0.001) participants post session.

DISCUSSION

Hepatitis B virus causes a life threatening infection of liver that often leads to chronic liver disease and put people at high risk of death. The present study was undertaken to assess the knowledge and awareness of undergraduate dental students about the Hepatitis B. This was followed by an informative lecture by a medical professional and the students were reassessed for any kind of improvement. In this study, it was seen that there is significant gain in the knowledge and awareness of all the groups regarding HBV after the lecture series. This is quite an expected finding but could not be substantiated due to the lack of similar studies where an intervention through lecture is undertaken. Shinde N et al (2012)¹⁷ conducted a questionnaire based study on 370 dental healthcare workers and students to assess the knowledge and management approach towards hepatitis patients. An interactive lecture session was conducted but no questionnaires were refilled to reassess the change in knowledge of the participants. The response was measured only in terms of change, if any, towards the attitude and practical management of hepatitis patients and it was found that there was a little change in the willingness of participants to treat hepatitis patients. Furthermore, in the present study, there is a large variation in the knowledge and awareness amongst the participants regarding hepatitis etiology, modes of transmission, vaccination, diagnosis and PEP, even after the lecture. This could be attributed to first year participants. Intergroup comparisons for knowledge show that the first year students have a significantly less knowledge than rest of the groups. The first year BDS students are just the routine medical students with biology as a subject. Looking at their curriculum in the school years, they are not well versed with the blood borne infections and the clinical infection control measures and there is no formal school based health education for students in India. That's why probably, even after the session, there is a significant difference of values for the first year from the rest of the groups for all the parameters. Moreover, as per the dental curriculum in India, students are entering the clinics only in third year. So the first and the second year students are practically non clinical students who have no formal clinical training for the infection control procedures. There are a few studies wherein the BDS students of different academic years are comparatively evaluated for their knowledge, attitude and practices related to HBV infection but none of them has taken the first year students into the comparisons (Singh A and Jain S, 2011)¹⁸ (Singh A et al, 2011)¹⁹ (Saini R et al, 2010)¹⁶. In a study conducted only on first year students, Mohit Bansal et al (2013)² found that out of a total of 223 first year dental students of three different colleges, 73.1% were aware that Hepatitis B is an infectious disease and 54.7% knew about vaccine availability for hepatitis B. In another study where the study population comprises only first and second year students, it is observed that only 59.7% were aware of

	vs. 1 st yr				vs. 3 rd yr				vs. Final	yr		
· ·	Before		After		Before		After		Before		After	
Group	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value
Interns	-2.336	.019*	-3.026	.002**	-0.287	0.774	-1.951	0.051	-2.349	.019*	-3.026	.002**
lstyr	-	-	-	-	-2.106	.035*	-1.193	0.233	-4.424	<.001**	0.000	1.000
3 rd yr	-	-	-	-	-	-	-	-	-2.672	.008**	-1.193	0.233

p e" 0.05 signifies non-significant results, p < 0.05 signifies statistically significant results (*), p< 0.001 signifies statistically highly significant results (**)

Table 6: Comparison of Knowledge and awareness am ongst the respondents regarding diagnosis for HBV

	vs. 1 st yr	- <u>1</u> 4	<u> </u>	<u></u>	vs. 3 rd yr		· · · ·		vs. Final	yr		
han	Before		After		Before		After		Before		After	
Group	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value
Interns	-2.178	.029*	-2.484	.013*	-0.263	0.793	-1.230	0.219	-0.263	0.793	-2.484	.013*
l⁵tyr	-	-	-	-	-2.227	.026*	-1.333	0.183	-2.227	.026*	@.0 0 0	1.000
3 rd yr	-	-	-	•	-	-	-	-	0.000	1.000	-1.333	0.183

p e" 0.05 signifies non-significant results, p < 0.05 signifies statistically significant results (*), p< 0.001 signifies statistically highly significant results (**)

Table 7: Comparison of Knowledge and awareness amongst the respondents regarding post -exposure prophylaxis for HBV

	vs. 1 st yr		ŗ	······································	vs. 3 rd yr		ı		vs. Final y	/L	1	
	Before		After		Before		After		Before		After	
Group	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value	z-score	p-value
Interns	-1.479	0.139	-3.800	<.001**	-0.663	0.507	-3.443	.001**	-2.171	.030*	-3.800	<.001**
lstyr	1	4	I	t	-0.836	0.403	-0.583	0.560	-0.733	0.464	0.000	1.000
3 rd yr	I			1	1	,	1	,	-1.554	0.120	-0.583	0.560
p e″ 0.05 :	signifies non	1-significant	results, p < (0.05 signifie	s statisticall	ly significant	results (*), p	o< 0.001 sig	nifies statisti	ically highly	significant r	esults (**)

Hepatitis B infection (Vasanthakumar AH and D'Cruz AM, 2013) ²¹.

In our study, a significant difference in terms of knowledge and awareness is seen in interns group with respect to third year and final year post session. As the interns are working with the patients, so their theoretical knowledge is better co-related to their cumulative practical knowledge of three years of clinical work. A similar kind of study on Irànian students, wherein different year BDS students are compared to each other for their knowledge about HBV, also show that the knowledge increases as the number of years of education increases (Alavian SM et al, 2011)¹. The target of primary prevention is hard to be achieved if the participants have a low knowledge for post exposure prophylaxis as is shown in this study. These findings are similar to a study done by Khan N et al (2010)¹¹ to determine the vaccination status. knowledge, attitude and practice regarding hepatitis B and C among medical students of Karachi. 76% of the students did not have the knowledge regarding post exposure prophylaxis. These findings are in contrast to the findings of Sowmya Kasetty et al (2013)¹⁰ who reported 93% knowledge of the dental professionals regarding PEP for hepatitis. Intervention in the form of an informative lecture definitely has led to the improvement of knowledge of participants in our study.

The results, in general, have indicated that the students' knowledge on hepatitis generally increased through the curriculum. Earlier studies in the literature also shows that knowledge about the infection control measures increases generally with increase in the years of practice and higher education (Cheng HC et al,2012)4 (Ebrahimi M et al, 2012)6. Interestingly, this study shows that the third year students have an edge over the final year for their knowledge and awareness parameters at certain points either at pre session or post session evaluation. The reason for this finding could be related to their on-going continuing education in the subjects of general medicine and general surgery (infectious diseases, pathogenesis, prevention and treatment). So the questions about HBV could be better understood in the light of theoretical concepts. But these findings stand in sharp contradiction to the findings in other studies where the third year students have lesser knowledge and awareness about HBV infection when compared to fourth year students (Ramkrishnan Mahesh et al, 2014) 14

Limitations of the Study

Out of a total of 500 students, 200 participated in the

study so a good sample size and a 100% response rate are among the strong points of the study. But as this is a questionnaire based study so, the accuracy of its results largely depends on the reliability of the participants' memory and honesty while filling the questionnaire. Secondly, only a short term reassessment of the knowledge of students was done i.e. immediately after the lecture session. An assessment for long term retention of knowledge could not be done as one of the groups of the study participants i.e. interns batch passed out.

CONCLUSIONS

Highlights of the study

- There is overall a sigificant gain in knowledge of participants after the lecture.
- Out of all the groups, first year participants have the least and the interns have the highest knowledge about HBV.
- Third year students show a significant difference with final year for knowledge and awareness about HBV, meaning thereby that along with the clinical exposure, a sound theoretical back-up is needed even for final year students which is lacking in their curriculum.

It is very strongly recommended here that the curriculum of BDS final year students, which currently is primarily focusing on the core subjects of dentistry, should include special theory lectures, assignments and tutorials about the basics of infection control in clinical settings. There is a constant need for health education to remove misconceptions or inadequacies in knowledge. This can be brought about by well structured health education programs, guiz competitions or interactive sessions with the students. Onsite training of students in the form of mock drills can leave a permanent training experience in their minds. Constant monitoring of their activities related to patient care and even the disposal of biohazardous wastes is required for prevention of infections. This study emphasizes the need of enhancing the knowledge about infection control through continuing dental education programs at regular intervals.

ACKNOWLEDGEMENTS

We sincerely wish to thank Dr Sukhwinder Singh (MD Medicine) who has kindly consented for an interactive lecture session for the participants.

REFERENCES

- Alavian SM, Mahboobi N, Mahboobi N, Savadrudbari MM, Azar PS, Daneshvar S. Iranian dental students' knowledge of hepatitis B virus infection and its control practices. J Dental Educ. 2011; 75(12):1627-34.
- Bansal M, Gupta N, Vashisth S. Knowledge and awareness of Hepatitis B among first year Undergraduate Students of Three Dental Colleges in Haryana. Dental Journal of Advanced Studies 2013: 1(1): 15-17.
- 3. Cattone JA, Molinari JA. Hepatitis B vaccine: an update. J Calif Dent Assoc 1989; 17:11-12.
- Cheng HC, Su CY, Huang CF, Chuang CY. Changes in compliance with recommended infection control practices and affecting factors among dentists in Taiwan. J Dent Educ. 2012; 76(12):1684-90.
- 5. Dutta S. An overview of molecular epidemiology of hepatitis B virus (HBV) in India. Virol J. 2008;5:156. [PubMed]
- Ebrahimi M, Ajami B, Rezaeian A. Longer Years of Practice and Higher Education Levels Promote Infection Control in Iranian Dental Practitioners. Iran Red Crescent Med J. 2012 Jul;14(7):422-9. Epub 2012 Jul 30.
- Goebel WM. Reliability of medical history in identifying patients likely to place dentists at an increased hepatitis risk. J Am Dent Assoc. 1979; 98: 907-13.
- Hadler SC, Sorley DL, Acree KH, et al. An Outbreak of Hepatitis B in a Dental Practice. Ann Intern Med 1981; 95(2): 133–138.
- 9. HB El-Serag. Epidemiology of Viral Hepatitis and Hepatocellular Carcinoma. Gastroenterology. 2012 May; 142(6): 1264–1273.e1. doi:10.1053/j.gastro.2011.12.061.
- Kasetty S, Mohania A, Dwivedi D, Tijare M, Kallianpur S and Gupta S. A Cross- Sectional Study on the Knowledge of Hepatitis B Infection among Dental Professionals. Journal of Virology & Microbiology 2013 Vol. 2013 (2013), Article ID 288280, DOI:10.5171/2013.288280
- 11. Khan N, Ahmed SM, Khalid MM, Siddiqui SH, Merchant AA. Effect of gender and age on the knowledge, attitude and practice regarding

hepatitis B and C and vaccination status of hepatitis B among medical students of Karachi, Pakistan. J Pak Med Assoc 2010; 60(6): 450-5.

- Levin ML, Maddrey WC, Wands JR, Mendeloff AL. Hepatitis B transmission by dentists. JAMA 1974; 228(9): 1139– 1140.
- Mccarthy GM. Risk of Transmission of Viruses in the Dental Office. J Can Dent Assoc.2000; 66: 554-557.
- 14. Ramakrishnan Mahesh, Chandran Arthi, Samuel Victor, and Seiramineni Ashokkumar. Hepatitis
 - ¹ B Infection Awareness among Dental Graduate Students: A Cross Sectional Study. Int Sch Res Notices. Volume 2014 (2014), Article ID 389274, 6 pages. http://dx.doi. org/10.1155/2014/389274
- Reingold AL, Kane MA, Murphy BL, Checko P, Francis DP, Maynard JE. Transmission of hepatitis B by an oral surgeon. J Infect Dis 1982; 145(2): 262–268.
- Saini R, Saini S, Sugandha RS. Knowledge and awareness of Hepatitis B infection amongst the students of Rural Dental College, Maharashtra, India. Ann Nigerian Med 2010; 4(1): 18-20.

- 17. Shinde N, Baad R, Nagpal DK, Prabhu PR, Surekha LC, Karande P. Managing HIV/ hepatitis positive patients: present approach of dental health care workers and students. J Contemp Dent Pract. 2012 Nov 1; 13(6):882-5. Epub 2012 Nov 1.
- 18. Singh A and Jain S. Prevention of hepatitis B; knowledge and practices among medical students. Healthline.2011; 2(2): 8-11.
- Singh A, Purohit BM, Bhambal A, Saxena S, Singh A, Gupta A. Knowledge, attitudes, and practice regarding infection control measures among dental students in Central India. J Dent Educ. 2011, 75(3):421-27.
- Spijkerman IJ, van Doorn LJ, Janssen MH, Wijkmans CJ, Bilkert-Mooiman MA, Coutinho RA, et al. Transmission of hepatitis B virus from a surgeon to his patients during highrisk and low-risk surgical procedures during 4 years. Infect Control Hosp Epidemiol 2002; 23:306-12.
- 21. Vasanthakumar AH, D'Cruz AM. Awareness regarding hepatitis B immunization among preclinical Indian dental students. J Oral Health Oral Epidemiol 2013; 2(2): 97-101.

A SURVEY ONFARKING MANAGEMENT SYSTEM AND DESIGN OF INTELLIGENT VEHICLE PARKING MANAGEMENT SYSTEM USING VIDEO ANALYTICS

*Neeru Mago and Dr.Satish Kumar

Department of Computer Science and Applications, Panjab University SSG Regional Centre, Hoshiarpur

Abstract

With the rapid development of connectivity and mechanization, vehicle ownership has been increasing quickly. Parking management problems are more urgent in populated areas especially dense ones. Various aspects confirm the importance of promoting intelligent vehicle parking management system. This paper aims to present a review on intelligent systems for parking space detection based on image processing technique along with various applications, challenges and scope of video analytics for improving existing parking management system. An intelligent vehicle parking management system (IVPMS) is also proposed to design a real-time optimized Parking Management System based on video analytics.

Keywords: Parking management system (PMS), CCTV, Video Analytics, Image processing.

INTRODUCTION

The industrialization of the world, increase in population, slow paced city development and mismanagement of the available parking space, has resulted in parking related problems. There is a due

need for a secure, efficient and reliable system that can be used for searching the unoccupied parking facility, guidance towards the parking facility, along with the proper management of the parking facility.



Fig. 1: Parking Lots

Currently. most of the existing vehicle parks do not have a systematic system as desired in Fig 1. Most of them are manually managed and a little inefficient. Major problem during Vehicle Park is about time being wasted in parking spaces search. This problem usually occurs in urban areas, where number of vehicles is high as compared to the availability. These ineffective conditions happened due to lack of implementation. Various systems have been implemented to ensure smoothness of traffic in vehicle park area. Transformation from manual to fully automated, computerized systems is now carried out. Entrances are controlled by barrier gates where parking tickets technolo In this part Analytics Section Intelligen Vehicle design a System 6 draws VIDEO /

technology has led to simplifications in many ways.

In this paper, Section 2 provides an overview of Video Analytics (VA). Section 3 will give review of literature. Section 4 describes the challenges of Existing Intelligent systems. Section 5 proposes an Intelligent Vehicle Parking Management System (IVPMS)to design a real-time optimized Parking Management System based on video analytics. And finally Section 6 draws the conclusion of the paper.

VIDEO ANALYTICS (VA)

Video analytics (VA) is the capability of automatically analyzing video to detect and determine temporal

*Corresponding Author: neerumago@pu.ac.in MS received: November 15, 2016; Accepted: December 2, 2016

are used extensively for access purpose. Growth of

and spatial events. This technical capability is used in a wide range of domains including entertainment, health-care, retail, automotive, transport, home automation, flame and smoke detection. safety and security. These algorithms can be used as software on general purpose machines, or as hardware in specialized video processing units.

VA is a new technology and in many domains VA is implemented on CCTV systems, either distributed on the cameras or centralized on dedicated processing systems. It is possible to build other functionalities, such as identification, behavior analysis by the internal representation.

Video analytics is a part of computer vision and thereby of artificial intelligence. Computer vision is an interdisciplinary field that deals with how computers can be made to gain high-level understanding from digital images or videos. Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and in general, it deals with the extraction of high-dimensional data from the real world in order to produce numerical or symbolic information. As a scientific sense, computer vision is concerned to the theory behind artificial systems that extract information from images. The image data can take many forms, such as video sequences, views from multiple cameras, or multidimensional data from a medical scanner. As a technological discipline, computer vision seeks to apply its theories and models for the construction of computer vision systems.

Video analytics is defined as computer vision based surveillance algorithms and systems that extract contextual information from video. This can allow online and post-event detection of events of interest, which is useful for traffic management due to additional data available

REVIEW OF LITERATURE

Al-Kharusi, H. and Al-Bahadly, I. in their paper present an intelligent system for parking space detection based on image processing technique. This system captures and processes the rounded image drawn at parking lot and draws information of available spaces. In this, camera takes photos to show occupancy. With this image, the particular parking vacancy can be known and then the processed information is used to guide a driver to an available car park rather than wasting time to find one. The proposed system has been developed in both software and hardware platform. Faheemet.al in their paper reviews different IPS used for parking guidance, parking management and gives a way to economic analysis. Such system help in problems due to the unavailability of a reliable, efficient and modern Parking system, also the use of different techniques such as Expert Systems, wireless sensor based, fuzzy based. GPS based, Vehicular communication based and Vision based reduces the parking related issues.

Honghai Liu et.al in their paper provides a comprehensive account on theory and application of intelligent video systems and analytics. It enlightsvideo system architectures, tasks, and related analytic methods also clearly demonstrates that the importance of intelligent video systems and analytics play that can be found in various domains such as transportation and surveillance. Research directions are outlined with a focus on what is essential to achieve the goals of intelligent video systems and analytics.

Mohammed Y Aalsalem, WazirZada Khan in their paper [6] proposed a smart Vehicle Parking Monitoring and Management System called CampusSense for Jazan University whose students, faculty and staff members are facing parking problems while parking their cars in parking lots of the University. The key concern of our proposal is to automate the current manual parking system with efficient use of the parking lots. This system leads to reduce the frustration and annoyance of everyone while car parking in the University parking zones.

M. Rizwan and H. A. Habib in their paper proposed secure parking framework based on video analytics for human activity recognition and user interaction through smartphone application. Machine learning algorithms for human activity recognition using smart camera were used. Algorithms were used to process the parking lot video to extract meanings form human activities while mobile phone application was used to communicate with the user. Image registration algorithm marked incoming and leaving vehicles to keep track of available parking bins. Activities happening in the parking area e.g. human-vehicle human-human interaction, parking, interaction. entering and exiting the parking lot were recognized using support vector machine classification on space time features representation of the scene. In order to train and test the activity identification algorithm real world video dataset VIRAT (1.0) were used. Video analytics algorithms were embedded into smart camera hardware. Video backup was maintained at backend surveillance server.

Qing Tian et. al in their paper present paper introduces an intelligent parking management system based on LPR (License Plate Recognition), recognizing license plate automatically at the parking lot access and realizing vehicle information integrated management conveniently. In the system, LPR is carried out through video streaming frame by frame to choose the best result with a high speed. After accurate LPR. the vehicle information, such as LP number, LP color, car type and access time, will be stored in system database also the system interface is designed very friendly and simple for administrators to operate. which can largely improve the whole performance of LPR system. Experiments show that this system can achieve high correct rate at 95%, and can be applied to real-time implementation.

R. Yusnitaet.al in their paper designed an intelligent parking space detection system based on image processing. With identification of images drawn at parking lot as a reference on image detection, it makes detection of image as a reference more efficient compared to the use of a moving object. The conceptualization of this project is to discover the parking system by usage of image processing rather than sensor base. Intelligent parking system (IPS) is developed using an integrated image processing approach to reduce cost of sensor and wiring hassle.

Vanessa W.S. Tang, Yuan Zheng and Jiannong Cao in their paper describe a Wireless sensor networks (WSN) based intelligent car parking system. In the system, low-cost wireless sensors are deployed into a car park field, with each parking lot equipped with one sensor node, which detects and monitors the occupation of the parking lot, this status is detected by sensor nodes is reported periodically to a database via the deployed wireless sensor network and its gateway. The database can be accessed by the upper layer management system to perform various management functions, such as finding vacant parking lots, auto-toll, security management, and statistic report. A prototype of the system is implemented using crossbow motes. The system evaluation shows the effectiveness of our proposed car parking system.

CHALLENGES IN THE EXISTING SYSTEMS

Though with many useful approaches towards such analysis, there still remain certain areas that need to

be improved on with accuracy and reliability being the major limitations in the systems before intelligent systems to completely take over. However the researchers are making a valiant effort to improve the methods mainly in the following aspects.

i. Real - Time Applicationand Computational Complexity

Intelligent systems often require real-time processing for quick responses. Analysis has to be performed at the frame rate of the video system. However, computer vision often takes very complex computations. The computational complexity restrains the systems of real-time application.

ii. Reliability and Flexibility

Reliability and flexibility are mostly concerned in practical applications. A good Intelligent system should be flexible in different environments and weather conditions, with varying illuminations, initial parameters, predefined conditions, as well as rain, snow, shadows, noises, and occlusions.

iii. Efficiency and Accuracy

Both efficiency and accuracy are important factors in IVPMS. Unfortunately, they cannot always be satisfied with both sides. In all analytic methods of object detection, tracking, background subtraction, 3D sensing, learning, classification, video text detection, behavior detection, and event recognition, there are still many challenges to achieve better accuracy. IVPMS is often required with extensive computation of visual information, but also given the detection task of object so revents. Even without considering the efficiency, the accuracy of current system is still very low.

iv. Distributed and Networked

Nowadays, there are hundreds of thousands of cameras distributed on one of many cites. Distributed smart cameras represent important future IVPMS systems. However, networked and centralized analysis and control become more important than everfor efficient use of all of the video sources. Simultaneously, factors of coding, encryption, packetization, authentication, and transcoding have to take into consideration for data security in the networks.

v. Hardware and Software for Video Processing

Researchers are pursuing new generation of hardware devices and software strategies so that

artificial vision can understand much of what biological vision can. Kohler et al. recently designed a smart camera with an array of elementary motion detectors, where the motion-detection directions and the angle between correlated receptors are reconfigurable online. It allows a flexible and simultaneous detection of complex motion fields such as translation, rotation, and zooming. The compact device benefits many motion-based applications such as obstacle avoidance, distance control, and speed regulation.

INTELLIGENT VEHICLE PARKING MANAGEMENT SYSTEM (IVPMS)

An intelligent vehicle parking management system (IVPMS) in Fig 2 is proposed to design a real-time optimized Parking Management System based on video analytics which will be helpful to allocate vehicles with the available parking slot number at entry point. People need not to get frustrated in finding the vacant parking area by circling round and round the parking lot. It will also eliminate the need of human assistant guiding people where to park.



Fig 2: Intelligent Vehicle Parking MANAGEMENT System(IVPMS) using Video Analytics

IVPMS mainly consists of two modules:

i) User Interface Module (UIM): This module provides the application-based user interface where a new vehicle arrived at entry-point of the parking lot. Here the free lot availability will be checked from database and if a lot is free, the Ticket will be generated that contains the vehicle no., time and date of entry and parking lot no. during exit, the same Ticket submitted by the owner of the vehicle will be matched from the database to generate the bill as per the hours used for the parking area. ii) Real-Time Parking lot Module: This module provides the real-time detection of free parking lot using image processing techniques. Ahigh resolution CCTV Camera is installed in the parking area which will capture videos of parking lot 24*7 and store it in Video Server/Repository where various video/image processing techniques be applied for detection of available parking lot.

Applications of Proposed System

 To automate the Parking Management System (PMS) using video analytics techniques.

- An automatic parking system is used to make the whole process of parking vehicles more efficient and less complex for both drivers and administrators.
- iii. To capture information about the vehicles entering and exiting from the parking lot.
- iv. To help people by allocating parking slot at entry point. Thus saving their time which is otherwise wasted in finding the parking slot themselves or guided by humans.
- v. To count the number of vehicles and the time duration for which they have parked in the parking lot.
- vi. To read the number plate of the vehicle.
- vii. The information related to vehicles stored in the database can be helpful for making decisions and policies at organizational level.
- viii. The system can be used for traffic management.

CONCLUSION

In this paper, a survey is conducted on various parking management systems is conducted and a design of Intelligent Vehicle Parking Management System (IVPMS) is proposed. It involves installation of high resolution CCTV Camera at a fixed location above the systematic parking area, capture videos of parking lot 24*7 and storing it in Video Server/Repository where various video/image processing techniques be applied for detection of available parking lot. It will also enhance and automate the manual system of finding parking lot for the vehicles. Furthermore, video repository can be efficiently organized and analyzed using Video Analytics techniques. The system can be further enhanced for video surveillance and security purpose.

REFERENCES

- Al-Kharusi, H. and Al-Bahadly, I. (2014) Intelligent Parking Management System Based on Image Processing. World Journal of Engineering and Technology, 2, 55-67.
- Faheem, S.A. Mahmud, G.M. Khan, M. Rahman1 and H. Zafar, A Survey of Intelligent Car Parking System. Journal of Applied Research and TechnologyVolume 11, Issue 5, October 2013, Pages 714–726.
- Honghai Liu et.al, Intelligent Video Systems and Analytics: A Survey. IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, VOL.9, NO.3, AUGUST 2013, pg 1222-1233.
- Mohammed Y Aalsalem, WazirZada Khan, CampusSense - A Smart Vehicle Parking Monitoring and Management System using ANPR Cameras and Android Phones. ICACT Transactions on Advanced Communications Technology (TACT) Vol. 5, Issue 2, March 2016, pg 809-815.
- M. Rizwan, H. A. Habib, Video Analytics Framework for Automated Parking. Technical Journal, University of Engineering and Technology (UET) Taxila, Pakistan Vol. 20 No.IV-2015, pg 87-94.
- Qing Tianet.al., Design of Intelligent Parking Management System Based on License Plate Recognition. JOURNAL OF MULTIMEDIA, VOL. 9, NO.6, JUNE 2014, pg 774-780.
- R. Yusnita, FarizaNorbaya, and Norazwinawati Basharuddin, Intelligent Parking Space Detection System Based on Image Processing. International Journal of Innovation, Management and Technology, Vol. 3, No. 3, June 2012, pg 232-235.
- Vanessa W.S. Tang, Yuan Zheng, Jiannong Cao, An Intelligent Car Park Management System based on Wireless Sensor Networks. 2006 1st International Symposium on Pervasive Computing and Applications, pg 65-70.

TEXT FEATURE SPACE OPTIMIZATION USING ARTIFICIAL BEE COLONIZATION

*Pallavi Grover and Sonal Chawala

Department of Computer Science & Application, Panjab University, Chandigarh

Abstract

With the rapid growth of Internet, more and more natural language text documents are available in electronic format, making automated text categorization a must in most fields. Given that, text classification task suffers with a major issue of high dimensional feature space. This results in inaccurate classifications and requires large amount of computational time & resources. One way to look at this problem is to treat it as an optimization problem. Existing feature set can be reduced in dimension by using one of the recently developed, nature inspired algorithm (Artificial Bee Colony) along with semantic value of features. The proposed study aims at developing framework for optimization of feature space which is used to represent set of categories in text classification. The research work intends to utilize a recently developed, Artificial Bee Colonization algorithm along with semantic similarity scores. The outcome of this work is likely to increase efficiency and accuracy of classification by optimization of feature set. Also since classification will be done based on semantics, unlike syntactic value of words, it is likely that there will be enhancement in precision of classification. Although a prototype is proposed to be developed and tested using specific datasets, the suggested framework will be applicable to all areas where feature selection is still a bottleneck in text classification applications.

Keywords: Text Classification, Artificial Bee Colony, Feature Space, Support Vector Machine, Naive Bayes, k-Nearest Neighbor, Supervised Learning

INTRODUCTION

A. Text Classification

Text classification is a task of assigning predefined categories to free- text documents. It can provide conceptual views of document collections and has important application in the real world. For example, news stories are typically organized by subject categories (topics) or geographic codes; academic papers are often classified by technical domains and sub-domains; patient reports in health care are often indexed from multiple aspects, using taxonomies of disease categories, types of surgical procedures, insurance reimbursement codes and so on.

More explicitly, If diis a document of the entire set of documents D and {c1, c2,cn} is the set of all the categories, then text classification assigns one category cjto a document dj. There are two types of classification approaches: Supervised and Unsupervised Learning. Text classification is mostly done using supervised learning techniques, though attempts have been made using unsupervised learning algorithms as well.

In unsupervised learning, the label of pattern is unknown class. In this type of learning scheme classifier automatically develops a label for each pattern. Unsupervised algorithm search for similarity between each sample of data in order to determine whether they can be characterized by forming a group or cluster. There are a number of unsupervised machine learning techniques used for clustering. The most popular approaches include: neural networks, k-means, hierarchical clustering.

In supervised learning, the input sample is identified as member of a predefined class. These classes can be conceived of as finite set, defined a priori based upon human knowledge or some other domain specific expertise. In these algorithms, a segment of data is labeled as per known classifications and the objective is to search for patterns and construct mathematical models. These models then are evaluated on new data instances on the basis of their predictive capacity. Widely used learning algorithms are K-Nearest Neighbor, Support Vector Machine, Rocchio, Decision Tree induction, Naive Bayes etc.

B. Vector Space

The task of text categorization requires the document to be transformedinto a vector. Each dimension

of this vector corresponds to a term present in the whole dataset. If a term ever occurs in a document, its occurrence will be a non-zero. A document may require 100s of terms for its representation in vector form. Therefore, it brings a critical question: should we use all the terms appeared in the datasets? Or should we just select some representative terms considering the fact that there are so many terms in a dataset while not all of them are necessary for text categorization. This problem is known as feature selection in text classification. Feature selection is extremely important for text categorization since it is quite normal to have more than ten-thousand terms in a document dataset. Such high dimensionality makes it very difficult to carry out text categorization using machine learning algorithms. By doing feature selection, not only can we decrease the dimension. but also we can eliminate redundant and irrelevant features, so that classification performance can be improved, learning and executing process can be made faster, and the structure of the learning model can be simplified [1].

C. Semantic Similarity

Semantic similarity is a metric defined over a set of documents or terms, where the idea of distance between them is based on the likeness of their meaning or semantic content as opposed to similarity which can be estimated regarding their syntactical representation (e.g. their string format) [2]. These are mathematical tools used to estimate the strength of the semantic relationship between units of language, concepts or instances, through a numerical description obtained according to the comparison of information supporting their meaning or describing tiveir nature [3].

D. Swarm Intelligence

Swarm intelligence (SI) is the collective behavior of decentralized, self-organized systems, natural or artificial. SI systems consist typically of a population of simple agents or boids interacting locally with one another and with their environment. The inspiration often comes from nature, especially biological systems. The agents follow very simple rules, and although there is no centralized control structure dictating how individual agents should behave, local, and to a certain degree random, interactions between such agents lead to the emergence of "intelligent" global behavior, unknown to the individual agents. Examples in natural systems of SI include ant colonies, bird flocking, animal herding, bacterial growth, fish schooling and microbial intelligence.

LITERATURE SURVEY

Joachims [4] investigates four different methods for document classification: theNaive Bayes classifier, the nearest neighbor classifier, decision trees and a subspace method. These were applied to seven-class Yahoo news groups. Their experimental results indicate that the Naive Bayes classifier and the subspace method outperform the other two classifiers on the data sets.

Nicolosi et al. [5] highlights the problem of feature selection and provides a brief overview of the area of text classification. It discusses Pruning, Random, Chi-Squared, Information Gain, Probability Ratio, Sampling based techniques Document Frequency, Bi-Normal Separation as common approaches to feature selection.

Khan et al. [6] provides a review of the theory and methods of document classification and text mining, focusing on the existing literature. The paper concludes that Information Gain and Chi Square statistics are most commonly used and well performed methods for feature selection among Filter methods available. Support Vector Machine, K-Nearest Neighbor and Naïve Bayes are shown to be most appropriate classifiers in literature.

Mihalcea et al. [7] presents a method for measuring the semantic similarity of texts, using corpus-based and knowledge-based measures of similarity. Through experiments performed on a paraphrase data set, they have shown that the semantic similarity method outperforms methods based on simple lexical matching, resulting in up to 13% error rate reduction with respect to the traditional vector-based similarity metric. They have used Pointwise Mutual Information and Latent Semantic Analysis as Corpus based measures and J&C, Lesk, Lin and W&P, Resnik as Knowledge based measures for similarity.

Bollegala et al. [8], proposed a method that exploits page count and text snippets returned by a web search engine and defined various semantic similarity scores for two given words P and Q using page counts for the queries 'P','Q' and 'P AND Q'. Those different similarity scores have been integrated using SVM to leverage a robust semantic similarity measure. Results show that the proposed measure outperforms all the existing web based similarity measures by wide margin achieving a correlation coefficient of 0.834 with an improvement in accuracy (F-Measure of 0.78).

Singh et al. [9] uses unsupervised classification of documents into similar groups. using Heuristic K-means and fuzzy C-means algorithm for text clustering. Their experiment over standard datasets and conclude that fuzzy clustering produces better results than both K-Means and Heuristic K-Means on almost all datasets and is more stable method. It was observed that tf.idf produces better clustering results. Heuristic K means performs the best out the three for tf.idf feature used, with and without stop word removal and stemming done respectively.

Kim et al. [10] talks about dimension reduction method using Centroid, Orthogonal Centroid, and LDA/GSVD. For comparison, they also applied LSI/ SVD, which does not attempt to preserve cluster structure upon dimension reduction. Testing has been done on SVMs, kNN, and centroid-based classifiers. For the three cluster-preserving methods, the results show surprisingly high prediction accuracy, which is essentially the same as in the original full space. Results with the Centroid dimension reduction method became better compared to those from the full space for the completely disjoint MEDLINE data set, but became worse for the REUTERS data set. Experimental results showed that with several dimension reduction methods that are designed particularly for clustered data, higher efficiency for both training and testing can be achieved without sacrificing prediction accuracy of text classification even when the dimension of the input space is significantly reduced.

Dorigo et al. [11] is a research article that talks about Ant Colony Optimization. The goal of article was to introduce ant colony optimization and to survey its most notable applications providing background information on the foraging behavior of ants. Multiple Objectives dynamic modifications of the data, and the stochastic nature of the objective function and of the constraints, have been suggested as future application areas. Towards the end it provides an overview of some other algorithms that, although not directly related to ACO, are nonetheless inspired by the behavior of ants.

Karaboga et al. [12] compares the performance of ABC algorithm with that of differential evolution (DE), particle swarm optimization and evolutionary algorithm (EA) for multi-dimensional numeric problems. The performance is evaluated on five numerical benchmark functions. The behavior of ABC algorithm under different control parameter values has also been analyzed. Simulations results show that the performance of ABC algorithm is comparable to those of the mentioned algorithms and can be efficiently employed to solve engineering problems with high dimensionality.

Karaboga et al. [13] discusses how ABC has been used for data clustering on benchmark problems and the performance of ABC algorithm has been compared with ten classification techniques. Thirteen of typical test data sets from the UCI Machine Learning Repository have been used to demonstrate the results of the techniques. For each problem, Classification Error Percentage (CEP) was calculated. The result shows that ABC algorithm outperforms in 12 problems. Test Error rates and Ranking(as given to all the techniques, based on their performance) show that clustering with ABC offers superior generalization capability.

RESEARCH GAP

As evident from the literature review text classification suffers from several issues, high dimensionality feature space being a major one. Also it is clear that, feature space is vital to every category given in classification problem. So when a new/test document comes in, its features are extracted and compared to the set of features of every category and the class of new/test document is decided using those features. Evident from the description, size of the feature space can go up to order of 10,000 words. Clearly large number of feature comparisons are required between new/test and existing feature set to deduce category of new/test document. One way to look at this problem is to treat it as an optimization problem. Existing feature set can be reduced in dimension by using one of the recently developed nature inspired algorithm. To further elaborate, traditional text classification has been mostly done using bag of words concept where the syntactic value, i.e. the word itself is taken into account. There is no mention of the meaning of the words in the feature set. This work intends to perform the classification process taking semantics into account thereby increasing the correctness of classification. Hence designing a framework for optimizing feature space using semantics can be a valuable and necessary area of research.

RESEARCH METHODOLOGY

The research methodology will have the following stages:

- Designing framework for feature space optimization: This stage will consist of in-depth study and identification of classifier, preprocessing techniques and feature selection using filtration approach to be used for development of framework for the proposed work.
- Building a prototype for suggested framework: A prototype of the proposed framework will be developed to study the effectiveness.
- Evaluating the prototype: Prototype developed in the previous stage will be implemented for testing and will be compared with traditional classification methods.

DETAIL DESIGN

Data Acquisition: Standard datasets used in text classification will be used [14].The datasets will be divided into two parts namely Training documents and the testing documents. Training Data Set refers to the collection of records whose class labels are already known and is used to build the categorization model. It is then applied to the test data set. Test Data Set refers to the collection of records whose class labels are known but when given as an input to the built categorization model, should return the accurate class labels of the records. It determines the accuracy of the model based on the count of correct and incorrect predictions of the test records [17].

Pre-processing: This stage involves basic sieving of relevant and irrelevant terms. Converting the text document in particular format, tokenization, stemming, removal of stop words etc are part of pre-processing the document.

Feature Set (FS): After pre-processing a basic feature set shall be created, at this stage which can be of the order of 10000 words. Dimension of this feature set can be further reduced using Filter and Wrapper Approach.

Filter Approach: Fig.1 explains the working of filter selection approach [18]. This approach doesn't require induction algorithm for feature selection. Document Frequency, Information Gain, Mutual Information, Chi Square Test, Term Strength are few approaches available in this category. Chi Square test is found to the best filter approach in literature [19] [20] and will be used in this work.



Fig. 1: Feature Selection using Filter Approach

Feature Space Optimization: At this stage wrapper approach is used (as shown in fig.2). Several classifiers are available in literature like Naïve Bayes, KNN, Decision Trees, and Support Vector Machines etc. Support Vector Machine is considered to have achieved the best results for text classification as shown in table 1 and table 2 [15]. On the contrary, [16] claims KNN and Naïve Bayes to be the best classifiers. It's worth nothing that text classification performance depends on the classifier used, so identification most appropriate classifier will be done. Comparison will be made among SVM, Naïve Bayes and kNN. Out of these, two classifiers will be chosen. Next task will be feature space reduction using recently developed, swarm intelligent algorithm called Artificial Bee Colony Algorithm. Several swarm intelligent algorithms exist in literature but ABC has been cited as best optimization algorithm based on the results achieved on benchmark datasets [12] [13]. This algorithm will make use of similarity function for evaluating semantic relatedness among the terms representing the feature set.

Table 1: Naïve Bayes self-feature selection [15]

Percentage (%)	With Ste Feature (%)	emming Accuracy	Without S Features (%)	Stemming Accuracy
100	3669	70.2	5704	65.4
90	3302	68.8	5134	67.4
80	2935	71.5	4563	73.6
70	2568	76.5	3993	77.7
60	2201	80.6	3422	80.4
50	1835	81.7	2853	83.8
40	1468	84.1	2282	86.3
30	1101	88.7	1711	89.2
20	734	88.0	1141	91.8
10	367	-	570	92.4



Fig. 2: Detailed design of the proposed framework

Termination: A feature selection process will be terminated under one of the following criteria, as cited in literature [21] [22]:

- 1. Whether the search is complete.
- 2. Whether a predefined size of feature subsets is selected.
- 3. Whether a predefined number of iterations are executed.
- 4. Whether an optimal or sufficiently good feature subset according to the evaluation function has been obtained.
- 5. Whether the change (addition or deletion of features) of feature subsets does not produce a better subset.

Final FS: The feature set obtained after achieving the termination criteria is the final, optimised set which classifier will refer to, to classify test document.

101

Table 2: SVM self-feature selection [15]

Percentage (%)	With Stemming Feature Accuracy (%)		Without S Features (%)	Stemming Accuracy
100	3669	69.5	5704	67.0
90 ·	3302	66.3	5134	67.1
80	2935	65.7	4563	72.8
70	2568	66.3	3993	76.7
60	2201	65.2	3422	82.4
50	1835	62.0	2853	85.9
40	1468	62.0	2282	8.88
30	1101	61.4	1711	89.7
20	734	63.6	1141	91.2
.10	367	66.3	570	94.1

EXPECTED OUTCOME

The major problem in text classification is high dimensional vector spaces which hampers classification results in terms of accuracy. So the outcome expected of this work is increase in efficiency and accuracy of classification by optimization of feature set defining every category. Also since classification will be done based on semantics, unlike syntactic value of words, it is likely that there will be enhancement in precision of classification. It is well understood by now that vector spaces are of the order of thousands or ten thousands. But with their optimization an implicit outcome expected is, that the whole process will consume lesser time in comparison to text classification done using traditional methods.

PROPOSED VALIDATION

Cross-validation procedure is the most regularly used to evaluate the performance of a classifier. In k-fold cross-validation, the data is divided into k subsets of (approximately) equal size. The classifier is trained times, each time leaving out one of the subsets from training, but using only the omitted subset to compute the classification accuracy. Leave-one-out (LOO) cross-validation (CV) is a special case of k-fold crossvalidation where k equals the sample size.

Based on classifier selected:

 Each classifiers performance shall be evaluated using metrics Precision, Recall and F-Measure following cross validation technique · Performance of both classifiers will be evaluated.

With respect to traditional Classification techniques:

• The two-shortlisted classifier's performance will be evaluated with traditional classifiers.

SIGNIFICANCE OF WORK

Text Classification has its application in several areas like spam filtering, genre classification, sentiment analysis etc. It suffers from an inherent issue of high dimension feature space which not only slowers the classification process but also makes it prone to inaccurate classification process. The major reason of taking up dimensionality reduction and its optimization as major problem is to increase classification accuracy which will help in making the process precise, efficient and rapid in comparison to the tradition methods of classification. Another aspect is to introduce semantics in text classification. This translates into taking meaning of words, in given vector space, into account than just the word itself.

REFERENCES

- [1] Xue B., Zhang M. and Browne. W.N., Single feature ranking and binary particle swarm optimization based feature subset ranking for feature selection, in Proceedings of the Thirty-Fifth Australasian Computer Science Conference - Volume 122, Melbourne, Australia, 2012, pp. 27-36.
- [2] SemanticSimilarity-Wikipedia. http://en.wikipedia. org/wiki/Semantic_Similarity
- [3] Harispe S., Ranwez S. Janaqi S., Montmain J. Semantic Similarity from Natural Language and Ontology Analysis (2015).Synthesis Lectures on Human Language Technologies8:1: 1–254.
- [4] T. Joachims. Text categorization with support vector machines: Learning with many relevant features. In Proceedings of the European Conference on Machine Learning, pages 137–142, Berlin, 1998
- [5] Nicolosi. N., Feature Selection Methods for Text Classification, November 7, 2008
- [6] Bloehdorn, S. and Hotho, A. Boosting for text classification with semantic similarity features. In Proc. of the 6th international conference on Knowledge Discovery on the Web: advances in Web Mining and Web Usages Analysis (Seattle, WA, 2006). Springer-Verlag

102

- [7] Mihalcea, R., Corley, C. and Strapparva, C. Corpusbased and knowledge-based measures of text semantic similarity. In Proc. of the 21st national conference on Artificial Intelligence-Vol 1 (Boston, 2006) AAAI Press
- [8] Bollegala, D., Matsao, Y. and Ishizuka, M. Measuring Semantic Similarity between Words Using Web Search Engines. In Proc of 2007 international world wide web conference committee, ACM
- [9] Singh, K.V., Tiwari, N. and Garg, S. Document Clustering using K-Means, Heuristics K-Means and Fuzzy C-Means. In Proc of 2011 international conference on Computational Intelligence and Communication Systems
- [10] Kim, H., Howland, P. and Park, H. Dimension Reduction in Text Classification with Support Vector Machines, Journal of Machine Learning Research 6 (2005)
- [11] M. Dorigo, T. Sttzle, and M. Birattari.(2006). Ant colony optimization. Computational Intelligence Magazine, 1(4), 28-39
- [12] Karaboga, D. and Basturk, B. On the performance of artificial bee colony (ABC) algorithm, Applied Soft Computing (2008) 687-697
- [13] Karaboga, D. and Ozturk, C. A novel clustering approach: Artificial Bee Colony (ABC) Algorithm, Applied Soft Computing (2011) 652-657
- [14] http://web.ist.utl.pt/acardoso/datasets/

- [15] Bei Yu, An evaluation of text classification methods for literary study, 2008, Graduate School of Library and Information Science, University of Illinois at Urbana-Champaign, USA.
- [16] VaibhavC.Gandhi, Jignesh A. Prajapati Review on Comparison between Text Classification Algorithms, International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)Volume 1, Issue 3, September – October 2012.
- [17]. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data mining, Chapter 4 Pearson Addison Wesley, 2005.
- [18] Wu, Shuang, Comparative Analysis of Particle Swarm Optimization Algorithms for Text Feature Selection (2015).Master's Projects. Paper 386.
- [19] Yiming, Y. And Pederson, J.O., A Comparative Study on feature selection in text categorization 1997
- [20] Rogati. M., Yang. Y. High-Performing Feature Selection for Text Classification, CIKM'02, November 4–9, 2002, McLean, Virginia, USA.
- [21] Tan, Feng, *Improving Feature Selection Techniques* for Machine Learning Dissertation, Georgia State University, 2007.Http://scholarworks. gsu.edu/cs_diss/27
- [22] Dash, M. And Liu, H. Feature selection for classification. International Journal of Intelligent Data Analysis, 1(3), 1997.

PROBIOTIC COCKTAIL MEDIATED SUPPRESSION OF INFLAMMATORY RESPONSE GENERATED IN Shigella dysenteriae type 1 INFECTED HUMAN INTESTINAL EPITHELIAL CACO-2 CELLS.

*Radhika Trikha¹, Naresh Sachdeva², Praveen Rishi³, Rupinder Tewari¹

¹Department of Microbial Biotechnology, Panjab University, Chandigarh, 160014, India ²Department of Endocrinology, Post Graduate Institute of Medical Education and Research, Chandigarh, 160012, India ³Department of Microbiology, Panjab University, Chandigarh, 160025, India.

ABSTRACT

Shigella dysenteriae type 1 is one of the most virulent bacterial pathogens causing contagious diarrhea that can be fatal especially in young children. Though this disease can be controlled by antibiotics, but the emergence of drug resistance has forced the scientists to develop new and natural alternatives to prevent and treat diseases. A study was carried out to assess the effect of novel probiotic cocktail on *Shigella* infected intestinal epithelial Caco-2 cells. Probiotic cocktail of three probiotic lactobacilli namely, *L. rhamnosus*, *L. paraplantarum* and *L. pentosus* isolated from healthy human infants, significantly reduced adherence and internalization of *Shigella* on Caco-2 cells by 61.2% and 74.6%, respectively. Moreover, cell viability of infected Caco-2 cells was significantly increased to 71% by cocktail. *Shigella*mediated acute inflammatory response generated in infected Caco-2 cells was significantly downregulated by cocktail. Our results suggest the use of probiotic cocktail as a natural alternative for treating *Shigella* infection.

Keywords: Probiotic, Lactobacillus, Shigella dysenteriae, Caco-2 cells, inflammation.

INTRODUCTION

Worldwide, gastrointestinal infections caused by myriad of microorganisms have become a major cause of morbidity and mortality, especially in developing countries. Shigellosis, a gastrointestinal infection caused by group of bacteria under the genus Shigella, has turn out to be the foremost reason for casualties resultant of gut infections (Sureshbabu et al., 2016). Shigella belongs to family enterobacteriacea and is grouped into 4 species i.e. Shigella boydii, S. dysenteriae, S. flexneri and S. sonnie. Out of 4 species S. dysenteriae receives special attention due to its role in causing deadly epidemic dysentery outbreaks, particularly in developing countries where incidences occur 20 times more in comparison to developed countries (Sureshbabu et al., 2016). S.dysenteriae serotype 1 (Sd1) is one of the most virulent serotype of S. dysenteriae owing to its low infectivity dose of 10-100 cells, emerging antibiotic/ drug resistance, lack of vaccine counterparts and secretion of cytotoxic, enterotoxic and neurotoxic Shiga toxin (Marteyn et al., 2012). Globally, 164.7 million cases per year of shigellosis are estimated, of which nearly 163 million incidences occur in developing nations. Further, line of concern is drawn based on fact that 60% of all the cases and 61% of all the deaths due to shigellosis arise in children below 5 years (Sureshbabu et al., 2016).

Sd1 causes excruciating dysentery by invading colonic mucosa and generating acute inflammatory response (Niyogi, 2005; WHO., 2005; Moorthy *et al.*, 2010).

The foremost step for Shigella to destruct colonic epithelium is its adherence to intestinal epithelial cells (Moorthy et al., 2010). Once Sd1gets adhered to epithelial cells it gets internalized where it starts replicating and subsequently generates host immune response (Moorthy et al., 2010). The key determinant of shigellosis is ability of Sd1to adhere, invade and colonize intestinal lining (Moorthyet al., 2010; Niyogi, 2005). Direct contact between Shigella and host cell is required for entry and invasion of Shigella in epithelial lining, further expressing virulent effector molecules that leads to inflammation damage of intestinal lining (Parsot and Sansonetti, 1996; Francois et al., 2000). Human epithelial cells possess various toll like receptors (TLRs) belonging to family of transmembrane proteins that act as cellular effectors for microorganism detection and play role in activating signal pathways for directing both innate and adaptive immune responses (McClure and Massari, 2014). Lipopolysacchride (LPS) of Sd1 is mostly detected by TLR4 of intestinal epithelium (Moorthy et al., 2010; Raja et al., 2011). Activated TLRs and shiga toxin released by Sd1 activates array of signalling molecules such as nuclear transcription factor (NF- $\kappa\beta$) which further gets translocated to the nucleus upon activation and trigger gene induction resulting in elevated expression of inflammatory cytokinespredominantly interleukins (IL) such as IL-1, IL-8, Tumour necrosis factor-alpha (TNF- α), IL-6 etc. (Bharrhan *et al.*, 2011; Philpott *et al.*, 2000, 2004; Schroeder and Hilbi, 2008). Signal cascade of inflammatory cytokines and chemokines leads to onset of mucosal inflammatory damage during infection (Schroeder and Hilbi, 2008).

In the last decade, the role of probiotics in controlling bacterial infections is on the rise (Mikelsaar, 2011a, b; Gowry et al., 2016). However there are limited numbers of reports on use of probiotics for the control of Sd1. Only a few Lactobacillus strains such as L. acidophilus, L. rhamnosus, L. casei and L. fermentum are reported in literature possessing anti-Shigella activity (Alam and Bhatnagar, 2006; Moorthy et al., 2007; Nawaz et al., 2011). There are several reports documenting ability of probiotic lactobacilli to inhibit pathogenic adherence and invasion of colonic epithelium (Abedi et al., 2013). There has been significant increase in preventive and therapeutic potential of probiotic microorganisms generally belonging to Lactobacillus and Bifidobacterium genus (Kechagia et al., 2013). The term "immuniobiotics" has been used for probiotics that promote host health by modulating mucosal immune system of host. Lactobacilli are widely documented to exhibit protection against enteropathogens mediated inflammation of intestinal lining and this protection is credited to the alteration in balance between secretion of pro-inflammatory and anti-inflammatory cytokines in epithelial lining (Alvarez et al., 2009; Hormannsperger and Haller, 2010). Lactobacilli strains are also reported to regulate inflammatory reactions initiated by bacterial infection by down-regulating expression levels of pro-inflammatory cytokines and up-regulating antiinflammatory cytokines (Borruel et al., 2002; Tien et al., 2006; Hakansson and Molin, 2011; Wells, 2011).

In the present study, probiotic lactobacilli were accessed for their potential to reduce adherence and internalization of Sd1to intestinal epithelial Caco-2 cellsalong with immunomodulatory changes brought by them to create tolerating environment that can prevent over induced inflammatory response imperative for disease development.

MATERIALS AND METHODS

Bacterial strains growth and maintenance

Shigella dysenteriae sero type 1 was procured from

Department of Microbiology, Post Graduate Institute of Medical Education and Research, Chandigarh, India. Growth was attained in Luria Bertani (LB) broth (Hi Media; India) on incubation at 37°C on 180 rpm for 16-18 hours before use. Probiotic lactobacilli isolated from human infants' faeces, identified using 16SrRNA gene sequencing identification methodas *L. pentosus* [KJ802480], *L. paraplantarum* [KJ802481] and *L. rhamnosus* [KJ802482] were used to carry out present study. Lactobacilli strains were grown in De Man Roger Sharpe (MRS,Hi Media; India) medium under static conditions at 37°C for 24 hours before use.

Cell line growth and maintenance

Caco-2 cell line was procured from National Cell Culture Collection (NCCS), Pune, India. The cells were grown and maintained in Dulbeco's Modified Eagles Medium at 37°C in presence of 95% air and 5% CO_2 till the confluency was achieved. Once Caco-2 cells attained confluency, they were maintained in DMEM medium for 2 weeks for obtaining fully differentiated form, before performing experiments.

Experimental design

Three probiotic lactobacilli, L. pentosus, L. paraplantarum and L. rhamnosus were used for cell line studies. Experiment was performed in 8 different groups which are as a) control group (C) consisting of Caco-2 cells infected with Sd1, b) treatment group 1 (T1) consisting of L.pentosus+ Caco-2 cells + Sd1, c) Treatment group2 (T2) comprising L. paraplantarum+ Caco-2 cells+Sd1, d) Treatment group 3 (T3) having L. rhamnosus+ Caco-2 cells+ Sd1, e) treatment group 4 (T4) with L. pentosus+ L. paraplantarum +Caco-2 cells+ Sd1, f) treatment group 5 (T5) with L. pentosus + L. rhamnosus+ Caco-2 cells+ Sd1, g) treatment group 5 (T6) with L. paraplantarum + L. rhamnosus +Caco-2 cells+ Sd1, h) treatment group 6 (T7) comprising all the three lactobacilli, L. pentosus+ L. paraplantarum+ L. rhamnosus +Caco-2 cells+ Sd1.

Caco-2 cells $(1 \times 10^6 \text{ cells/ ml})$ were grown as monolayers in 6 well tissue culture plate, once fully differentiated Caco-2 cells monolayer was attained, Sd1 $(1 \times 10^8 \text{ cells/ ml})$ and probiotic lactobacilli $(1 \times 10^8 \text{ cells/ ml})$ as per treatment group were co-seeded in 6 well tissue culture plates, with MOI (1:100) and kept for 5 hours of incubation at 37°C in presence of 95% air and 5% CO₂ to carry out adherence and internalization assay in accordance with Moorthy *et al.* (2010).

Estimation of Adherence and Internalization of Sd1on Caco-2 cells

Adherence and internalization of Sd1 to Caco-2 cells in presence of various probiotic lactobacilli treatment groups was carried out in seven treatment groups and one control group. After 5 hours of incubation, medium was completely removed from wells of tissue culture plate and Caco-2 cells were properly washed thrice with PBS (10mM, pH 7.0) to remove unadhered bacteria.

Enumeration of adhered bacteria (A): To compute number of adhered Sd1 on Caco-2 cells, Caco-2 cells were trysinized with 1 ml of trpysin-EDTA solution (0.025%; HiMedia, India) and further serially diluted and spread plated on Deoxycholate agar (DCA, HiMedia, India) plates. Plates were incubated for 24 hours and number of colony forming units/ml (cfu/ ml) of Sd1 were calculated. Use of specific medium (DCA) for evaluating number of Sd1 adhered to the Caco-2 cells avoided interference in calculating number of Sd1 adhered to the Caco-2 cells as DCA medium only supports distinct growth of Sd1.

Enumeration of internalized bacteria (I): Similarly number of internalized Sd1 in Caco-2 cells was calculated by lysing Caco-2 cells in tissue culture plates by 0.5% triton X 100 for 10 minutes. Cell lysates were serially diluted, spread plated on DCA plates and kept for incubation for 24 hours at 37°C. Plates were observed and number of colony forming units/ml of Sd1 was computed as B. Number of internalized bacteria was calculated by using following formula:

Internalized bacteria (I) = B-A

Examining cytotoxicity of Sd1 infected Caco-2 cells in presence of probiotic lactobacilli

Cell viability of Caco-2 cells was calculated in accordance to 3-(4, 5-dimethyl thiazole 2 yl)-2,5diphenyl tetrazolium bromide (MTT) cytotoxicity assay (Moorthy et al., 2010) using Xpert[™]Cell Assay Teaching Kit (HiMedia, India). Cellular oxidoreductases mainly NAD(P)H dependent enzymes are capable of reducing MTT into insoluble end product, formazan, which is purple coloured and spectrophotometrically detected. Hence, amount of formazon formed reflects the number of viable cells in the sample. The Caco-2 cells were divided into groups consisting of uninfected Caco-2 cells (C1), Caco-2 cells infected with Sd1 (C2), Caco-2 cells co-incubated with Sd1 and probiotic lactobacilliin different individual and combinational treatment groups (T1-T7) as mentioned above in experimental design. Percentage cell viability of Caco-2 cells was calculated as stated by Moorthy et al. (2010).

Expression analysis of immunomodulatory genes-a) qualitative reverse transcriptase PCR (RT-PCR) and b) quantitative real time PCR (qPCR)

Fully differentiated Caco-2 cells (10⁶cells/ml)were divided into three groups to carry out expression analysis of genes for toll like receptors (TLR-2, TLR-4, TLR-9), nuclear transcriptional factor (NF- $\kappa\beta$), pro-inflammatory cytokines (IL-1β, IL-8, TNF-α) and anti-inflammatory cytokines (IL-10, TGF-B) with B-actin as housekeeping gene. Control group (C) consisted of fully differentiated normal un-infected Caco-2 cells (10⁶cells/ml). The infective group (I) consisted of fully differentiated Caco-2 cells seeded with 1 ml Sd1 (10°cfu/ml) and treatment group (T) contained fully differentiated Caco-2 cells co-seeded with 1 mI Sd1 (109 cfu/mI) and 1 mI of probiotic cocktail of L. pentosus, L. paraplantarum and L. rhamnosus (10⁹ cfu/ml). All the groups were incubated for 5 hours at 37°C in presence of 95% air and 5% CO₂. After 5 hours of incubation, ribonucleic acid (RNA) was extracted from Caco-2 cells from the respective control, infection and treatment groups of Caco-2 cells using trizol reagent (Invitrogen, Thermo-fisher scientific, California, USA) in accordance with manufactures specifications for performing RNA extraction. All RNA samples used in the study were treated by DNase I (ThermoFisher Scientific, California, USA) as per manufacturer guidelines. RNA (500µg) extracted from normal, infected and treated Caco-2 cells was converted to Complementary Deoxyribonucleic Acid (cDNA) using RevertAid first strand cDNA synthesis kit (ThermoScientific, Massachusetts, USA) using oligo (dT)₁₈ primer, RiboLock RNase inhibitor (20 U/ µI), 10mM dNTP mix, RevertAid M-MuLV reverse transcriptase (200 U/ µl) in 20 µl of reaction mixture and was amplified for 60 min at 42°C, followed by heating at 70°C for 5 min to terminate the reaction.

a) RTPCR: cDNA obtained from control group, infection group and treatment group was subjected to the PCR using set of primers (Origene Technologies, Rockville, USA) as mentioned in table 1. All the primers were reconstituted in milli-Q water as per manufacturer specifications to obtain 100 µM primer stock solutions. Working stock solution of primer sets was further obtained by diluting primer stock solution 10 times further. PCR reactions were carried out in thermocycler (Mastercycler nexus gradient, Eppendorf, Germany). b) qPCR: Quantification of gene expression was carried out by performing real time polymerase chain reaction (gPCR) using SYBR green dye (Fermentas, Thermo-Scientific, Massachusetts, USA). gPCR was carried out in Light cycler 480 (Roche, Basel, Switzerland) and was programmed aspreincubation at 95°C for 10 min, amplification step at 95ÚC for 15 sec, 62°C for 20 sec, 74°C for 20 sec for 40 cycles, melting at 95°C for 1 sec and 67°C for 1 minutes followed by cooling at 40°C for each reaction, respectively. Melting curve analysis showing single peak was carried out to confirm product specificity. The fold difference in gene expression for each gene, relative to β-actin was calculated after normalization of threshold cycle (Cp) value of each gene with β-actin using light cycler 480 software programme (Roche, Bassel, Switzerland) on Roche Light cycler 480 instrument.

Statistical analysis

Results obtained were represented as mean \pm SD. Student t-test was used to calculate difference in mean values between control and treatment groups and expressed in terms of significant differences by use of Graphpad prism software (version 4.3).All the experiments were repeated three times in triplicates.

RESULTS

Effect of probiotic lactobacilli treatment on adherence and internalization of Sd1 on Caco-2 cells

Shigella dysenteriae serotype 1 is one of the most noxious intracellular pathogens that adheres and invade intestinal epithelial cells to cause infection. Probiotics have tendency to adhere, colonize and internalize intestinal epithelial cells. Therefore, pathogen adherence and internalization by intestinal epithelial cells can be reduced in presence of probiotic microorganisms due to competitive inhibition mechanism (Abedi *et al.*, 2013). The viable cells of all the three probiotic lactobacilli *L. pentosus*, *L. paraplantarum* and *L. rhamnosus* were employed individually (T1-T3 groups) and in combination (T4-T7 groups), to evaluate reduction of Sd1 adhesion and internalization on Caco-2 cells. Number of Sd1 (cfu/ ml) obtained in the study are presented in Table 2.

Thirty three percentage and 18.5% of Sd1 cells gets adhered and internalized to intestinal epithelial Caco-2 cells in absence of probiotic microorganisms (C group). Percentage adherence and internalization of Sd1 on intestinal epithelial Caco-2 cells was tremendously reduced when probiotic lactobacilli were co-seeded along with Sd1 as observed in different treatment groups (T1-T7) (Fig. 1). Probiotic cocktail of all the three lactobacilli (T7) led to the maximum reductionin Sd1 adherence (61%; p<0.001)and Sd1 internalization (74.6%; p<0.001) on intestinal epithelial Caco-2 cells, followed by treatment groups (T4-T5) consisting of combination of two probiotic lactobacilli corresponding to reduction in Sd1 adherence to Caco-2 cells ranging from 46.16 to 51.6% and internalization of Sd1 to Caco-2 cells from 67% to 72.8%, respectively. However, when Caco-2 cells were co-seeded with individual probiotic lactobacilli (T1-T3) along with Sd1, L. rhmanosus (T3) exhibited significant reduction in Sd1 adherence (42%; p<0.05) and internalization (61.6%; p<0.05) to intestinal epithelial Caco-2 cells, followed by L. pentosus(T2; 33.6%, 55.4%; p<0.05) and L. paraplantarum(T3; 18.2%, 47.6%; p<0.05), respectively (Fig. 1).

Survivability of Caco-2 cells when co-seeded with Sd1 and probiotic lactobacilli

MTT cell assay was performed to evaluate cell viability ofCaco-2 cells under normal (C1), Sd1 infected (C2) and probiotic treated (T1-T7) conditions. Sd1 infected intestinal epithelial Caco-2 cells (C2) exhibited 65.4% (p<0.05) decrease in cell viability in comparison to normal non-infected Caco-2 cells (C1), due to the Caco-2 cells cytotoxicity upon infection (Fig. 2). However, in presence of probiotic lactobacilli along with Sd1, Caco-2 cells showed increased cell viability in comparison to Sd1 infected Caco-2 cells, as presented in Fig. 2. Out of three lactobacilli namely L. pentosus (T1), L. paraplantarum (T2) and L. rhamnosus (T3), Caco-2 cell viability was significantly (p<0.05) increased upon L. rhamnosus (T3) and L. pentosus (T1) treatment, to 63% and 60% addition, respectively, in comparison to Sd1 infected Caco-2 cells with 33% of cell viability. Whereas, L. paraplantarum (T2) treatment did not significantly increased Caco-2 cells viability in comparison to Sd1 infected Caco-2 cells. However, when combination of two probiotic lactobacilli (T4-T6) were used for treatment, Caco-2 cell viability in range varying from 62 to 82% (p<0.05) was observed. Maximum Caco-2 cell viability (85%; p<0.05) was observed with probiotic cocktail of all the three probiotic lactobacilli used together for treatment (Fig. 2).

Expression analysis of immunomodulatory genes

Expression analysis of different immunomodulatory genes was carried out to access the role of each gene in Sd1 infection of Caco-2 cells. In the above



Fig. 1: Percentage reduction in adherence and internalization of Sd1 in presence of probiotic lactobacilli treatment groups.
Values expressed as mean±Standard deviation; *p<0.05 in comparison to control group C (Shigella infectedCaco-2 cells).
Experiment was performed in 8 different groups which are as, a) control group (C) consisting of Caco-2 cells infected with Sd1,
b) treatment group 1 (T1) consisting of L.pentosus + Caco-2 cells + Sd1, c) Treatment group 2 (T2) comprising L. paraplantarum
+ Caco-2 cells + Sd1, d) Treatment group 3 (T3) having L. rhamnosus + Caco-2 cells + Sd1, e) treatment group 4 (T4) with L.
pentosus + L. paraplantarum + Caco-2 cells + Sd1, f) treatment group 5 (T5) with L. pentosus + L. rhamnosus + Caco-2 cells +
Sd1, g) treatment group 5 (T6) with L. paraplantarum + L. rhamnosus + Caco-2 cells + Sd1, h) treatment group 6 (T7) comprising
all the three lactobacilli, L. pentosus+ L. paraplantarum+ L. rhamnosus + Caco-2 cells + Sd1.

Gene	Primer sequence 5`-3`	Tm(°C)
TLR-2	F-CTTCACTCAGGAGCAGCAAGCA R-ACACCAGTGCTGTCCTGTGACA	54.0
TLR-4	F- CCCTGAGGCATTTAGGCAGCTA R- AGGTAGAGAGGTGGCTTAGGCT	54.0
TLR-9	F-TGAGCCACAACTGCATCTCGCA R-CAGTCGTGGTAGCTCCGTGAAT	54.0
NF-κβ	F- GGCAGACCAGTGTCATTGAGCA R- CAGCAGAAAGCTCACCACACTC	57.0
IL-1β	F- CCACAGACCTTCCAGGAGAATG R- GTGCAGTTCAGTGATCGTACAGG	57.0
IL-8	F- GAGAGTGATTGAGAGTGGACCAC R- CACAACCCTCTGCACCCAGTTT	57.0
TNF-α	F- CTCTTCTGCCTGCTGCACTTTG R- ATGGGCTACAGGCTTGTCACTC	57.0
IL-10	F- TCTCCGAGATGCCTTCAGCAGA R- TCAGACAAGGCTTGGCAACCCA	57.0
TGF-β	F- TACCTGAACCCGTGTTGCTCTC R- GTTGCTGAGGTATCGCCAGGAA	57.0
β-actin	F- CACCATTGGCAATGAGCGGTTC R- AGGTCTTTGCGGATGTCCACGT	57.0

Table 1	:	Set	of	primers	used i	in	present	study
							productic	- control y

Primers designed in accordance to OriGene Technologies, Rockville, MD



Fig. 2: Effect of probiotic lactobacilli treatment on percentage survivability of Caco-2 cells infected by Shigella dysenteriae type 1.

#p<0.05 in comparison to C1 (normal non-infected Caco-2 cells): *p<0.05 in comparison to C2 (Challenge group: infected Caco-2 cells): \$p<0.01 in comparison to C2 (Challenge group: infected Caco-2 cells).

Experiment was performed in groups which are as, a) uninfected Caco-2 cells (C1), b) Caco-2 cells infected with Sd1 (C2), c) treatment group 1 (T1) consisting of L.pentosus + Caco-2 cells + Sd1, d) Treatment group 2 (T2) comprising L. paraplantarum + Caco-2 cells + Sd1, e) Treatment group 3 (T3) having L. rhamnosus + Caco-2 cells + Sd1, f) treatment group 4 (T4) with L. pentosus + L. paraplantarum + Caco-2 cells + Sd1, g) treatment group 5 (T5) with L. pentosus + L. rhamnosus + Caco-2 cells + Sd1, h) treatment group 5 (T6) with L. paraplantarum + L. rhamnosus + Caco-2 cells + Sd1, i) treatment group 6 (T7) comprising all the three lactobacilli, L. pentosus + L. paraplantarum + L. rhamnosus + Caco-2 cells + Sd1.

S. No.	Experimental Group	Cfu/ml of Sd1 in adhesion assay	Cfu/ml of Sd1 in invasion assay
1.	Control (C)	12000±32	18000±78
2.	Treatment Group 1 (T1)	9000±54	6000±45
3.	Treatment Group (T2)	10000±46	12000±98
4.	Treatment Group (T3)	8000±76	5000±40
5.	Treatment Group (T4)	3000±75	9000±45
6.	Treatment Group (T5)	2000±42	4000±39
7.	Treatment Group (T6)	1000±45	2200±20
8.	Treatment Group (T7)	800±65	870±19

Table 2: Number of Sd1 cells calculated as cfu/ml in control and treatment sets for adhesion and invasion assay



Fig. 3: Effect of probiotic cocktail on the levels of genes expression as measured by reverse transcriptase PCR in Caco-2 cells infected by Shigella dysenteriae type 1.

[Lane 1: 100 bp marker; Lane 2: Beta actin; Lane 3: Interleukin-One Beta (IL-1 β), Lane 4: InterleukinEight (IL-8); Lane 5: Tumour Necrosis Factor-Alpha (TNF- α); Lane 6:Nuclear transcriptional factor-Kappa Beta (NF- $\kappa\beta$); Lane 7: Interleukin Ten (IL-10); Lane 8: Tumour Growth Factor-Beta(TGF- β); Lane 9: Toll Like Receptor Two (TLR2); Lane 10:Toll Like Receptor Four (TLR4); Lane 11: Toll Like Receptor Nine(TLR9)].

sections, seven treatment groups composed of individual lactobacilli, combination of two lactobacilli and combination of three lactobacilli for treatment were used. Out of all the seven treatment groups, treatment group 7th (T7) i.e. probiotic cocktail of all the three probiotic lactobacilli was most significant and effective treatment to reduce Sd1 mediated cytotoxicity in Caco-2 cells. Hence, further expression analysis of immunomodulatory genes during infection and treatment was assessed with T7 treatment group.

a) Qualitative-Reverse Transcriptase PCR (RT-PCR)

Qualitative determination of gene expression of various immunomodulatory genes (as mentioned in materials and methods section) was carried out by performing RT-PCR. Variation in level of intensity of amplified PCR product bands for each gene (as seen in Fig. 3), indicated change in levels of gene expression under infection (I) and treatment (T) conditions. All the genes $(TLR-2, TLR-4, TLR-9, NF-\kappa\beta, IL-1\beta, IL-8, TNF-\alpha, IL-10, TG_{Fe}\beta)$ considered in present study were expressed varyingly. As observed in Fig. 3, expression of $NF-\kappa\beta$, pro-inflammatory genes $IL-1\beta$. IL-8 and $TNF-\alpha$, and

TLR 4were highly expressed in Sd1 infected Caco-2 cells in comparison to uninfected Caco-2 cells. Caco-2 cells treated with probiotic cocktail showed decreased expression of above mentioned genes (*NF-k* β , pro-inflammatory genes *IL-1* β , *IL-8* and *TNF-* α , and *TLR* 4, and but exhibited increased expression of anti-inflammatory genes (*IL-10* and *TGF-* β) and toll like receptor *TLR2* and *TLR9* suggesting their role in protection of infected Caco-2 cells from inflammatory damage. RT-PCR provides only qualitative indication of variation in gene expression, hence to quantitate gene expression and evaluate fold change in gene expression in infected and treated Caco-2 cells in comparison to gene expression in normal Caco-2 cells, gPCR was performed.

b) Quantification of gene expression in Sd1 infected Caco-2 cells upon probiotic lactobacilli cocktail treatment

qPCR was carried out to quantitate gene expression and evaluate fold change in gene expression in Caco-2 under control, infection and treatment group. Results of qPCR are presented below:

> Toll like receptor genes (TLR2, TLR4, TLR9)

Toll like receptors play important role in identification of foreign entity and signalizing immune system (Abreu, 2010). There are number of TLRs present on intestinal epithelial cells, in present study gene expression (mRNA levels) of *TLR2*. *TLR4* and *TLR9* was investigated. TLR2 recognizes Gram positive microorganisms and TLR4 recognizes Gram negative microorganisms (Abreu, 2010), whereas TLR9 recognizes CpG islands present in microbes (Wells, 2011). Expression levels of each TLR varied in control, infection and treatment groups of Caco-2 cells as described in Fig. 4.

In comparison to un-infected Caco-2 cells, Sd1 infected Caco-2 cells showed significant increase in gene expression of *TLR2* (2 folds: p<0.05) and enormous increase in *TLR4* expression (276 folds; p<0.001). On the other hand, in comparison to infected Caco-2 cells, probiotic cocktail treated Caco-2 cells showed significant decrease (83.6%; p<0.01) in TLR4 expression and significant increase in TLR2 (>95%;

p<0.01) and TLR9 (20.66%; p<0.05) expression. This signifies that when Caco-2 cells were co-seeded with Sd1 and probiotic consortium, *TLR2* expression was increased, facilitating recognition of probiotic microorganisms and decreased *TLR4* expression, hindering recognition of Sd1 by Caco-2 cells. Hence, competitive reduction in adherence of Sd1 on Caco-2 cells in presence of probiotics was observed. Increased expression of *TLR9* in probiotic treated Caco-2 cells leads to recognition of probiotic microorganisms especially *Lactobacillus* strains which contain numerous unmethylated CpG islands (Bouladoux *et al.*, 2012).

Nuclear transcription factor (NF-κβ)and proinflammatory cytokines (IL-1β, IL-8, TNF-α) expression levels

NF- $\kappa\beta$ is one of the most important nuclear transcription factors that plays key role in regulation of immune responses against bacteria. NF- $\kappa\beta$ regulates various cytokine production especially pro-inflammatory cytokines, like IL-1 β , IL-8 and TNF- α (Moorthy *et al.*,



Fig. 4: Effect of probiotic cocktail on the levels of gene expression as measured by real time PCR in Caco-2 cells infected with Shigella dysenteriae type 1.

[Nuclear transcriptional factor Kappa Beta (NF-ĸB), Interleukin-One Beta (IL-1B), InterleukinEight (IL-8), Tumour Necrosis Factor-Alpha (TNF-A),Interleukin Ten (IL-10), Tumour Growth Factor-Beta(TGF-B), Toll Like Receptor Two (TLR 2), Toll Like Receptor Four (TLR 4) and Toll Like Receptor Nine(TLR 9)]. Infection Vs control was found to be significant (p<0.05)

Treatment Vs control was also found to be significant (p<0.001)

2010; Bharrhan *et al.*, 2011). Sd1 infected Caco-2 cells expressed high levels of *NF*- $\kappa\beta$ (99 folds; p<0.05) in comparison to un-infected Caco-2 cells. Whereas, probiotic cocktail treated Caco-2 cells resulted into significant decrease (95.9%; p<0.01) in expression of *NF*- $\kappa\beta$ in comparison to infected Caco-2 cells (Fig. 4). Elevated expression of *NF*- $\kappa\beta$ let to the significant increase in the expression of pro-inflammatory genes *IL*-1 β , *IL*-8 and *TNF*- α expression by 37 folds (p<0.05), 44 folds (p<0.05) and11 folds (p<0.05), respectively. However, probiotic treated Caco-2 cells resulted in significant decrease in expression of above mentioned pro-inflammatory genes *IL*-1 β , *IL*-8 and *TNF*- α by 94.5% (p<0.01), 95.4% (p<0.01) and 18.1% (p<0.05) in comparison to Sd1 infected Caco-2 cells.

Expression levels of anti-inflammatory cytokines (IL-10, TGF-β)

Anti-inflammatory cytokines controls the proinflammatory cytokines mediated inflammation and tissue injury. Anti-inflammatory cytokines such as IL-10 and TGF-ß play key role in limiting massive inflammatory reactions (Hakansson and Molin, 2011). Expression levels of IL-10 and $TGF-\beta$ were significantly enhanced in Sd1 infected Caco-2 cells in comparison to uninfected Caco-2 cells by 9 folds (p<0.05) and 46 folds (p<0.05) as depicted in Figure 4. Whereas, expression levels of these anti-inflammatory cytokines IL-10 and $TGF-\beta$ in probiotic treated Caco-2 cells were highly increased by 94.5% (p<0.01) and 35.1% (p<0.05) in comparison to Sd1 infected Caco-2 cells. Enhanced expression levels of anti-inflammatory genes in probiotic treated infected Caco-2 cells lead to reduction of massive inflammation that can lead to epithelial lining destruction (Hakansson and Molin, 2011).

DISCUSSION

Shigella being facultative intracellular pathogen has prominent specificity for primate hosts mainly humans (Schroeder and Hilbi, 2008). Sd1 has been categorized as bioterror agent in category B by CDC that can lead to bioterrorism. Approximately, 10-100 cells of Sd1 can lead to infection in humans, hence, low inoculum size place it in high risk infectious organism (WHO., 2005). Pathogenesis of Sd1is grounded on its ability to adhere intestinal epithelial cells, followed by invasion of colonic epithelium where multiplication of *Shigella* takes place. This further result in acute intestinal inflammatory response that contributes to colonic epithelial destruction leading to dysentery (Moorthy *et al.*, 2010; Fiorentino *et al.*, 2014). In order to combat Shigella mediated intestinal infection, Shigella adherence and internalization by intestinal epithelial cells should be targeted (Fiorentino et al., 2014). Specific medium (DCA) supporting distinct growth of Sd1 was used to calculate number (of Sd1 adhered to and invaded in Caco-2 cells. In the present study, probiotic cocktail of all the three probiotic lactobacilli namely L. pentosus, L. paraplantarum and L. rhamnosus maximally reduced Sd1 adherence and internalization to intestinal epithelial Caco-2 cells by 61.2% and 74.6%, respectively. Synergistic effect of all the three probiotic lactobacilli led to the highest reduction inSd1adherence and internalization to intestinal epithelial Caco-2 cells in comparison to individual lactobacilli treatment. Our results are in accordance with Moorthy et al. (2010) who observed lactobacilli (L. acidophilus and L. rhamnosus) mediated reduction in Sd1 adherence and internalization. In addition to it, there are several other reports documenting ability of probiotic lactobacilli to inhibit pathogenic adherence and invasion of colonic epithelium (Bernet et al., 1994; Lee et al., 2003; Jankowska et al., 2008; Abedi et al., 2013; Walshamet al., 2016). The mechanism behind inhibition of adherence and internalization of Sd1 on Caco-2 cells can be attributed to competition for space and nutrient uptake on intestinal lining in presence of probiotic lactobacilli (Moorthy et al., 2010). There are numerous reports signifying ability of probiotics to inhibit adherence and internalization entropathogens on intestinal epithelial cells (Gorbach et al., 1987; Coconnieret al., 1993; Collado et al., 2006; Mappleyet al., 2011). Additionally, probiotic lactobacilli are reported to stimulate mucus production by goblet cells and strengthens intestinal barrier that plays critical role in controlling EPEC/EHEC like pathogenic infections (Caballero-Franco et al., 2007; Bergstrom et al., 2010). There are numerous reports on potential of L. rhmanosus to inhibit adhesion of pathogens to intestinal surfaces but ability of L. pentosus and L. paraplantarum to compete with Sd1 is reported for the first time, hence needs to be explored further. Moreover, it has been reported that indigenous strains of lactobacilli are more effective as they possess strong adhesion ability for bacterial cell surface as compared to other dairy strains commercially available in market (Wang et al., 2008; Duary et al., 2011).

Caco-2 cells upon Sd1 infection, exhibited only 33% of cells survivability and rest 67% of Caco-2 cells were observed to be cytotoxic. On the other hand, when Caco-2 cells were co-cultured with Sd1and probiotic lactobacilli, increase in percentage survivability of

Caco-2 cells was observed. Probiotic cocktail of all the three lactobacilli led to maximum survivability and least cytotoxicity of Sd1 infected Caco-2 cells. Our results are in accordance with Moorthy et al. (2010) who also documented that lactobacilli strains leads to decrease in Caco-2 cell cytotoxicity caused by S. dysenteriae. Similarly, there are also reports on potential of lactobacilli to reduce intestinal pathogens mediated epithelial cell cytotoxicity other than Shigella (Maudsdotter et al., 2011). Probiotic cocktail of all the three probiotic lactobacilli exhibited most significant and promising effects in reducing Sd1 mediated cytotoxicity and invasion of intestinal epithelium. Therefore, probiotic cocktail was used for further studies to evaluate immunomodulatory effect on Sd1 infected Caco-2 cells.

Host immune response generated against Sd1 invasion of colonic epithelium contributes to over induced inflammatory response imperative for disease development. In present study, keeping in mind quest for understanding host microbe interaction on mucosal immunity, expression levels of toll like receptors, signalling molecule and various cytokines was evaluated. Expression levels of TLRs (*TLR2, TLR4* and *TLR9*), transcriptional factor (*NF*- $\kappa\beta$), cytokines (*1L*-1 β , *IL*-8, *TNF*- α , *IL*-10, *TGF*- β) was evaluated by performing RTPCR and qPCR inCaco-2 cells seeded with Sd1 in absence and presence of novel probiotic cocktail.

The intestinal epithelial cells possess numerous pathogen associated molecular patterns like toll like receptors that recognize particular microorganisms (Ozinsky et al., 2000; Galdiero et al., 2002). Toll like receptors play pivotal role in inducing intestinal inflammation (Villenaet al., 2014). In current study, expression levels of TLR2 recognizing Gram positive bacteria (Kelly and Conway, 2005), TLR4 recognizing lipopolysaccharides (LPS) of Gram negative bacteria (Kelly and Conway, 2005) and TLR9 recognizing CpG islands in bacteria (Rachmilewitz et al., 2004) were evaluated. In the present study, mRNA expression levels of TLR2, TLR4 and TLR9 in intestinal epithelial Caco-2 cells uponSd1 infection was significantly (p<0.05) increased in comparison to uninfected Caco-2 cells. Our results are in accordance with Massari et al. (2006) and Raja et al. (2011) who documented that TLR2 is associated with recognizing shiga toxin produced by Sd1 and TLR4 is associated with recognizing LPS of Sd1 contributing to the initiation of infection. Increased expression of TLR9

in intestinal epithelial Caco-2 cells upon Sd1 infection is not reported till date, hence needs to be explored further. On the other hand, when Caco-2 cells were co-seeded with Sd1 and probiotic cocktail, significant (p<0.05) decrease in expression of TLR4 by 83.6% and significant (p<0.05) increase in expression of TLR2 by 99.1% and TLR9 by 95.1% was observed. Our findings are in line with Rizzo et al. (2013) and Villena et al. (2014) who reported use of lactobacilli for combating intestinal infection by down-regulating TLR4 expression. Whereas increased expression of TLR2 which specifically recognizes Gram positive bacterial cell wall and TLR9 in intestinal epithelial cell upon incubation with lactobacilli has also been reported by Kitazawa et al. (2008), Alvarez et al. (2009b) and Salva et al. (2010), suggesting role of TLR2 and TLR9 in recognizing Gram positive lactobacilli by intestinal epithelial cells that competes with pathogen. Therefore, increased expression of TLR2 and TLR9 and decreased expression of TLR4 in probiotic treated Caco-2 cells in comparison to Sd1 infected Caco-2 cells plays crucial role in delimiting invasion of Sd1 and promoting probiotic lactobacilli colonization on intestinal epithelium.

TLR4 mediated activation of nuclear transcriptional factor NF-kß further signals secretion of proinflammatory cytokines such as IL-1 β , IL-8 and TNF-a leading to chronic inflammation in host cells (Jobin and Sartor, 2000; Haller et al., 2004; Villena et al., 2014). In present study, expression levels of NF- $\kappa\beta$, *IL-1* β , *IL-8* and *TNF-* α in Sd1 infected intestinal epithelial cells was significantly (p<0.01) enhanced in comparison to uninfected Caco-2 cells. Our results are in line with Sansonettiet al. (1999), Kohler et al. (2002), Roselli et al. (2006), Hormannsperger and Haller. (2010) and Moorthy et al. (2010) who documented increased expression of NF- $\kappa\beta$ that further increases expression of pro-inflammatory cytokines such as *IL-1* β , *IL-8* and *TNF-* α in epithelial cells upon Shigella infection, leading to intestinal lining dysfunction and tissue damage. Interestingly, in present study it was noted that Caco-2 cells co-seeded with Sd1 and probiotic cocktail showed significant decrease in gene expression of NF- $\kappa\beta$, IL-1 β , IL-8 and TNF- α genes in comparison to Caco-2 cells seeded with only Sd1. There are several other reports that suggest potential of lactobacilli to down-regulate gene expression of NF- $\kappa\beta$ and its associated pro-inflammatory cytokines that counteracts enteropathogen induced mucosal inflammation (Villena et al., 2005; Roselli et al., 2006; Salvaet al., 2010; Shimazu et al., 2012; Kitazawa et *al.*, 2014). Moreover, Moorthy*et al.* (2010) documented lactobacilli mediated down-regulation of *IL-8* and *TNF-* α in Sd1 infected Caco-2 cells.

Inflammatory damage of intestinal lining can be further restricted by action of anti-inflammatory cytokines such as IL-10 and TGF-B that specifically helps in limiting inflammatory reactions in host cell and maintaining gut homeostasis (Letterio and Roberts, 1998; Sanchez-Munoz et al., 2008). In present study significant increase in expression of anti-inflammatory genes in Caco-2 cells infected with Sd1 was observed. This increase in anti-inflammatory genes during infection can be attributed to play role in preventing complete intestinal damage so that bacteria can survive and multiply in intestinal epithelium in order to establish infection (Chen et al., 2005; Kim et al., 2005; Ingersoll and Zychlinsky, 2006). However, the mRNA levels of *IL-10* and *TGF-\beta* gene were highly augmented in Caco-2 cells co-seeded with Sd1 and probiotic cocktail in comparison to mRNA levels in Sd1 infected Caco-2 cells. Our findings are in line with Dielemanet al. (2003), Otte et al. (2004), Corr et al. (2007) and McClemens et al. (2013) who reported that increased expression of anti-inflammatory genes in host epithelial cells upon interaction with probiotic lactobacilli helps in combating number of enteric infections. Moreover, it has been widely reported that IL-10 and TGF-B specifically down-regulates expression of NF- $\kappa\beta$ and pro-inflammatory cytokines in intestinal epithelial cells, therefore preventing excessive mucosal inflammation during diseased condition (Letterio, 2005; Roselli et al., 2007; Foye et al., 2012; McClemens et al. 2013).

CONCLUSION

Probiotic lactobacilli cocktail of L. pentosus (KJ802481), L. paraplantarum (KJ802482) and L. rhamnosus (KJ802483) is reported as one of the natural alternatives to treat Sd1mediated infection in humans. With this study, mechanistic approach of how probiotics can successfully confer Sd1 infection is put across. Novel probiotic cocktail can successfully compete with Sd1 for attachment sites on intestinal epithelial Caco-2 cells resulting in diminution of Sd1 invasion of Caco-2 cells. Moreover, probiotic cocktail effectively down-regulated expression of genes responsible for acute inflammation and up-regulated expression of genes that unrest inflammatory damage in Sd1 infected Caco-2 cells. Hence, probiotic cocktail hold the potential to modulate innate immune responses and generate anti-inflammatory effects that can play crucial role in protecting intestinal cells from adverse effects mediated by Sd1.

ACKNOWLEDGEMENTS

Dr R.K Malik, Microbiology Division, National Dairy Research Institute, Karnal, India and Dr Pradip Sen from Institute of Microbial Technology, Chandigarh for their valuable guidance; Dr Arvind Gulati and Ms Shashi, Institute of Himalayan Bioresource Technology, Palampur, India for assisting in identification of bacterial isolates and DST-INSPIRE, India for financial assistance.

REFERENCES

- 1. Abedi, D., S. Feizizadeh., V. Akbari, and A. Jafarian-Dehkordi. 2013. *In vitro* anti-bacterial and antiadherence effects of *Lactobacillus delbrueckii* subsp *bulgaricus* on *Escherichia coli.* Res. Pharm. Sci., 8 (4) : 260-268.
- 2. Abreu, M.T. 2010. Toll-like receptor signalling in the intestinal epithelium: how bacterial recognition shapes intestinal function. Nature. Rev. Immunol., 131-144.
- Alam, S. and S. Bhatnagar. 2006. Current status of anti-diarrheal and anti-secretory drugs in the management of acute childhood diarrhea. Indian. J. Pediatrics., 73.
- Alvarez, S., J. Villena., M. Tohno., S. Salva, and H. Kitazawa. 2009. Modulation of innate immunity by lactic acid bacteria: impact on host response to infections. Curr. Res. Immunol., 3: 87 - 126.
- Bergstrom, K.S.B., V. Kissoon-Singh., D.L. Gibson., C.X. Ma., M. Montero., H.P. Sham., N. Ryz., T.N. Huang., A. Velcich., B.B. Finlay., K. Chadee, and B.A. Vallance. 2010. Muc2 protects against lethal infectious colitis by disassociating pathogenic and commensal bacteria from the colonic mucosa. Plos. Pathogens., 6 : 1 - 25.
- Bernet, M.F., D. Brassart., J.R. Neeser, and A.L. Servin. 1994. *Lactobacillus acidophilus* LA 1 binds to cultured human intestinalcell lines and inhibits cell attachment and cell invasion by enterovirulentbacteria. Gut., 35 (4): 483 - 489.
- Bharrhan, S., A. Koul., K. Chopra, and P. Rishi. 2011. Catechin suppresses an array of signalling molecules and modulates alcohol-induced endotoxin mediated liver injury in a rat model. PlosOne., 6 (6) : e20635.
- 8. Borruel, N., M. Carol., F. Casellas., M. Antolin., F. de Lara., E. Espín., J. Naval., F. Guamer, and J.R.
Malagelada. 2002. Increased mucosal tumour necrosis factor a production in Crohn's disease can be downregulated *ex vivo* by probiotic bacteria. Gut., 51 (5): 659 - 664.

- Bouladoux, N., J.A. Hall., J.R. Grainger., L.M. dos Santos., M.G. Kann., V. Nagarajan., D. Verthelyi, andY. Belkaid. 2012. Regulatory role of suppressive motifs from commensal DNA. Mucosal.Immunol.,5(6): 623–634.
- Caballero+Franco, C., K. Keller., C.D. Simone, and K. Chadee. 2007. The VSL#3 probiotic formula induces mucin gene expression and secretion in colonic epithelial cells. American. J. Physiol. Gastroint. Liver. Physiol., 292 : 315 - 322.
- Chen, C.C., S. Louie., H.N. Shi, and W.A. Walker. 2005. Preinoculation with the probiotic *Lactobacillus acidophilus* early in life effectively inhibits murine *Citrobacter rodentium* colitis. Pediatr. Res., 58 : 1185 - 1191.
- Coconnier, M.H., M.F. Bernet., S. Kerneis., G. Chauviere., J. Fourniat, and A.L Servin. 1993. Inhibition of adhesion of enteroinvasive pathogens to human intestinal Caco-2 cells by *Lactobacillus acidophilus* strain LB decreases bacterial invasion. FEMS. Microbiol. Lett., 110 (3): 299 - 305.
- Collado, M.C., M. Gueimonde., Y. Sanz, and S. Salminen. 2006. Adhesion properties and competitive pathogen exclusion ability of Bifidobacteria with acquired acid resistance. J. Food. Prot., 69 (7): 1675 1679.
- 14. Corr, S.C., C.G. Gahan, and C. Hill. 2007. Impact of selected *Lactobacillus* and *Bifidobacterium* species on *Listeria monocytogenes* infection and the mucosal immune response. FEMS. Immunol. Med. Microbiol., 50 : 380 - 388.
- Dieleman, LA., M.S. Goerres., A. Arends., D. Sprengers., C. Torrice., F. Hoentjen., W.B. Grenther, and R.B. Sartor. 2003. *Lactobacillus* GG prevents recurrence of colitis in HLA-B27 transgenic rats after antibiotic treatment. Gut., 52 : 370 - 376.
- Duary, R.K., Y.S. Rajput., V.K. Batish, and S. Grover. 2011. Assessing the adhesion of putative indigenous probiotic lactobacilli to human colonic epithelial cells. Indian. J. Med. Res., 134: 664 – 671.

- Fiorentino, M., M.M. Levine., M.B. Sztein, and A. Fasano. 2014. Effect of wild-type Shigella species and attenuated Shigella vaccine candidates on small intestinal barrier function, antigen trafficking, and cytokine release. PlosOne., 9 (1): e85211.
- Foye, O.T., I. Huang., C.C Chiou, W.A. Walker, and H. Ning. 2012. Early administration of probiotic Lactobacillus acidophilus and/or prebiotic inulin attenuates pathogen-mediated intestinal inflammation and Smad 7 cell signaling. FEMS. Immunol. Med. Microbiol., 65 (3): 467 - 480.
- Francois, M., V. Le Cabec., M.A. Dupont., P.J. Sansonetti, and I. Maridonneau-Parini. 2000. Induction of necrosis in human neutrophils by Shigella flexner requires type III secretion, IpaB and IpaC invasins, and actin polymerization. Infect. Immun., 68 : 1289 - 1296.
- Galdiero, M., M. Vitiello., E. Sanzari., M. D'Isanto., A. Tortora., A. Longanella, and S. Galdiero. 2002. Porins from Salmonella enterica serovar Typhimurium activate the transcription factors activating protein1 and NF-kappa B through the Raf-1-mitogen activated protein kinase cascade. Infect. Immun., 70: 558 - 568.
- 21. Gorbach, S.L. 1987. Bacterial diarrhoea and its treatment. Lancet.,2: 1378 1382.
- Gowri, R. S., P. Meenambigai., P. Prabhavathi., P. Rajeswari, and L.A. Yesudoss. 2016. Probiotics and its Effects on Human Health-A Review. Int. J. Curr. Microbiol. App. Sci., 5 (4): 384 - 392.
- 23. Hakansson, A.and G. Molin. 2011. Gut Microbiota and Inflammation. Nutrients., 3 (6): 637-682.
- Haller, D., L. Holt., A. Parlesak., J. Zanga, and A. Bauerlein. 2004. Differential effect of immune cells on non-pathogenic Gramnegative bacteria-induced nuclear factorkappaB activation and pro-inflammatory gene expression inintestinal epithelial cells. Immunol., 112 : 310 - 320.
- Hormannsperger, G. and D. Haller. 2010. Molecular crosstalk of probiotic bacteria with the intestinal immune system: clinical relevance in the context of inflammatory bowel disease. Int. J. Med. Microbiol., 300 : 63 - 73.

- Ingersoll, M.A. and A. Zychlinsky. 2006. ShiA abrogates the innate T-cell response to Shigella flexneri infection. Infect. Immun., 74 : 2317 - 2327.
- Jankowska, A., D. Laubitz., H. Antushevich., R. Zabielski, and E. Grzesiuk. 2008. Competition of Lactobacillus paracasei with Salmonella enterica for adhesion to Caco-2 Cells. J. Biomedicine. Biotechnol., Article ID 357964. 6 pages.
- Jobin, C. and R.B. Sartor. 2000. NF-κappaβ signaling proteins as therapeutic targets for inflammatory bowel diseases. Inflamm. Bowel. Dis., 6 : 206 - 213.
- Kechagia, M., D. Basoulis., S. Konstantopoulou., D. Dimitriadi., K. Gyftopoulou., N.Skarmoutsou, and E.M. Fakiri. 2013. Health benefits of probiotics: a review. ISRN. Nutrition., Article ID 481651, 7 pages.
- Kelly, D. and S. Conway. 2005. Bacterial modulation of mucosal innate immunity. Mol. Immunol., 42: 895 - 901.
- 31. Kim, D.W., G. Lenzen., A.L. Page., P. Legrain., P.G. Sansonetti, and C. Parsot. 2005. The Shigella flexneri effector OspG interferes with innate immune responses by targeting ubiquitinconjugating enzymes. Proc. Natl. Acad. Sci. USA., 102 :14046 - 14051.
- Kitazawa, H., M. Tohno., T. Shimosato, and T. Saito. 2008. Development of molecular immunoassay system for probiotics via Tolllike receptors based on food immunology. Animal. Sci. J., 79 : 11 -- 21.
- Kitazawa, H. and J. Villena. 2014. Modulation of respiratory TLR3- antiviral response by probiotic microorganisms: lessons learned from *Lactobacillus rhamnosus* CRL1505. Front. Immunol., 5 : 201 - 216.
- 34. Kohler, H., S.P. Rodrigues, and B.A. McCormick. 2002. Shigella flexneri interactions with the basolateral membrane domain of polarized model intestinal epithelium: role of lipopolysaccharide in cell invasion and in activation of the mitogen-activated protein kinase ERK. Infect. Immun., 70: 1150 - 1158.
- 35. Lee, Y.K., K.Y. Puong., C. Arthur., A. Ouwehand, and S. Salminen. 2003. Displacement of

bacterial pathogens from mucus and Caco-2 cell surface by lactobacilli. J. Med. Microbiol., 52: 925 - 930.

- 36. Letterio, J.J. 2005. TGF-beta signaling in T cells: roles in lymphoid and epithelial neoplasia. Oncogene., 24 : 5701 - 5712.
- 37. Letterio, J.J. and A.B. Roberts. 1998. Regulation of immune responses by TGF-beta. Annu. Rev. Immunol., 16: 137 - 161.
- Mappley, L.J., M.A. Tchorzewska., W.A. Cooley., M.J. Woodward, and R.M. La Ragione. 2011. Lactobacilli antagonize the growth, motility, and adherence of *Brachyspira pilosicoli*: a potential intervention against avian intestinal spirochetosis. Appl. Environ. Microbiol., 77 (15): 5402 - 5411.
- 39. Marteyn, B., A. Gazi, and P. Sansonetti. 2012. Shigella. Gut. Microbes., 3 (2) : 104 – 120.
- Massari, P., A. Visintin., J. Gunawardana., K.A. Halmen., C.A. King., D.T. Golenbock, and L.M. Wetzler. 2006. Meningococcal porin PorB binds to TLR2 and requires TLR1 for signaling. J. Immunol., 176 : 2373 - 2380.
- Maudsdotter, L., H. Jonsson., S. Roos, and A.B. Jonsson. 2011. Lactobacilli reduce cell cytotoxicity caused by *Streptococcus pyogenes* by producing lactic acid that degrades the toxic componentlipoteichoic acid. Antimicrob. Agents. Chemother., 55 (5): 1622 - 1628.
- McClemens, J., J. Kim., H. Wang., Y. Mao., M. Collins., W. Kunze., J. Bienenstock., P. Forsythe, and W. Khan. 2013. *Lactobacillus rhamnosus* ingestion promotes innate host defense in an enteric parasitic infection. Clin. Vaccine. Immunol., 20 (6): 818 - 826.
- 43. McClure, R.and P. Massari. 2014. TLR-Dependent Human Mucosal Epithelial Cell Responses to Microbial Pathogens. Frontiers. Immunol., 5 : 386 (1 - 13).
- 44. Mikelsaar, M., V. Lazar, A. Onderdonk, and G. Donelli. 2011a. Do probiotic preparations for humans really have efficacy? Microbial. Ecology.Health. Dis., 22 : 10128.
- 45. Mikelsaar, M.2011b. Human microbial ecology: lactobacilli, probiotics, selective decontamination. Anaerobe., 17 (6): 463-467.

- Moorthy, G., M.R. Murali, and S.N. Devaraj. 2007. Protective role of lactobacilli in *Shigella dysenteriae1*-induced diarrhea in rats. Nutr., 23: 424 - 433.
- 47. Moorthy, G., M.R. Murali, and S.N. Devaraj. 2010. Lactobacilli inhibit Shigella dysenteriae1 induced pro-inflammatory response and cytotoxicity in host cells via impediment of Shigella-host interactions. Dig. Liver. Dis., 42 : 33 - 39.
- Nawaz, M., J. Wang., A. Zhou., C. Ma., X. Wu, and J. Xu. 2011. Screening and characterization of new potentially probiotic lactobacilli from breast-fed healthy babies in Pakistan. Afr. J. Microbiol. Res., 5 (12) : 1428-1436.
- **49.** Niyogi, S.K. 2005. Shigellosis. J. Microbiol., 43 : 133 143.
- Otte, J.M., E. Cario, and D.K. Podolsky. 2004. Mechanisms of cross hypo responsiveness to Toll-like receptor bacterial ligands in intestinal epithelial cells. Gastroenterol.,126: 1054 -1070.
- Ozinsky, A., D.M. Underhill., J.D. Fontenot., A.M. Hajjar., K.D. Smith., C.B. Wilson., L. Schroeder, and A. Aderem. 2000. The repertoire for pattern recognition of pathogens by the innate immune system is deened by cooperation between toll-like receptors. Proc. Natl. Acad. Sci. USA., 97 : 13766 - 13771.
- 52. Parsot, C. and P.J. Sansonetti. 1996. Invasion and pathogenesis of *Shigella* infections. Curr. Top. Microbiol. Immunol., 209 : 25 - 42.
- 53. Philpott, D.J. and S.E. Girardin. 2004. The role of Toll-like receptors and Nod proteins in bacterial infection. Mol. Immunol., 41 : 1099 - 1108.
- 54. Philpott, D.J., S. Yamaoka., A. Israel, and P.J. Sansonetti. 2000. Invasive Shigella flexneri activates NF-kappa B through a lipopolysaccharide-dependent innate intracellular response and leads to IL-8 expression in epithelial cells. J. Immunol. 165: 903 - 914.
- Rachmilewitz, D., K. Katakura., F. Karmeli., T. Hayashi., C. Reinus., B. Rudensky., S. Akira., K. Takeda., J. Lee., K. Takabayashi, and E. Raz. 2004. Toll-like receptor 9 signaling mediates the anti-inflammatory effects of

probiotics in murine experimental colitis. Gastroenterol., 126 : 520 - 528.

- Raja, S.B., M.R. Murali., H. Devaraj, and S.N. Devaraj. 2011. Differential expression of gastric MUC5AC in colonic epithelial cells: TFF3-wired IL1b/Akt crosstalk-induced mucosal immune response against *Shigella dysenteriae* infection. J. Cell. Sci., 125 (3) : 702 - 713.
- 57. Rizzo, A., A. Losacco, and C.R. Carratelli. 2013. Lactobacillus crispatus modulates epithelial cell defense against Candida albicans through Toll-like receptors 2 and 4, interleukin 8 and human β -defensins 2 and 3. Immunol. Lett., 156 (1-2) : 102.-.109.
- Roselli, M., A. Finamore., M.S. Britti., S.R. Konstantinov., H. Smidt., W.M. de Vos, and E. Mengheri. 2007. The novel porcine *Lactobacillus sobrius* strain protects intestinal cells from enterotoxigenic *Escherichia coli* K88 infection and prevents membrane barrier damage. J. Nutr., 137: 2709 - 2716.
- Roselli, M., A. Finamore., M.S. Britti, and E. Mengheri.
 2006. Probiotic bacteria *Bifidobacterium* animalis MB5 and Lactobacillus rhamnosus GG protect intestinal Caco-2 cells from the inflammation associated response induced by enterotoxigenic *Escherichia coli* K88. Br. J. Nutr., 95 : 1177 - 1184.
- Salva, S., J. Villena, and S. Alvarez. 2010. Immunomodulatory activity of *Lactobacillus rhamnosus* strains isolated from goat milk: impact on intestinal and respiratory infections. Int. J. Food. Microbiol., 141 : 82 - 89.
- Sanchez-Munoz, F., A. Dominguez-Lopez, and J.K. Yamamoto-Furusho. 2008. Role of cytokines in inflammatory bowel disease. World. J. Gastroenterol., 14: 4280 – 4288.
- Sansonetti, P.J., J. Arondel., M. Huerre., A. Harada, andA. Matsushima. 1999. Interleukin-8 controls bacterial transepithelial translocation at thecost of epithelial destruction in experimental shigellosis. Infect. Immun., 67 : 1471 - 1480.
- Schroeder, G.N. and H. Hilbi. 2008. Molecular pathogenesis of *Shigella* spp: Controlling Host Cell signaling, invasion, and death by type III secretion. Clin. Microbiol. Rev. J., 21 (1): 134 - 156.

- Shimazu, T., J. Villena., M. Tohno., H. Fujie., S. Hosoya., T. Shimosato., H. Aso., Y. Suda., Y. Kawai., T. Saito., S. Makino., S. Ikegami., H. Itoh, and H. Kitazawa. 2012. Immunobiotic *Lactobacillus jensenii* elicit anti-inflammatory activity in porcine intestinal epithelial cells by modulating negative regulators of the toll like receptor signaling pathway. Infect. Immun., 80 : 276 - 288.
- 65. Sureshbabu, J., P. Venugopalan, and W. Abuhammour. 2016. *Shigella* Infection Clinical Presentation. Medscape.
- Tien, M.T., S.E. Girardin., B. Regnault., L.L. Bourhis., M.A. Dillies., J.Y. Coppée., R. Bourdet-Sicard., P.J. Sansonetti, and P. Thierry. 2006. Anti-Inflammatory Effect of *Lactobacillus casei* on *Shigella*-Infected Human Intestinal Epithelial Cells. J. Immunol., 176 : 1228 - 1237.
- 67. Villena, J. and H. Kitazawa. 2014. Modulation of intestinal TLR4-inflammatory signalling pathways by probiotic microorganisms: lessons learned from *Lactobacillus jensenii* TL2937. Front. Immunol.,4 : 512.

- Villena, J., S. Racedo., G. Agüero., E. Bru., M. Medina, and S. Alvarez. 2005. *Lactobacillus casei* improves resistance to pneumococcal respiratory infection in malnourished mice. J. Nutr., 135 : 1462 - 1469.
- Walsham, A.D., D.A. MacKenzie., V. Cook., S. Wemyss-Holden., C.L. Hews., N. Juge, and S. Schuller. 2016. *Lactobacillus reuteri* inhibition of enteropathogenic *Escherichia colia*dherence to human intestinal epithelium. Front. Microbiol. 7 : Article 244 (10 pages).
- Wang, B., H. Wei, J. Yuan, Q. Li., Y. Li., N. Li, and J. Li. 2008. Identification of a surface protein from *Lactobacillus reuteri* JCM1081 that adheres to porcine gastric mucin and human enterocyte-like HT-29 Cells. Curr. Microbiol., 57 (1): 33 - 38.
- 71. Wells, J.M. 2011. Immunomodulatory mechanisms of lactobacilli.Microbial. Cell. Factories., 10 (SUPPL 1): s17.
- 72. World Health Organization. 2005. Guidelines for the Control of Shigellosis, including epidemics due to Shigella dysenteriae type 1.

USING CONCEPT MAP NETWORK BASED CONSTRUCTIVIST LEARNING ENVIRONMENTS (CLE) FOR TEACHING LEARNING PROGRAMMING

*Minakshi Sharma and Sonal Chawla

Department of Computer Science and Applications, Panjab University, Chandigarh (India)

Abstract

Traditional methods of teaching learning follow teacher centric approach where teacher decides the learning path and all the students follow same learning pattern irrespective of their learning style, speed and inconsistencies in knowledge. Online learning management systems(LMSs) although facilitate anytime anywhere learning, these still follow fixed learning path. As learner in these processes is only a passive participant, these methods fail to provide him with in-depth understanding of concepts. Constructivist theory of learning advocates active participation of learners in the process of learning and allows him to create his own knowledge structures. A constructivist learning environment should be such that it caters to the learning needs of different learners and provides them with different learning paths.

Aim of this research work is to design a concept map network based CLE to teach programming language concepts as an alternative to traditional classroom methods and study students' perspective about its effectiveness. A prototype of concept map network based CLE was designed and tested for teaching how to write a simple program in C language. Students' perceptions about their learning experiences were collected through a questionnaire and analysed further to find how effective this method of learning is. Majority of students found that the proposed method was a better alternative to other method as each student could follow his own learning style and remove his/her misconceptions.

Keywords: ADDIE model, Concept maps, Constructivist Learning Environments, Learning Design, Theory of Constructivism

I. INTRODUCTION

Study of programming languages has become an integral part of many disciplines in higher education, but students still find it difficult to learn the concepts and apply them to solve practical problems. The reasons can be many. First and foremost is that, in a typical classroom environment, there is a passive dissemination of knowledge and the transmission of knowledge from teacher to the student is not complete. Second important reason is that every student comes with some pre-existing notions about the concepts and it is equally important to address these in order to remove any misconceptions. A constructivist learning environment or CLE, where learner actively participates in the process of his own learning, can effectively address these issues. There are many applications of constructivist principles in computer science and software development education [3][4][8] [10][12][13][17][22][30] [31] [32]. This paper focuses specifically on teaching programming languages using a CLE.

An effective CLE is based on two pillars, one is the pedagogical framework that can provide guidelines to create such learning environment and second are the tools that can be used to actually design and implement a CLE.

First component, that is, the pedagogical framework in case of CLEs is based on theory of constructivism given by Piaget in 1975. For the second component, i.e., the tools for implementing the CLE, concept maps have been used. Primary reason for selecting concept maps as tools is that these maps are fundamentally based on theory of constructivism and can enhance learning in students by stimulating simultaneous, deductive or intuitive, concrete, and subjective processes relevant to their style of learning [19]. Also, concept maps have been successfully used in various fields of education as scaffolds to assist teaching learning process.

This paper aims at exploring the use of CLE based on concept maps in designing a network to teach programming language concepts that can promote constructivist learning among students. Content of this paper is organized as follows. Section II discusses the theoretical foundations necessary to understand the content of the paper. Use of concept maps for teaching programming concepts has been discussed in section III. Section IV contains the actual design of concept map network to teach programming, section V discusses implementation and evaluation of a prototype of CLE designed. Findings have been discussed in section VI along with limitations in section VII. In the end, Section VIII contains conclusion of the study.



Fig. 1: ADDIE Instructional Design Model

II. THEORETICAL FOUNDATION

In order to design an effective CLE that can enhance actual knowledge acquired by the students, it should be based on strong pedagogical foundations. Theory of constructivism provides the required pedagogical support and advocates active involvement of the learner. There are many learning models that can provide pedagogical base to a CLE, however, ADDIE model developed by Association for Educational and Communication Technology (AECT) is the base for all the other models, hence is used to provide framework to the proposed model. Both of these are discussed briefly as below:

A. Theory of constructivism

Theory of constructivism for learning was given by Piaget in 1975. It defines learning as a process where learners are actively involved in construction of their own knowledge. With the help of constructivist learning activities, learners are able to form their own representations of knowledge and pinpoint inconsistencies between their preexisting and the new knowledge. This enables the learner to modify their existing knowledge structures to create new, more accurate ones [29]. There is also a change of role of teachers as they act more as facilitators who may create scaffolds to give a direction or content related help or may emphasize on important concepts.

Further, cognitive constructivists advocate that learning environments should be designed in such a manner that learners are able to independently explore the knowledge repositories to get the content and information about related concepts. Also, these environments should be able to provide multiple paths or multiple representations of the reality to the learners which they can explore. Thus, in constructivist learning environment, the responsibility of learning is on the learners themselves, hence, encouraging learner-centered approach.

1) Principles of Constructivism

Based upon postulates of theory of constructivism, many researchers [3][6][7][11][15][16][19][28][33] [34][35][36][37] have given various principles to be adopted in order to create an effective CLE. Most of them are as follows -

- Theory of constructivism emphasizes that learning is a process of active construction and not passive assimilation of knowledge, so CLEs should be learner centric and learners should discover the concepts themselves rather than being directed by someone to do so.
- The process of constructing knowledge means that learner should be presented with multiple representations of the concepts in various different contexts where he can choose any path he wants in order to have a clear picture about the concepts.
- Constructivist learning also requires learners to use their skills in constructing knowledge for solving real world problems. Hence, rather than applying knowledge to solve abstract problems, knowledge must be applicable in real scenarios.
- In constructivist learning environments, teachers serve only as facilitators of learning and not as transmitters of knowledge. Hence, teachers must learn how to understand learners to interpret their responses better and guide them more effectively in order to facilitate learning.
- Constructivist learning environments support "collaborative construction of knowledge through social negotiation, not competition among learners for recognition"[16]. Hence, learning is supported by the knowledge that also comes through interaction of learners with other people, e.g., instructors, fellow learners.

Based on these constructivist principles, many researchers have developed and used various tools for teaching learning different subjects. Among all, use of concept maps has been very popular and most effective technique to be used in a constructivist setting. Evangelia Gouli in her research used concept mapping as a tool for web based learning[10], Keppens et.al in their study [17] used concept mapping to assess the knowledge acquired by the students in computer programming, Bernhard and Mok in [8] discuss the use of concept mapping in the field of informatics. A. Mühling in his research work[23] discusses in detail, use of constructivism and concept mapping for assessing the knowledge acquired by the learners.

B. The Learning Model

Learning designs represent new possibilities for increasing the quality and variety in the process of teaching and learning.

Hence, to implement the principles of a theory into practical model, a learning design model can be helpful. The ADDIE model given by AECT provides the basic steps to create a learning model in general and a CLE in specific to our study. Five steps in the ADDIE model are shown in fig 1 and are explained below-

- (a) analysis, where designer decides on the material to be learned.
- (b) design, where learning objectives are described and an instructional approach is chosen;
- (c) development, in which actual learning material is created.
- (d) implementation, in which the developer uses the materials with the learners; and
- (e) evaluation, in which the developer assesses the effectiveness of the designed learning material.

To embed constructivism in designing of a learning system, the designer must keep in mind that "the design task is to create an environment where knowledge-building tools and the means to create and manipulate artifacts of understanding are provided, not one in which concepts are explicitly taught" [14].

In the development step, instructional designers can include activities that enable learners to construct knowledge themselves rather than by having the meaning conveyed to them by the teacher. These activities also provide them with the problems they will encounter in the real world. In implementation and evaluation steps, constructivist practices can be implemented by engaging students in the construction, content, and revisions of the course. Through this type of social constructivism, not only students learn from each other, but they also participate in group knowledge construction.

III. CONCEPT MAPS

The technique of concept mapping is fundamentally based on the ideas of constructivism and meaningful learning [34]. Concept maps have been successfully used as learning and teaching aids as well as for the assessment and investigation of persons' knowledge structures in countless scenarios, studies, and subject domains[1]. These include computer science education like didactics of informatics [10], computer programming [17] and computer science [31][8]. A concept map can serve as an advance organizer for students, helping them to integrate newly presented material into their personal cognitive structure [2].

A Concept map has two main components: Concepts which are represented as labeled boxes and Propositions which are links between two concepts. These propositions may themselves be linked [27]. Third component may be added as a focus question to define a context and help focusing on relevant aspects more easily [24]. Fig. 2 shows an example concept map drawn using Cmap tool.



Fig. 3: Example Concept map

Use of concept maps in teaching learning and assessing has been an active area of research in subjects like physics, biology, history etc., where knowledge structures can be defined in hierarchical manner. Although many areas of computer science are well suited for constructivist approaches [23], its application in the field of programming, which is considered as one of the difficult areas in computer science education, needs to be explored.

"To become a competent computer scientist as well as a competent programmer, a person must acquire a certain set of skills as well as a certain body of knowledge. Even basic programming skills require factual knowledge about syntax elements and conceptual knowledge about program flow"[22]. Moreover, the factual knowledge acquired by the learner should be tightly connected with the programming skills required to use that factual knowledge in practical problems. Hence, teaching learning programming using constructivist approach can be more beneficial because in such a setting, students are actively involved in the process of their own knowledge construction by selecting learning path and performing various activities to develop skills along with conceptual learning.

Concept maps are best suited to create a constructivist setting for teaching learning programming as these can effectively create visual representation of the knowledge to be acquired. Also, the relationship between various concepts under a context is represented in the form of inter-related maps with explanations about a concept also linked with concepts. Such representation is also similar to the manner in which information is stored in human brains and hence can help in lifelong learning.

IV. DESIGNING CONCEPT MAP NETWORK FOR TEACHING PROGRAMMING

This section mainly discusses the designing of a CLE that uses concept map network as framework. The proposed framework uses interconnected concept maps to create a CLE which implements all the principles of constructivism. Also, the designing of CLE is based on ADDIE model. Following subsections explain the working of such model:

A. Learning Design

As the proposed learning environment is based on ADDIE model, the five steps are implemented as follows -

(a) Analysis: This step deals with selecting the material to be learnt. For the purpose of carrying out this study, a list of total 33 concepts from C programming was shortlisted. The concepts selected were considered to be helpful in achieving learning objective. Also, the learning material in the form of ppts, videos, text files and activities was either created or downloaded. This material known as learning stimulus was helpful in explaining the selected concepts effectively.

- (b) Design: This step is associated with specifying learning objectives and choosing an instructional approach. Primary learning objective in this study was to enable participant students to write a simple C program at the end of the study. In order to achieve this objective, first step was to develop conceptual knowledge among the learners about the selected concepts in such a manner that there is actual learning instead of just passive dissemination of knowledge. Instructional approach selected was based on principles of constructivism. Hence, concept map network based CLE was designed and implemented.
- (c) Development: This step involved the creation of actual constructivist learning environment and is discussed in next subsection.
- (d) Implementation: Proposed CLE was implemented with first year undergraduate students at DAV College, Chandigarh as these students were to study C programming as their main subject and also, they were new to programming.
- (e) Evaluation: Evaluation of the proposed system was done, by analyzing the students' responses in the form of questionnaires, to the effectiveness of the new method of teaching.

B. Concept Map Network

Concept map network is an interconnected network of concept maps which works as the teaching learning component of learning environment. It consists of various concept maps which are connected to each other using common concepts. A learner can move from one map to another to learn about either details of that concept or various different contexts where a concept can be used. Moreover, the concepts in a concept map are also linked to learning stimulus which contains presentations, activities or other learning material related to that concept. The concept map network follows the principles of constructivism discussed in Section III. There many tools available for creating the proposed concept map network. This study used CMap tools, as it was easy of use and there are many features available which are useful in implementing constructivist principles.

C. Methodology for Creating Concept Map Network

According to Canãs et al. [24], while drawing concept maps for teaching following points should be kept in mind:

1. Selection of a domain for the concept map;

- 2. Definition of a focus question;
- Identification of key concepts that apply to the domain;
- 4. Ranking of the key concepts;
- 5. Construction of a preliminary concept map;
- Identification of cross-links between different parts of the map;
- 7. Identification of linking words.

As the concept map network was created to teach C language concepts required to write a simple C program, domain is already defined. Next step is to identify and rank key concepts, so, a list of 33 concepts was short listed by a subject expert. These concepts were then ranked on the basis of their use in writing a simple C program. Further, these concepts were grouped together in the form of individual concept maps. Each concept map either presented an answer to a focus question or presented relations between different concepts in different contexts.

The approach followed in designing concept map network was top down approach where preliminary concept map contained elements of a C program. Fig 3 shows an example of the preliminary concept map. All the elements of a C program are shown in the form of concepts. Also, a brief introduction about a concept is provided when mouse hovers on that concept node.

After drawing concept maps, these were interlinked and were navigable in following forms-

 Different concept maps containing same concept were linked on a concept node in order to represent multiple representations of that concept in different contexts. This enables the learner to follow multiple paths in order to clearly understand the concept.



Fig. 3: Preliminary Concept Map

 In addition to this, concept maps were also linked in order to explain a concept in more detail, i.e., a concept appearing in a concept map can be



Fig. 4: Framework for the CLE used

linked to another concept map that provides more detailed explanation about that concept.

Also, learning stimulus attached to the concepts is stored as an independent entity which may be shared between different concepts or concept maps.

Final design of the proposed CLE is given in fig 4 and various components are explained thereafter.

Further, concepts in a concept map were also linked to learning stimulus or content which either explained the concept, provided examples or activities etc. required to understand the meaning of the concept. Fig 3 shows an example where concept "variable" is linked to three things. One is the link to another concept map that contains details about different types of variables. There are two more links to the content namely detail and data types which contain the explanation about variables and available data types respectively. Hence, learner may choose any of the paths depending upon his requirement and interest.

Concepts: A simple prototype of the above designed CLE was created to achieve the learning objective of "how to write a simple C program". In order to write a program, the learner should have basic knowledge about the programming language he is going to use, its standard libraries which contain some predefined functions and syntax of that language. Moreover, any program consists of three main steps namely, input, processing and output. So, knowledge about the functions used for taking input and giving output to the user and statements used for processing of data is also required. In addition to this, other important conceptual knowledge requirements are how the data is stored, how to use inbuilt functions and overall structure of a C program.

To provide this much of basic conceptual knowledge, a total of 33 concepts were identified. List of concepts is given as follows-

C Language, Syntax, Standard libraries, Programming Techniques, Program, Pre-processor directives, Header files, Data, Data types, Variables, variable declaration, variable initialization, variable assignment, constant declaration, Local, Global, Constants, Functions, Statements, Input, Output, Executable, printf, scanf, inbuilt functions, userdefined functions, mandatory function, optional function, main(), integer, character, float, double.

Concept Map Repository: It contained pre-designed concept maps for learning above mentioned concepts.

Learning Stimulus Repository: As described earlier, learning stimulus repository contained learning content that was useful in explaining an individual concept in a particular context or in understanding focus question of a concept map. Also, this repository contained activities for self-assessment by the learner.

Concept Map Network: Concept map network consisted of interconnected network of concept maps stored in concept map repository and combined through the common concepts. In order to keep focus on the learning objective, only those concept maps were connected which were helpful to the students in achieving goal. In addition to this, concept nodes contained links to the learning material stored in learning stimulus repository.

V. IMPLEMENTATION AND EVALUATION OF THE PROPOSED CLE

This proposed CLE was implemented at DAV College, Chandigarh, Computer science department, with first year students of BCA and B.Sc. Computer Science who were studying any programming language for the first time. Students were explained the purpose and methodology of study along with learning objective. Total of 45 students agreed to be part of the study. These students were taught the concepts using designed CLE and total of five lectures were given for the study. At the end of study, these students were given questionnaire to evaluate the performance of the same. 34 students returned the filled questionnaires which were then further analysed to study effectiveness of the CLE.

Following research questions were posed as part of evaluating the proposed CLE -

RQ1: Was there was any change in perception about the given CLE, among students after the learn-ing process was over?

RQ2: Whether students would like to continue their further learning in C using the same method?

RQ3: Do students find any change in their conceptual knowledge after study was over?

RQ4: Was the CLE able to cater to individual needs of the students?

VI. FINDINGS AND DISCUSSION

Findings have been discussed below in the form of answers to the research questions posed in previous section.



Fig. 5: Students' perception of CLE

RQ1: Was there was any change in perception about the given CLE, among students after the learning process was over?

Analysis of Q1, Q2 and Q4 in the questionnaire attempted to find what students thought about the learning method and whether there was any change in their perception after study was over.

Fig. 5 represents analysis of students' perception

about CLE, once study was over. Whereas 85% thought it to be better than alternative method of learning, after study was over, 15% thought opposite.

Fig. 6 shows change in perception of students about proposed CLE before and after study. The graph shows that 53% of the students registered positive change in their perception, 38% registered no change and 9% registered negative change. 38% students included those students also who rated the CLE higher even before beginning of the study.

RQ2: Whether students would like to continue their further learning in C using the same method?

In answer to this question, as many as 94% students wanted to continue with proposed CLE as a preferred mode of learning C programming concepts, whereas 6% students preferred traditional classroom method. There were no students who were not sure about their choice. Fig. 7 shows graphical representation of choices of students.

RQ3: Do students find any change in their conceptual knowledge after study was over?

Fig. 8 represents perception of students about change in knowledge using proposed CLE. 88% students found that there is positive change in their knowledge using proposed CLE, 6% found no change whereas 6% responded with don't know option.

RQ4: Was the CLE able to cater to individual needs of the students?

This research question was answered by studying students' responses to more than one questions and the analysis of the answers pointed towards following important points -

- Pace of learning of each student is different. In case of traditional classroom teaching methods, it is difficult to correctly identify the learning abilities of the students and hence individual learning needs are hard to provide for. Using the given CLE, the researchers could identify the pace of learning of individual students as 9% of the students learnt concepts in 1 lecture, another 50% in two lectures, 21% in three lectures, 9% in 4 lectures and 12% took more than four lectures.
- Moreover, some of the learners took more time as they studied certain concepts in detail whereas the others stuck to what was required. Hence, by observing the learning path of individual students, students with different abilities can be easily separated.



Fig. 6: Change in perception of students

 Proposed CLE provided students with different choices in style of learning and it was found that video lectures(41%) followed by activities(38%) were most preferred modes of learning whereas text notes(8%) were least preferred. However, individual student gave his individual preferences about learning method.

Figures 9 and 10 show graphical representations of these analysis.



Fig. 7: Willingness to continue with CLE



Fig. 8: Perception about change in knowledge



Fig. 9: Pace of learning



Fig. 10: Preference of learning mode

After analyzing students' responses, following observations can be made:

- 1./Almost all the students found this new method of learning to be better than traditional classroom method as the process of learning was unique for every student and was learner driven.
- 2. In the beginning, although some students were reluctant to use the CLE for learning as it required learner to be an active participant, however at the end of the study, perceptions of most of the students changed as 96% of the students wanted to continue the use of CLE for rest of the concepts.
- Different students have different learning needs with respect to time taken, learning style and also path of learning. Use of CLE caters to individual needs of the students by providing multiple paths.

VII. LIMITATIONS OF THE STUDY

The study was carried out for small period of time and hence consisted of few concepts. Also, the results discussed although show clear preference of the students towards CLE as a tool for learning C programming, were based only on students' perception. Actual knowledge gained by the students and their ability to apply this knowledge in solving practical problems was not measured. Further research may be carried out to work on these two parameters. Also, teacher's perspective is an important consideration in understanding whether this CLE is able to point and correct students' misconceptions and hence may be included in further study.

VIII. CONCLUSION

A constructivist learning environment designed using the concept maps has been proved to be effective in many subjects and can also be effective in teaching learning programming languages and skills. Concept maps networks can provide multiple learning paths to the students, hence catering to their individual style of learning. But the effectiveness of the learning system depends upon the design of the maps and their interrelationships. Hence, the concepts should be selected carefully and it should be ensured that the constructivist principles are followed by the learning model developed.

REFERENCES

- [1] Al-Kunifed, Ali & Wandersee, James H., "One hundred references related to concept mapping", Journal of Research in Science Teaching, 27(10), 1990, pp. 1069–1075.
- [2] Ausubel, David Paul, "Educational psychology: A cognitive view", Holt, Rinehart et Winston, Montreal, 1968.
- [3] Ben-Ari M., "Constructivism in computer science", Proceedings of the 29th SIGCSE Technical Symposium on Computer Science Education, Atlanta, Georgia, 1998, pp. 257–261.
- [4] Ben-David Kolikan, Y. (2001). Gardeners and cinema tickets: high school students' preconceptions of concurrency, Computer Science Education, 11(3), 221–245.
- [5] Booth, S. (2001). Learning computer science and engineering in context. Computer Science Education, 11(3), 169–188.
- [6] Duffy T.M., Lowyck J., Jonassen D.H., "Designing

environments for constructive learning", Springer-Verlag, New York, 1993.

- [7] Duit R., Roth W.-M., Komorek M., Wilbers J., "Fostering conceptual change by analogies – between Scylla and Charybdi",Learning and Instruction, 11, 2001, pp. 283–303.
- [8] Ertl, Bernhard & Mok, Sog Yee, "Conceptmapping in informatics", 2010, Log in (166/167), pp. 63–68.
- [9] Fowler, L., J. Armarego and M. Allen (2001). CASEtools: constructivism and its application to learning and usability of software development tools, Computer Science Education, 11(3), 261–272.
- [10] Gouli, Evangelia, "Concept mapping in didactics of informatics assessment. As a tool for learning in web-based and adaptive educational environments", PhD thesis, National and Kapodistrian University of Athens, Athen, 2007.
- [11] Gros, B., "Knowledge construction and technology", Journal of educational multimedia and hypermedia, 11(4), 2002, pp. 323–343.
- [12] Hadjerrouit, S. (1998b). A constructivist approach for integrating the Java Paradigm into the Undergraduate Curriculum. In Proceedings of the 3th Annual Conference on ITiCSE'98, Dublin. pp. 105–107.
- [13] Hadjerrouit, S. (1999). A constructivist approach to object-oriented design and programming. In Proceedings of the 4th Annual Conference on ITiCSE'99, Cracow. pp. 171–174.
- [1→] Hannafin, M. J., Hannafin, K. M., Land, S. M., & Oliver, K. (1997). Grounded practice and the design of constructivist learning environments. Educational Technology Research and Development, 45(3), 101-117.
- [15] Honebein P.C., Duffy T.M, Fishman B., "Constructivism and the design of learning environments: context and authentic activities for learning", T.M. Duffy, J. Lowyck, and D.H. Jonassen (Eds.), 1993, Designing Environments for Constructive Learning, Springer-Verlag, New York, 1993, pp. 88–108.
- [16] Jonassen D., " Objectivism versus constructivism: Do we need a new philosophical paradigm?",

Educational Technology Research and Development, 39(3),1991, pp. 5–14.

- [17] Keppens, Jeroen & Hay, David, "Concept map assessment for teaching computer programming", Computer Science Education 18(1), 2008, pp. 31–42.
- [18] Kruse, K. Introduction to instructional design and the ADDIE model. Retrieved April 25, 2009, from e-Learning and the ADDIE model. Web site: http://www.e-learningguru.com/articles/ art2_1.htm
- [19] Maria Jakovljevic, "Concept Mapping and Appropriate Instructional Strategies in Promoting Programming Skills of Holistic Learners", Proceedings of SAICSIT 2003, pp. 308 – 315
- [20] Matthews M.R., "Constructivism and science education: a further appraisal", Journal of Science Educational Technology, 11(2),2002, pp. 121–134
- [21] Mereno-Seco, F., and M.L. Forcada (1996). Learning compiler design as research activity. Computer Science Education, 7, 73–98.
- [22] Mühling Andreas, "Investigating knowledge structures in computer science education", PhD thesis, Jan, 2014.
- [23] Mühling, Andreas, Hubwieser, Peter & Brinda, Torsten, "Exploring teachers□ attitudes towards object oriented modelling and programming in secondary schools", Proceedings of the Sixth international workshop on Computing education research, Aarhus, Denmark, August 9-10 2010, ACM, New York, pp. 59–68.
- [24] Novak Joseph D. & Cañas Alberto J., "The theory underlying concept maps and how to construct and use them", Technical Report IHMC CmapTools, Jan, 2006, Rev Jan, 2008, Institute for Human and Machine Cognition, Florida.
- [25] Novak J. D. and Cañas A. J., The Theory Underlying Concept Maps and How to Construct and Use Them. Technical Report IHMC CmapTools 2006-01 Rev 01-2008, Florida Institute for Human and Machine Cognition (2008).

- [26] Novak, Joseph D. & Musonda, Dismas, "A twelveyear longitudinal study of science concept learning", American Educational Research Journal 28(1), 1991, pp. 117–153.
- [27] Novak, Joseph D., "Learning, creating, and using knowledge: Concept maps as facilitative tools in schools and corporations", 2nd ed., 2010, Routledge, London.
- [28] Phye G.D., "Handbook of academic learning: Construction of knowledge", Academic Press, 1997.
- [29] Piaget J., "The construction of reality in the child", Ballantine Books, 1975.
- [30] Pullen, M. (2001). The network workbench and constructivism: learning protocols by programming, Computer Science Education, 11(3), 189–202.
- [31] Sanders, Kate, Boustedt, J., Eckerdal, A., McCartney, Robert, Moström, Jan Erik, Thomas, Lynda & Zander, C., "Student understanding of object oriented programming as expressed in concept maps", SIGCSE Bulletin inroads 40(1), 2008, pp. 332–336.
- [32] Soendergaard, H., and P. Gruba (2001). A constructivist approach to communication skills instruction in computer science. Computer Science Education, 11(3), 203–209.

- [33] Spivey N.N., "The constructivist metaphor: Reading,writing, and the making of meaning", Academic Press, 1997.
- [34] Staver J.R., "Constructivism: sound theory for explicating the practice and science education", Journal of Research in Science Education, 35(5), 1998, pp. 501–520.
- [35] Steffe L.P., J. Gale, "Constructivism in education", Lawrence Erlbaum Associates, New Jersey, 1995.
- [36] Tam M., "Constructivism, instructional design, and technology: implications for transforming distance learning", Educational Technology & Society,3(2), 2000, pp. 50–60
- [37] Taylor D.R., "Developing powerful learning communities using technology", AACTE Briefs, 21(14), 2000, pp. 4–5.
- [38] Van Gorp, M.J., and D. Grissom (2001). An empirical evaluation of using constructive classroom activities to teach introductory programming. Computer Science Education, 11(3), 247–260.

Printed at : PANJAB UNIVERSITY PRESS, CHANDIGARH P.U.P. (405)-300+4P+10Reprint./06-01-2017

FORM IV (See rule 8)

1. 2.	Registration No. Place of Publication	: :	ISSN-0555-7631 Room No. 28-29, Old Correspondence Building Panjab University Chandigarh - 160014 (India)	
3.	Periodicity of publication	:	Annual	
4.	Publishers' & Editors' Name	•		
	Editor-in-Chief		Professor S.K. Mehta	
	Nationality	:	Indian	
	Editor	:	Professor Rajat Sandhir	
	Nationality	:	Indian	
	Address	:	Research Journal (Science) Room No. 28-29, Old Correspondence Building, Panjab University Chandigarh - 160 014	
5.	Printer's Name	:	Mr. Jatinder Moudgill	
	Nationality	:	Indian	
	Address	:	Manager Panjab University Printing Press Chandigarh - 160 014.	
6.	Name and Address of the individuals who own the newspaper and partners or shareholders holding more than one percent of the total capital.		Panjab University, Chandigarh	

Professor S.K. Mehta, hereby declare that the particulars given above are true to the best of knowledge and belief.

Professor S.K. Mehta Editor-in-Chief

PANJAB UNIVERSITY RESEARCH JOURNAL (SCIENCE)

Life Membership Form

Name Qualifications Area of Specialization		:				
Present Designation						
Address:	(Tick the address Local Members	s on which ye would recei	ou would like to r ve the Journal b	eceive the Journ ly Hand).	al.	
Office:						
		•	· · · · · · · · · · · · · · · · · · ·		······································	
		Resider	nce:			
		.				
		Telepho	one (O):	<u></u>		
			(K):(Mobile) [,]		· · · · · · · · · · · · · · · · · · ·	
		FAX	:		<u></u>	
		e-mail	:			
Payment Mode:		Cheque / Draft / Cash				
·	(Only local chequ of The Registrar	es are acceptable. Draft to be drawn in favour Panjab University, payable at Chandigarh.				
If By Cheque/Draft:		ft:				
		No	date	Amount _		
_ .		Name of Da				
Date:						
Place:			SI	GNATURES		
Subscript	ion fee:		tuloud			
Life Membership: Annual Subscription:			Rs. 3000/- Rs. 400/-	Le US	s \$ 250 \$ \$ 50	
Send to:	The Editor-in-Chie Research Journal Room No. 28-29, Old Corresponder Panjab University, Chandigarh-160 C	f, (Science), nce Building, 114 (India).				

INSTRUCTIONS TO AUTHORS

Panjab University Research Journal (Science) is published annually. The journal accepts original research papers or short notes and expository review articles in the field of various science subjects. The journal is open to all scientists engaged in original research in any discipline of science including Engineering and Information Technology. All manuscripts will be reviewed by two referees.

Manuscripts - The manuscripts should be typewritten (double spaced) with ample margins on one side of quarto bond paper (30 cm x 23 cm). Three complete copies of the manuscript along with a computer floppy/CD in Microsoft Word conforming to the journal's format is to be submitted. Page 1 should contain only title of manuscript, author(s) name(s) and affiliation(s), a short running title (abbreviated from the title) not exceeding 40 characters, name and complete mailing address of the person to whom correspondence should be addressed. Page 2 should contain an abstract not exceeding 150 words. The abstract should contain no illustration or reference to the figures, tables, or authors. The abstract should be followed by 3-4 key words. Acknowledgements should be inserted at the end of the text before References.

Short communication: A short communication should be a record of completed short investigation giving details of new methods or findings. It should not exceed 4 to 5 typed pages with an Abstract followed by Key words. Body of the text should not have any separate title.

References: References in the text should conform to the following style:-

Adherence of E. coli. to intestinal mucosal surface......pathogenesis (Beachey, 1981).

According to Arnoldi (1976), these feathers.....

The references at the end of article should be in alphabetical order and presented as follows:-

- Ahuja, D.B. 1990. Population dynamics of mustard aphid, *Lipaphis erysimi* (Kalt.) on Indian mustard Brassica juncea. Indian J. Plant Protection, 18: 233-235.
- Bener, A. and F.C. Erk. 1979. The analysis of whorls on specific fingerstips with respect to sex, bilateral asymmetry and genetic relationship. *Ann. Hum. Biol.*, 6:349-356.
- Buskrik, E.R., K.L. Anderson, and J. Brozek. 1956. Unilateral activity and bone and muscle development in the forearm. Res. Quart., 27 : 127-131.
- Jain, S.K. 1986. Orchid Wealth of India. In: Biology, Conservation, and Culture of Orchids (Ed.S.P.Vij) pp. 319-22. Affiliated East West Press (New Delhi).

Illustrations: Three sets of figures (preferably black and white), mounted on thick white sheet, must be submitted in camera-ready form. All illustrations should be lettered with stencil using Indian ink. The illustrations should preferably be in the form of text-figures. All figures whether photographs or drawing, must be numbered in single series (Fig. 1,2,3...etc.). The figures should be arranged and numbered in the order in which they are referred to in the text. The figures or photographs (plates) submitted for publication must be large enough to withstand some reduction. The ratio of length & width of the full figure plate must necessarily be in proportion to the page size of the journal *i.e.* 23 cm x 18 cm. Figures must carry magnification bars. Legends to figures should be typed on a separate sheet of paper to be inserted after References. Abbreviations used for the figures should be given in an alphabetical order after the legends.

Tables: Tables 1, 2, 3 should be single-spaced on separate page and numbered. Each table must bear a short descriptive heading.

Proofs: Page proof will be sent to corresponding author. Authors will be charged in the event of excessive alterations in the proofs.

Reprints: Ten reprints of each paper will be provided *gratis*. Additional copies may be ordered while returning the proofs. The cost of the extra reprints will have to be borne by the author.

Manuscripts and Correspondence should be addressed to the Editor-in-Chief, Research Journal (Science), Room No. 28-29, Old Correspondence Building, Panjab University, Chandigarh 160 014 (India). Telephone: 0172-2534376 & 0172-2534213; E-mail : resjoursci@pu.ac.in

Published by : EDITOR-IN-CHIEF Research Journal (Science) Panjab University, Chandigarh-160 014 INDIA

ISSN-0555-7631