Sundarapandian Vaidyanathan
Jan Zizka (Eds)

Computer Science & Information Technology

Second International Conference on Information Technology, Control, Chaos, Modeling and Applications (ITCCMA-2015)
Chennai, India, March 07 ~ 08 - 2015

AIRCC

Volume Editors

Sundarapandian Vaidyanathan,
R & D Centre,
Vel Tech University, India
E-mail: sundarvtu@gmail.com

Jan Zizka,
Mendel University in Brno, Czech Republic
E-mail: zizka.jan@gmail.com

ISSN: 2231 - 5403
ISBN: 978-1-921987-33-5
DOI : 10.5121/csit.2015.50501 - 10.5121/csit.2015.50507

Typesetting: Camera-ready by author, data conversion by NnN Net Solutions Private Ltd., Chennai, India

Preface

Second International Conference on Information Technology, Control, Chaos, Modeling and Applications (ITCCMA-2015) was held in Chennai, India, during March 07~08, 2015. International Conference on Fuzzy Logic Systems (FUZZY 2015), International Conference on Signal, Image Processing and Embedded Systems (SIGEM 2015), International Conference on Data Mining and Database Management Systems (DMDBS 2015) and International Conference on Natural Language Computing (NATL 2015) were collocated with the ITCCMA-2015. The conferences attracted many local and international delegates, presenting a balanced mixture of intellect from the East and from the West.

The goal of this conference series is to bring together researchers and practitioners from academia and industry to focus on understanding computer science and information technology and to establish new collaborations in these areas. Authors are invited to contribute to the conference by submitting articles that illustrate research results, projects, survey work and industrial experiences describing significant advances in all areas of computer science and information technology.

The ITCCMA-2015, FUZZY-2015, SIGEM-2015, DMDBS-2015, NATL-2015 Committees rigorously invited submissions for many months from researchers, scientists, engineers, students and practitioners related to the relevant themes and tracks of the workshop. This effort guaranteed submissions from an unparalleled number of internationally recognized top-level researchers. All the submissions underwent a strenuous peer review process which comprised expert reviewers. These reviewers were selected from a talented pool of Technical Committee members and external reviewers on the basis of their expertise. The papers were then reviewed based on their contributions, technical content, originality and clarity. The entire process, which includes the submission, review and acceptance processes, was done electronically. All these efforts undertaken by the Organizing and Technical Committees led to an exciting, rich and a high quality technical conference program, which featured high-impact presentations for all attendees to enjoy, appreciate and expand their expertise in the latest developments in computer network and communications research.

In closing, ITCCMA-2015, FUZZY-2015, SIGEM-2015, DMDBS-2015, NATL-2015 brought together researchers, scientists, engineers, students and practitioners to exchange and share their experiences, new ideas and research results in all aspects of the main workshop themes and tracks, and to discuss the practical challenges encountered and the solutions adopted. The book is organized as a collection of papers from the ITCCMA-2015, FUZZY-2015, SIGEM-2015, DMDBS-2015, NATL-2015.

We would like to thank the General and Program Chairs, organization staff, the members of the Technical Program Committees and external reviewers for their excellent and tireless work. We sincerely wish that all attendees benefited scientifically from the conference and wish them every success in their research. It is the humble wish of the conference organizers that the professional dialogue among the researchers, scientists, engineers, students and educators continues beyond the event and that the friendships and collaborations forged will linger and prosper for many years to come.

Sundarapandian Vaidyanathan
Jan Zizka

Organization

General Chair

Natarajan Meghanathan	Jackson State University, USA
Dhinaharan Nagamalai	Wireilla Net Solutions PTY LTD, Australia

Program Committee Members

Abri Nee. Badaoui Hadjira	University of Tlemecen, Algeria
A Hussain	University of Stirling, Scotland, UK
Aazibi	College of Technology at Alkharj, Saudi Arabia
Abbas Akkasi	Eastern Mediterranean University, Cyprus
Adnan Albar	King Abdulaziz University, Saudi Arabia
Ahmed arara	College of Technology at Alkharj, Saudi Arabia
Ajith Singh N	Manipur University, India
Akella Pathanjali Sastri	V.R.Siddhartha Engineering College, India
Ali Dorri	Islamic Azad University, Iran
Ali Hussein Mohammed	Alexandria University, Egypt
Alireza Afshari	Islamic Azad University, Iran
Amel Boufrioua	University Constantine 1, Algeria
Amir baharvandi	IEEE Transaction on Power Systems, Iran
Amit Chauhan	Babaria Institute of Technology, India
Amit Choudhary	Maharaja Surajmal Institute, India
Anamika Ahirwar	Rajiv Gandhi Technical University, India
Anil Kumar Dubey	Government Engineering College, India
Ankit Chaudhary	Truman State University, USA
Anwar Basha	S.A. Engineering College, India
Apai	Universiti Malaysia Perlis, Malaysia
Arash Habibi Lashkari	University New Brunswick (UNB), Canada
Arvind Kumar	Amity University, India
Ashraf A. Shahin	Cairo University, Egypt
Ashwani Kumar	SLIET Longowal, India
Avadhani PS	Andhra University, India
Ayush Singhal	Bhilai Institute of Technology, India
B.K.Verma	Rajiv Gandhi Memorial College, India
Bibhudatta Sahoo	National Institute of Technology Rourkela, India
Brojo Kishore Mishra	C. V. Raman College of Engineering, India
Chin-Chih Chang	Chung Hua University, Taiwan
D N Chandrappa	SJB Institute of Technology, India
Damodar Reddy	National Institute of Technology Goa, India
Daniel D. Dasig, Jr.	Jose Rizal University, Philippines
Dayakar C.V	Anna University, India
Diptoneel Kayal	West Bengal University of Technology, India
Doreswamy	Mangalore University, India

Technically Sponsored by

Networks & Communications Community (NCC)

Computer Science & Information Technology Community (CSITC)

Digital Signal & Image Processing Community (DSIPC)

Organized By

Academy & Industry Research Collaboration Center (AIRCC)

TABLE OF CONTENTS

Second International Conference on Information Technology, Control, Chaos, Modeling and Applications (ITCCMA-2015)

International Conference on Fuzzy Logic Systems (FUZZY 2015)

International Conference on Signal, Image Processing and Embedded Systems (SIGEM 2015)

International Conference on Data Mining and Database Management Systems (DMDBS 2015)

International Conference on Natural Language Computing (NATL 2015)

ANDROID APPLICATION TO EXTRACT THE STATISTICS OF AN HPC CLUSTER

S.Chakraborty, Miraz Nabi Azad, Sourav Sen, Pritomrit Bora
Aditya Singh, Bipal Das and Mohd.Tabeesh Noori

Department of Computer Engineering, NIT Silchar, Assam
www.nits.ac.in

ABSTRACT

*As the number of **HPC** systems across the globe is booming at a rapid pace. The task of system administration is turning out to be tedious. Using a computer for every petty work can be cumbersome. In recent times there has been a paradigm shift from PC to mobile on a rapid scale. So a need has risen for such paradigm shift in system administration too. To solve this problem, an android application has been developed which allows the admin to monitor the system statistics remotely using his cellphone.*

KEYWORDS

Android, Eclipse, Java, JSCH, SSH, IPMI.

1. INTRODUCTION

Android platform is the most promising and widely used operating system in recent times for smart phones and other hand held devices. So it is a good platform to develop a prototype application so that the system administrator of an HPC cluster can remotely login to the system and retrieve data regarding system health which will help him to take appropriate measures if needed without being physically present in vicinity of the system simply by using his or her cell phone.

2. OBJECTIVES OF PROPOSED PROJECT

- The application will act as a client and the administrator can connect to the ssh server by providing valid credentials.
- The administrator can use this application to analyze the statistics of the cluster by extracting information such as Memory usage, Hardware information, CPU and processing information, Disk space statistics and Network Packet statistics.
- This application also enables user to run **IPMI command** so that user can analyze information such as Power Status, Fan Sensors, Temperature Sensor and System Event Log.
- The application can also be used for visual representation of the extracted cluster information.

Sundarapandian et al. (Eds) : ITCCMA, FUZZY, SIGEM, DMDBS, NATL - 2015
pp. 01–06, 2015. © CS & IT-CSCP 2015 DOI : 10.5121/csit.2015.50501

3. SCOPE OF THE PROJECT

Many android applications with similar prototypes have been researched and developed but the existence of one single concrete application such as our application **HPC Health** is dubious. This application overcomes the problem of constant monitoring of the HPC cluster by enabling admin to access the system remotely and remain updated about the state of the system. As a new solution to develop such a system, this paper introduces the use of secure shell protocol using java.

4. RESEARCH IN THIS PAPER

The key research element in this paper is the introduction of a System Administration tool in mobile platform. For decades SSH has been used for the task of system monitoring through a PC or work station, but this paper shows us the possibility of doing same by using hand held devices or smart phones with the help of this application, since mobilization is the future. This paper also introduces tool for convenient System monitoring by providing visual aid such as plotting graph from the extracted information in real time which makes it more perspicuous and helps in quick decision making.

5. ANDROID

Android is a linux based operating system targeted for smart phones and hand held devices. The OS was developed by Android Inc and owned by Google since 2005.Tools and different API's for developing mobile application are provided by android SDK. Android offers a unified approach to application development for mobile devices which means developer need only develop for android and their application shall run on different devices powered by android.

6. SYSTEM ARCHITECTURE

Android OS is a stack of software components that consist of five sections and four main layers.

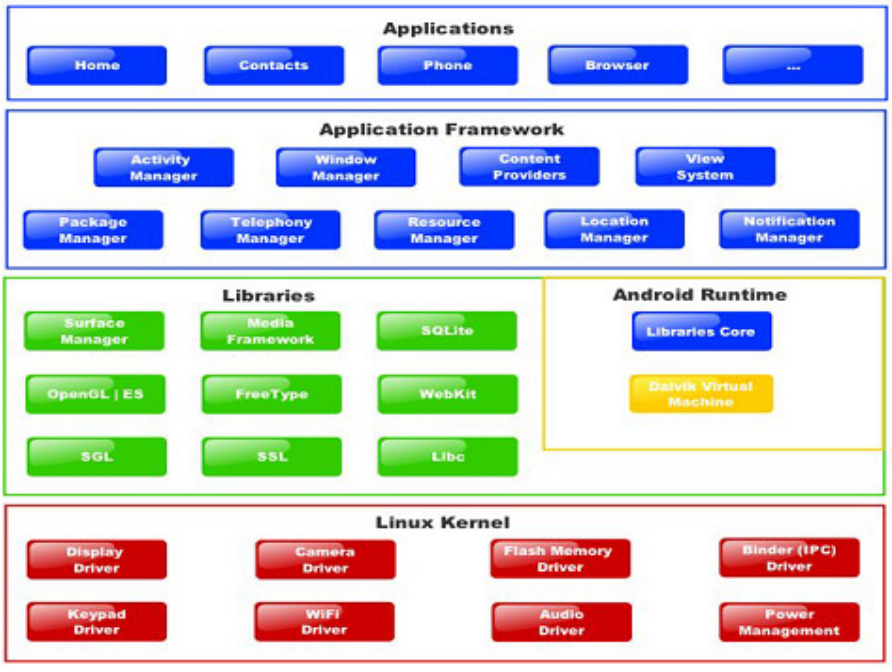


Fig 1. System architecture of Android

6.1. Android Application Development Environment

Android applications are written in java and compiled into byte codes which will be converted to .dex file (Dalvik Executable File) using dx converter. This will further be complied into android package file (apk file) that can be installed to an android device.

Android application consists of one or more of these four components. The main building blocks are:

- **Activity:** It is the core component of Android Application. It is a user interface that dictates how the user interacts with smart phone screen.
- **Services:** It is designed to keep running in the background to perform tasks that perform long running operations.
- **Content Providers:** The content providers are used as an interface to data. Content provider helps maintain shared data between applications.
- **Broadcast Receivers:** These are broadcast announcements made by the system.

7. TECHNOLOGIES USED

- **SSH AND Jsch:** SSH is a unix based interface and protocol for securely getting access to a remote computer. It is widely used by network administrator to control web and other kind of servers remotely. It provides strong authentication and secure communication over in secure channel by encrypting transmitted data during SSH session.
- **Jsch(Java Secure Channel):** Jsch is a java implementation of SSH. It is a Java library which provides the implementation of SSH functionality.
- **IPMI tool:** IPMI(Intelligent Platform Management Interface) is a an open standard hardware management subsystem to communicate .IPMI is a single command line interface useful for managing IPMI enabled devices .It enables user to manage system hardware ,monitor system health, monitor and manage the system environment independent of the operating system.

8. EXPERIMENTAL DESIGN

- Firstly to connect the android device to the server, ssh connection was planned to be used to accomplish which jsch library was incorporated in the android environment.
- For communication between the client application and the server, input and output streams were created.
- The commands to be fired on the server were sent through the output stream and the results were channeled back to the device through the input stream.
- Graphs were plotted to check the performance of the HPC system using the data received. This was accomplished using the GraphView api for android. To give a real time view of the performance the graph data was refreshed every few milli seconds using threads.

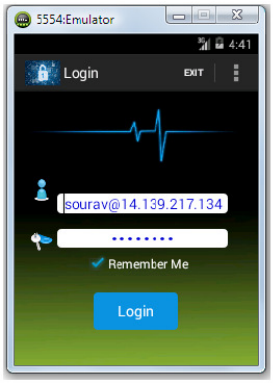


Fig 2. Login screen

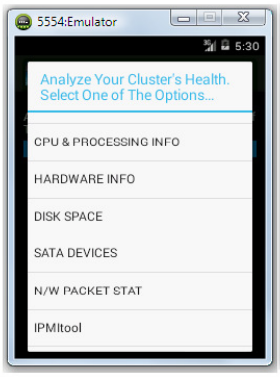


Fig 3. Menu screen

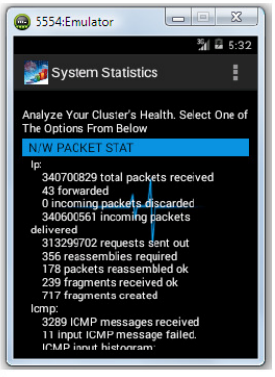


Fig 4. Output displayed

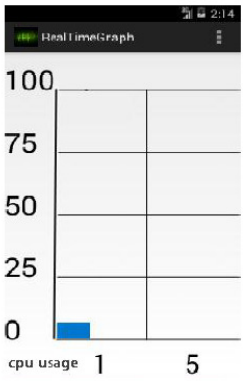


Fig 5. Percentage **CPU** usage graph

9. OVERVIEW

HPC Health will be a project consisting of Client and Server. The interaction between user and the system is depicted in the use case diagram given below.

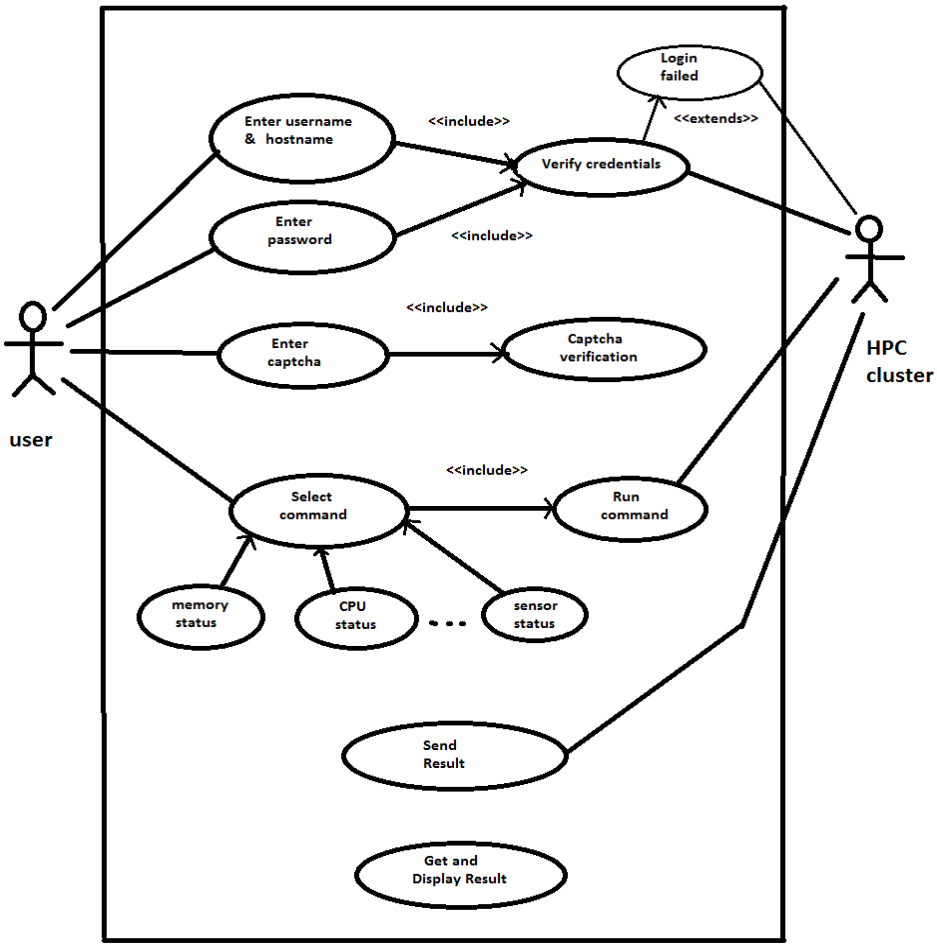


Fig 6. Use Case Diagram

The order of events that take place while manoeuvring the application by the user is depicted below with a activity diagram.

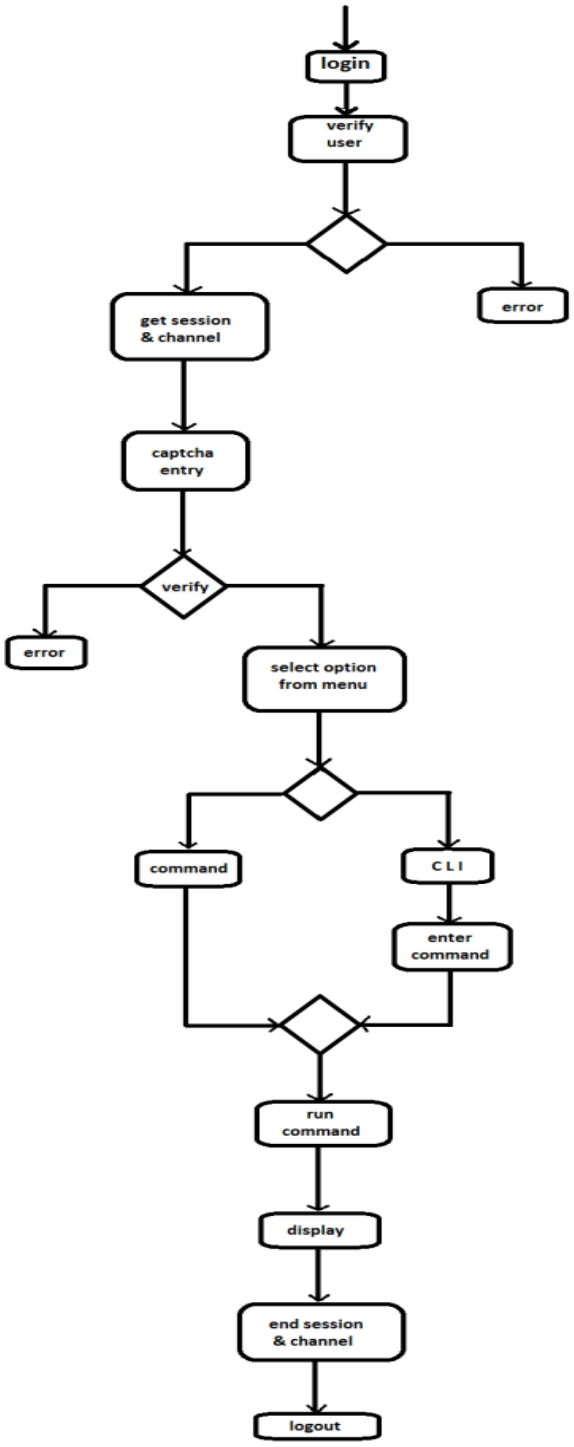


Fig7. Activity Diagram.

10. APPLICATION AND FUTURE SCOPE

Due to the rapid expansion in technology ,there is a need for fast computation which has led to a boom in the supercomputing industry .The increase in the number of HPC clusters has entailed for an advanced system administrating tool .In such a scenario our HPC Health application becomes a very competent tool as it provides features such as remote monitoring which makes the task of system administration very expedient.

There are a lot of features that could be incorporated into this application and we will attempt to target those in the coming months.

- The system administrator should be able to control the processes that are running in the system, start new ones and kill existing ones, if necessary.
- Our main aim will be to show all the processes in a drop down list so that user can select from them.
- We will try to incorporate more graphs in displaying the data so that it is more convenient for user to understand the state of the system.

11. CONCLUSION

This thesis project has covered mobile application development in Android platform. The basic components of android have been described along with the overview of the Android architecture. The outcome of this project has accomplished most of the goals we set at the start. This project was an opportunity to discover and explore new skills in the field of mobile application development. The final application can be useful to system administrators for keeping track of their systems (Cluster) remotely without disrupting the normal performance of the system.

ACKNOWLEDGEMENTS

We would like to extend our gratitude to Dr P.K. Sinha(Senior Director, HPC, CDAC), Mr Abhishek Das and the C-DAC members at NIT Silchar for their cordial support, valuable information and guidance provided by them, which helped us in moving ahead with this task through various stages. We are also very grateful for their cooperation during the period of our assignment.

REFERENCES

[1] Dr. Atsuhiko Yamanaka. Jcraft. JCraft, Inc. Web. 10 Jan. 2015.
[2] Jonas Gehring. Graph View. 16 Jan. 2015
[3] Ramzi N.Sansour, Nidal Kafri, Muath N.Sabha “A survey on mobile multimedia application development environment”.
[4] Ms Loveena Lionel “Android As A Server Platform”.
[5] Deepali Javale “Home Automation and Security System Using Android ADK ”
[6] Andreas Sommer, Stephen Krusche “Evaluation of cross platform frameworks for mobile applications”.
[7] Henning Heitkotter “Evaluating Cross Platform Development Approaches for Mobile Applications”
[8] Ifeanyi P. Egwutuoha, David Levy,Bran Selic Shiping Chen “A survey of fault tolerance mechanisms and checkpoint/restart implementations for high performance computing systems”.

COMPREHENSIVE PERFORMANCE ANALYSIS OF CHAOTIC COLOUR IMAGE ENCRYPTION ALGORITHMS BASED ON ITS CRYPTOGRAPHIC REQUIREMENTS

K S Tamilkodi[1] and Dr. (Mrs) N Rama[2]

[1]Assistant Prof in Computer Science, Presidency College, Chennai
tamil_vizhi@hotmail.com
[2]Associate Prof in Computer Science, Presidency College, Chennai
n_ramabalu@yahoo.com

"The state of being free from danger or threat." - *Security*

ABSTRACT

As we live and revel in a digital age, the day to day transmission of multimedia data over the internet is beyond our imaginations. Consequently, the increased risk of losing or altering the data during transit is more. Protection of this multimedia data (audio/speech, image, and video) becomes one of the major security concerns, because millions of Internet users worldwide, are infringing digital rights daily, by downloading multimedia content illegally from the Internet. The image protection is very important, as the image transmission covers the highest percentage of the multimedia data. Image encryption is one of the ways out to achieve this. Our world, built upon the concept of progression and advancement, has entered a new scientific realm known as Chaos theory. Chaotic encryption is one of the best alternative ways to ensure security. Many image encryption schemes using chaotic maps have been proposed, because of its extreme sensitivity to initial conditions, unpredictability and random like behaviors. Each one of them has its own strength and weakness. In this paper, some existing chaos based colour image encryption schemes are classified and analyzed with respect to various parameters like implementation, key management, security analysis and channel issues to fulfill some basic cryptographic requirements for chaos based image encryption algorithms from the year 2010 to 2014.

KEYWORDS

Chaotic algorithms, Cryptography and Chaotic maps.

1. INTRODUCTION

We live in a connected world and the internet play a major role in keeping us connected to share every last details of our life with others. In the realm of high-end internet technology, where size of a file and speed is not consideration, the greatest driving force in the transmission of multimedia data (audio, image and video) is the push towards making it more secure. When compared to audio and video in the multimedia transmission, the percentages of images are high. Image security is of more concern because of its widespread applications in Tele-medicine,

Sundarapandian et al. (Eds) : ITCCMA, FUZZY, SIGEM, DMDBS, NATL - 2015
pp. 07–19, 2015. © CS & IT-CSCP 2015 DOI : 10.5121/csit.2015.50502

E-Learning, Electronic publishing, Electronic financial transactions, Confidential video conferences, Entertainments, Economics, Politics, Personal communication, Military communications. In order to protect these multimedia contents cryptography appears to be an appropriate tool.

Cryptography is the art and science of protecting information by converting text in intelligible form into an unintelligible form in the presence of adversaries [**22**]. It can use either a private key (single key) or public key (double key) to encrypt the secret message. In private key cryptography single key is used for both encryption and decryption. Key management is difficult and the computational speed of private key encryption is tolerable. In public key cryptography two keys are used, one for encryption and the other for decryption. Both the keys are mathematically related and it is infeasible to deduce one key from the other. But it is not suitable for real world applications where the encryption speed is of concern.

Image encryption has become an important way to protect an image against illegal copying and distribution and also become extremely vital especially, while transmitting it on the internet, intranets and extranets. Image encryption is nothing but converting an original image into cipher image that is difficult to understand for an unintended users.Color image encryption is generally implemented by extracting and encrypting each channel (Red, Green, & Blue) independently and then combining these to get the encrypted image. Decryption is to get back the original image from the cipher image. No one can view the content of an image without knowing a decryption key.

The classical ciphers like DES (Data Encryption Standard), AES (Advanced Encryption Standard) and RSA (Rivest, Shamir and Adleman) are most suited for text and binary encryption but not ideal for multimedia applications because of the following reasons[23]

1. Multimedia data such as audio, video and image are very large-sized and bulky.

2. In digital images, adjacent pixels often have similar grey-scale values and strong correlations or image blocks have similar patterns, while for video data, consecutive frames are similar and only few pixels would differ from frame to frame.

3. For many real-life multimedia applications like video pay-per-view system, it is important that very light encryption should be made to preserve some perceptual information.

An encryption level can be enhanced by combining chaos theory and the cryptography. Chaotic systems and cryptographic algorithms have similarities like ergodicity, sensitive to initial conditions and parameters.

Hence, chaos based image encryption techniques are considered to be good for practical applications. Sufficiently large numbers of Chaos based image encryption algorithms have been proposed by many researchers for secure image transmission over insecure channel [6, 19]. However many of the proposed schemes failed to explain or do not possess a number of features that are fundamentally important to all kind of cryptosystems.

A good chaos based image encryption algorithm must specify the some of the basic cryptographic requirements such as implementation, key management, security analysis and channel issues in order to evaluate their security and performance. New chaos based image encryption techniques are developed day after day by ignoring these simple requirements. An attempt is made to study the performance of some colour image encryption techniques proposed from the year 2010 to 2014.

Like rain in monsoon, new image encryption techniques are evolving and so we have selected 15 colour image encryptions schemes using different chaotic maps like Cat Map, Chebyshev, Henon, Logistic, standard and sine map in this article. All these schemes are good in their own regard. Each one is unique in their respective implementation, key management and security issues. Finding a single encryption technique that can satisfy all the cryptographic requirements [1] is an impossible task.

The rest of the paper is organized as follows: in section 2 we introduced the concepts of Chaos Theory and its relationship with cryptography. Existing colour image encryption schemes are explored in section 3. Descriptions about some chaotic maps are given in section 4. In section 5 the rules to optimize the performance of chaos based cryptosystems are itemized and conclusions are given in section 6.

2. CHAOS AND CRYPTOGRAPHY

Chaotic dynamical systems are ubiquitous in nature (such as tornado, stock market, population growth in ecology, turbulence and weather) and laboratory (electrical circuits, lasers, chemical reactions, fluid dynamics and mechanical systems). Chaotic behavior has also found numerous applications in electrical and communication engineering, information and communication technologies, biology and medicine. Poincare is believed to be the one who studied chaos first in 19^{th} century. The "Butterfly Effect" was revealed by the father of chaos Edward Lorenz in 1963. In 1975, Li and Yorke published the paper "Period three implies chaos". Since then a lot of important concepts like Lyapunov exponents, dimensions and attractors have been introduced. [20, 24]

In a world of digital image encryption algorithms, there are umpteen number of applications developed with each have advantages / drawbacks over the others. Both cryptography and chaos theory dominate different parts of information security in remarkably different ways. But their similarities cannot be ignored, since both are best known for information protection against possible attacks. Chaos theory deserves credit for its bundle of unique properties.

In common usage, chaos means a state of disorder. Since there is no universally accepted mathematical definition of chaos, a commonly used definition is that, for a dynamical system to be said as chaotic, it must have the following properties:

1) It must be sensitive to initial conditions

2) Its periodic orbit must be dense

3) It must be topologically mixing

Dynamical systems are the study of how things change over time. Examples include the growth of populations, the change in the weather, radioactive decay, mixing of liquids such as the ocean currents, motion of the planets, the interest in a bank account. Some of these dynamical systems are well behaved and predictable, if we know how much money we have in the bank today, it should be possible to calculate how much we will have next month. However, some dynamical systems are inherently unpredictable and so are called chaotic. An example of this is weather forecasting, which is generally unreliable beyond predicting weather for the next three or four days. To quote Edward Lorenz, who was the first to realize that deterministic chaos is present in weather forecasting: Chaos is "when the present determines the future, but the approximate present does not approximately determine the future". In theory, if we could measure exactly the weather at some instant in time at every point in the earth's atmosphere, we could predict how it

will behave in the future. But because we can only approximately measure the weather (temperature, wind speed and direction), the future weather is unpredictable.

Many fundamental concepts in chaos theory, such as mixing and sensitivity to initial conditions and parameters, coincide with those in cryptography. The similarities and differences between the two are given [9] in Table 1. Chaos based algorithms provide a good combination of speed, complexity, high security, reasonable computational overheads and computational power.

Table1. Similarities and differences between chaos and cryptography

Chaotic systems	Cryptographic algorithms
Phase space: set of real numbers	Phase space: finite set of integers
Iterations	Rounds
Parameters	Key
Sensitivity to initial conditions /control parameters	Diffusion with a small change in the Plain Text / Key
Mixing	Diffusion with a small change in one PT-block of the whole PT
Ergodicity	Confusion
Deterministic dynamics	Deterministic pseudo-randomness
Structure Complexity	Algorithm (attack) complexity
Analytic methods	Algebraic methods

3. EXPLORATION OF EXISTING COLOUR IMAGE ENCRYPTION SCHEMES

In order to communicate an image over an insecure communication channel, it is necessary to develop an efficient chaos based image encryption algorithms. To meet this requirement, number of chaotic crypto systems has been proposed by researchers. Here is a list of fifteen such chaos-based cryptosystems.

3.1. "A Novel Image Encryption Algorithm based on Logistic Maps"

Dongming Chen et al [2] has proposed a block encryption algorithm using CBC (Cipher Block Chain) mode, two logistic maps and a secret key of 80-bits. Correlation analysis of two adjacent pixels, Histogram analysis, NPCR and UACI analysis as well as key sensitivity analysis are carried out by the authors to prove the security of their algorithm. The hardware implementation and an encryption time of this algorithm are stated by the authors.

3.2. "A Novel Color Image Encryption Algorithm Based on Chaotic Maps"

HuibinLu et al [5] has recommended an algorithm based on Chen and Lorenz systems to encrypt color images implemented in MATLAB 7.0 with the key space of about $\mathbf{10^{120}}$. In this algorithm, first image information is integrated into the Lorenz map, and then it is mixed into the Chen map via the Lorenz map. Correlation analysis of two adjacent pixels, Histogram and Entropy analysis, NPCR, UACI as well as key space and sensitivity analysis are carried out by the authors to prove

the security of the algorithm. The infeasibility of Brute-Force attacks and Resistance attack has been verified by the authors.

3.3. "A Novel Color Image Cryptosystem Using Chaotic Cat and Chebyshev Map"

Jianjiang CU Iet al [6] suggested a chaotic color image encryption method using Arnold-Cat and Chebyshev Maps with a key space of $\mathbf{2}^{153}$. Correlation analysis of two adjacent pixels, Histogram and Entropy analysis, as well as key space and sensitivity analysis are carried out by the authors to prove the security of the algorithm. The infeasibility of brute-force attacks has been verified by the authors. The hardware implementation, digital arithmetic and an encryption time of this algorithm are documented by the authors.

3.4. "Improved Image Encryption Algorithm Using Chaotic Map", International Journal of Computer Applications"

Joshi Rohit A et al [7] introduced an improved image encryption scheme based on Henon Map. To resist plain text attacks, both parts of the keys are generated using plain image. Statistical analysis, Correlation analysis, Histogram analysis, Key sensitivity analysis and Differential analysis, NPCR and UACI are carried out by the authors to prove the security of the algorithm.

3.5. "A New Chaotic Algorithms for Image Encryption and Decryption of Digital Color Images"

K. Sakthidasan et al [19] designed an image encryption scheme, which employs one of the three dynamic chaotic systems (Lorenz or Chen or LU chaotic system selected based on 16-byte key) to shuffle the position of the image pixels and another one of the same three chaotic maps to confuse the relationship between the cipher image and the plain image to resist attacks.Correlation analysis, Histogram analysis and Key sensitivity analysis are carried out by the authors to prove the efficiency of their algorithm.

3.6. "New Approach for Fast Color Image Encryption Using Chaotic Map"

Kamlesh Gupta et al [8] devised a technique which utilizes 3D Standard and 3D Cat Map with the key size of 148 Bits to provide better encryption. Correlation analysis, Histogram and Entropy analysis, as well as key space and sensitivity analysis, Differential analysis, NPCR, UACI, FIPS TEST and MAE are carried out by the authors to prove the security of the algorithm. The infeasibility of brute-force and differential attacks has been verified by the authors. The hardware and software implementation (MATLAB 7.0) are documented by the authors.

3.7. "An Inter-Component Pixels Permutation Based Color Image Encryption Using Hyper-chaos "

Musheer Ahmad et al [12] proposed an algorithm based on the concept of inter-component shuffling of image pixels using Arnold Cat Map and 2D hyper-chaotic system with the key space of about $\mathbf{10}^{-14}$. To encrypt all pixels, XOR operation and CBC mode is used. Correlation analysis of two adjacent pixels (H, V & D), Chi-Square Test, Histogram and Entropy analysis, as well as NPCR are carried out by the authors.

3.8. "A New Chaos-Based Image Encryption Scheme for RGB Components of Color Image"

Nashwan A. Al-Romema et al [13] introduced an image encryption algorithm based on chaotic logistic map implemented in MATLAB. They used another image as a key, that should be larger or of the same size of the plain image. Correlation analysis of two adjacent pixels (R, G & B),

Histogram analysis and MSE, as well as key sensitivity analysis are carried out by the authors to prove the security of the algorithm. The infeasibility of Brute-Force attacks has been verified by the authors.

3.9. "Digital Color Image Encryption Using RC4 Stream Cipher and Chaotic Logistic Map"

Ni G. A. P. Harry Saptarini et al [4] has suggested a color image encryption method implemented in C# (2005) based on RC4 stream cipher and chaotic logistic map with the key size of 256 Bytes. Experimental results such as Histogram and Entropy analysis, Key Sensitivity Test as well as NPCR and UACI are carried out by the authors.

3.10. "A Proposed Permutation Scheme Based On 3-D Chaotic System For Encrypting The Colored Images"

Osama M. Abu Zaid et al [14] proposed a color image encryption algorithm implemented in MATLAB 7.0 based on Chen's chaotic system. The experimental results and analysis like Correlation analysis of two adjacent pixels, Histogram analysis, NPCR and UACI analysis as well as key sensitivity analysis and Signal / Noise Ratio are carried out by the authors to prove the security of the algorithm. The hardware implementation details are specified by the authors.

3.11. "High Security Nested PWLCM Chaotic Map Bit-Level Permutation Based Image Encryption"

An image encryption scheme based on Nested Piece Wise Linear Chaotic Map with 96 Bits key size is proposed by QassimNasir et al [15]. The system is stream cipher architecture. The experimental results such as Correlation analysis of two adjacent pixels (H, V & D), Histogram and Entropy analysis, NPCR and UACI are carried out by the authors to prove the security of the algorithm.

3.12. "Enhancement and Analysis of Chaotic Image Encryption Algorithms"

An encryption algorithm implemented in MATLAB based on combining the Logistic and Henon maps to expand the parameters is proposed by R. Raja Kumar et al [16]. The pixel values of an image are changed by the XOR operation with chaos sequences generated by Logistic and Henon maps, and cyclic shift in binary. The experimental results such as Histogram Entropy analysis, NPCR and UACI are carried out by the authors. Key parameters and its ranges are also specified in this paper.

3.13. "An Improved Image Encryption Scheme Using Chaotic Logistic Maps"

Ravindra K. Purwar et al [17] presented an image encryption algorithm based on 2 chaotic logistic maps with 80-bit secret key to derive an initial condition. The initial conditions for the second logistic map are determined by the outcome of first logistic map and the secret key. Depending upon the outcome of the second logistic map, algorithm performs any of eight different types of operations on image pixels. The secret key is modified after encrypting a block of 16-pixels. Along with the hardware implementation details, experiment results like Correlation analysis, Histogram and Encryption Time analysis as well as key sensitivity analysis are carried out by the authors.

3.14. "New Algorithm For Color Image Encryption Using Chaotic Map and Spatial Bit-Level Permutation"

Rui Liu et al [18] proposed a SBLP and chaotic map to encrypt color image with the key space of about $\mathbf{10^{68}}$. Logistic chaotic sequence is used to shuffle the positions of image pixels and another Logistic map is used to rearrange the positions of the image pixels. The security analysis and experimental results such as Correlation analysis Correlation analysis, Histogram analysis, NPCR and UACI as well as key sensitivity analysis are carried out by the authors.

3.15. "Image Encryption and Decryption Using Chaotic Maps and Modular Arithmetic"

Shyamsunder et al [20] proposed encryption and decryption of an image using three different chaotic maps and modular arithmetic with the key space of about $\mathbf{2^{128}}$. Out of the three different maps, they suggested that the logistic mapis the fastest of all. Security analysis which includes Statistical analysis, Correlation analysis, Histogram analysis, Key sensitivity analysis, Chosen / Known Plain Text attacks, Encryption time and DMF (Deviation Measuring Factor) are carried out by the authors to prove the security of the algorithm.

4. CHAOTIC MAPS

Some of the chaotic maps used in the above reviewed papers are presented in this section.

4.1. MAPS

Systems can change at discrete times. A discrete time dynamical system is also called as Map. The dynamics is then given by a list of numbers. For example x_0=125, x_1=250, x_2=500, x_3=100, ...x_n represents the state variable x at the nth time instant. A map is then given by $\mathbf{x_{n+1} = F\ (x_n)}$ where $F(x_n)$ is the mathematical rule (function) governing the evolution of the system.

Chaotic maps are with a long history in nonlinear dynamical studies. Chaos can be produced by both discrete and continuous equations mathematically. The discrete systems such as Logistic map, Henon map, Standard map and Circular map can be expressed as [23] $\mathbf{x_{n+1} = F\ (x_n).}$

The continuous systems are known as flows, which can be expressed as $\mathbf{dx(t) / dt = F(x(t)).}$

The Lorenz equation, Rossler equation, Duffing's equation and Chua's circuit are some of the chaotic flows. The discrete maps and continuous flows have close relationship with one another.

4.2. LOGISTIC MAP

A system with sensitive dependence on initial conditions is the logistic equation [25]

$$X_{n+1} = R\ X_n\ (1 - X_n)$$

where R is a parameter, and X_n is the variable at the n^{th} iteration with value between 1 and 0, and n can be considered as the running variable. It is a recursive equation, which generates a new value from the previous value. It can be used as a simple model for species population with no predators, but limited food supply. In this case, the population is a number between 0 and 1, where 1 represents the maximum possible population and 0 represents extinction. R is the growth rate, and n-generation number. Logistic equation was proposed by Pierre Verhulst in 1845 [20].

4.3. ARNOLD CAT MAP

In mathematics, **Arnold's cat map** is a chaotic map from the torus into itself, named after Vladimir Arnold, who demonstrated its effects in the 1960s using an image of a cat, hence the name.

$$\begin{bmatrix} X_{n+1} \\ Y_{n+1} \end{bmatrix} = \begin{bmatrix} 1 & P \\ Q & PQ+1 \end{bmatrix} \begin{bmatrix} X \\ Y \end{bmatrix} \text{ MOD N}$$

where N is the width / height of the image.

4.4. STANDARD MAP 3D

The **standard map** (also known as the **Chirikov–Taylor map** or as the **Chirikov standard map**) is an area-preserving chaotic map from a square with side 2π onto itself [25]. It is constructed by a Poincaré's surface of section of the kicked rotator, and is defined by:

$$P_{n+1} = P_n + K \sin(\theta_n)$$

$$\theta_{n+1} = \theta_n + P_{n+1} \qquad \text{where } P_n \text{ and } \theta_n \text{ are taken modulo } 2\pi.$$

The properties of chaos of the standard map were established by Boris Chirikov in 1969.

4.5. LORENZ SYSTEM

In 1963, Edward Lorenz developed a simplified mathematical model for atmospheric convection. The model is a system of three ordinary differential equations now known as the Lorenz equations [25]

$$x^{\cdot} = a(y - x)$$

$$y^{\cdot} = cx - xz - y$$

$$z^{\cdot} = xy - bz$$

which is chaotic when a = 10, b = 8/3, c = 28.Here x, y and z make up the system state and a, b, c are the system parameters. The Lorenz equations also arise in simplified models for lasers, dynamos, brushless DC motors, electric circuits,chemical reactionsand forward osmosis. The Lorenz system is nonlinear, three-dimensional and deterministic.

4.6. CHEN SYSTEM

In 1999, Chen found chaotic attractor, also in a simple three-dimensional autonomous system, which nevertheless is not topologically equivalent to the Lorenz's equations [25]

$$x = a(y_0 - x_0)$$

$$y = (c - a)x_0 - x_0z_0 + cy_0$$

$$z = x_0y_0 - bz_0$$

is chaotic when a = 35, b = 3, c = [20, 28]

4.7. SINE MAP

Sine map is defined as [25]

$$X_{n+1} = a\ x_n^2 \sin(\pi\ x_n)$$

when $x_0 = 0.7$ and a=2.3, equation 2 has the simplified form. For the interval (0, 1) it generates chaotic sequence.

4.8. HENON MAP

The map was introduced by Michel Henon as a simplified model of the Poincare section of the Lorenz model [25]. The Henon map is a discrete-time dynamical system. It is one of the most studied examples of dynamical systems that exhibit chaotic behavior. The Henon map takes a point (x_n, y_n) in the plane and maps it to a new point

$$X_{n+1} = 1 - a\ X_n^2 + Y_n$$

$$Y_{n+1} = b\ Xn$$

The map depends on two parameters, *a* and *b*, where a = 1.4 and *b* = 0.3. For the classical values the Henon map is chaotic.

5. RULES TO OPTIMIZE THE PERFORMANCE OF CHAOS BASED CRYPTOSYSTEMS

The internet has numerous chaotic image encryption algorithms floating around and it is very difficult to evaluate which one of them is actually worth in terms of security and performance. Evaluating an algorithm is quite a finicky process. All the algorithms need to be calibrated to some sort of baseline and the tools used must be up to the task. Gonzalo Alvarez and Shujun Li suggested the following rules that researchers need to keep in mind while designing chaotic image encryption algorithms in order to eliminate the difficulties faced by the cryptanalysts.

Rule 1 A thorough description of the implementation of the chaotic systems involved should be provided.

Rule 2 For chaotic systems implemented in digital form, the negative effects of dynamical degradation should be taken into consideration with careful evaluation.

Rule 3 Without loss of security, the cryptosystem should be easy to implement with acceptable cost and speed.

Rule 4 The key should be precisely defined.

Rule 5 The key space K, from which valid keys are to be chosen, should be precisely specified and avoid non-chaotic regions.

Rule 6 The useful chaotic region, i.e., the key space K, should be discretized in such a way that the avalanche effect is guaranteed: two cipher texts encrypted by two slightly different keys k1, k2 should be completely different.

Rule 7 Partial knowledge of the key should never reveal partial information about the plaintext nor the unknown part of the key.

Rule 8 The algorithm or process of generating valid keys from the key space K should be precisely specified.

Rule 9 For two keys (or two plaintexts) with the slightest difference, no distinguishable difference between the corresponding cipher texts can be found by any known statistical analysis.

Rule 10 The cipher text should be statistically undistinguishable from the output of a truly random function, and should be statistically the same for all keys.

Rule 11 It should be checked whether the designed cryptosystem can be broken by the relatively simple known-plaintext and chosen-plaintext attacks, and even chosen-ciphertext attacks.

Rule 12 Resistance to differential and linear cryptanalysis should be proved or checked very carefully in digital block ciphers.

Rule 13 It should be checked whether the cryptosystem can be broken by all known chaos-specific attacks.

Rule 14 It should be checked whether the cryptosystem can be broken by all known application specific attacks.

Rule 15 To provide a sufficient security against brute-force attacks, the key space size should be $K > 2^{100}$.

Rule 16 When a keystream cipher is used, the security study should include the statistical test results conducted on the pseudo-random number generator.

Rule 17 A designed secure communication system should work in a real channel environment with−40 dB signal/noise ratio, with a certain limited bandwidth, and with attenuation between 0 dB and 16 dB.

Performance evaluations of the reviewed chaotic colour image encryption algorithms based on the above rules are summarized in Table 2.

6. CONCLUSIONS

As more and more image transmission go online, the responsibility to safeguard this, falls on the shoulders of cryptologists. Chaotic image encryption is one of the best ways to ensure security of image transmission. Numerous image encryption schemes using chaotic maps have been proposed. Each one is unique in designing their algorithms and its performance. Picking the precise one is totally dependent on the respective applications. In this analysis, we investigate issues like key related issues, security analysis and channel issues. Correlation and Histogram analysis were specified in all [2,4,5,6,7,8,12,13,14,15,16,17,18,19,20] the reviewed research articles. NPCR and UACI were carried out by most [2,4,5,6,7,8,12,14,15,16,18] of the research papers in order to prove the efficiency of their algorithms. Details like implementation, key

related issues, encryption type, resistance against cryptographic and chaos specific attacks are not specified clearly in most of the papers. In some articles, security measures like Mean Absolute Error [8], Mean Square Error [13], Entropy Analysis [4,5,6,12,13,14,15,18], Deviation Measuring Factors [20] and FIPS Test [8] were incorporated. To summarize, if the rules recommended by Gonzalo Alvarez and Shujun Li are followed, a reasonable degree of security and most acceptable features of cryptography can be guaranteed.

Table 2. Performance Analysis of Reviewed Colour Image Encryption Algorithms based on its Cryptographic Requirements

S No				Ref. No.	[3.1]	[3.2]	[3.3]	[3.4]	[3.5]	[3.6]	[3.7]	[3.8]	[3.9]	[3.10]	[3.11]	[3.12]	[3.13]	[3.14]	[3.15]
1.	Encryption Schemes	Symmetric	Stream				✓								✓				
			Block		✓						✓						✓		
		Asymmetric																	
		Hashing																	
2.	Encryption Algorithm				Algorithm designed by Authors	Algorithm designed by Authors	Algorithm designed by Authors	Algorithm designed by Authors	Algorithm designed by Authors	Algorithm designed by Authors	Algorithm designed by Authors	Algorithm designed by Authors	Algm.+RC 4 designed by Authors	Algorithm designed by Authors	Algorithm designed by Authors	Algorithm designed by Authors	Algorithm designed by Authors	Algorithm designed by Authors	Algorithm designed by Authors
3.	Chaotic Map Used (Dimension & Map Name)				1D – 2 Logistic Map	Chen & Lorenz	2D ACM & Chebyshev Map	1D Henon Map	Lorenz, Chen LU	3D standard & 3D cat map	ACM 3D, 2D Hyper-Chaotic map	Logistic Map	Logistic Map	CHEN'S CHAOTIC SYSTEM	NPWLCM	Logistic Map & Henon Map	2 Logistic Map	Logistic Map	Logistic, Chebyshev & Sine Map
4.	Performance Parameter	Chaotic Cipher	Analog																
			Digital	1.CP	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
				2.DA	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
				3.HSC	P4, 256RAM	-	AMD II, 2GB RAM	-	-	INTEL, 2GB RAM	-	-	-	INTEL I3, 3GB RAM	-	-	INTEL I3, 4GB RAM		INTEL,1.96 GB RAM
		Key Related Issues		Key Size	80-Bit		153 Bits	-	16 Byte	148 Bits		IMAGE	256 Bytes	-	96 Bits		80 Bits		
				Key Space	-	10^{120}	2^{253}	-	-	2^{148}	10^{14}	Very Large	-	-			2^{80}	10^{68}	2^{128}
			Key Space Analysis	Brute-Force Attacks($K>2^{100}$)	-	✓	✓	-	-	✓		-		-				✓	✓
				Key Sensitivity Test	-	✓	✓	Encryption & Decryption	✓	✓	✓ [NA]	Encryption & Decryption	✓	✓			✓	✓	✓
			Key Sensitivity Analysis	Para Sensitivity	-	✓	✓	-	-	-	-	-	-	✓	-	-	-	✓	-
				IC Sensitivity	-	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
				Ergodicity	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	-		✓	✓	✓

Parameters applied - ✓

CP	Computing Precision	DA	Digital Arithmetic	HSC	Hardware Software Configuration	SA	Statistical Analysis
HA	Histogram Analysis	CAP	Correlation of Adjacent Pixels	CA	Cryptographic Attacks	DCA	Differential Crypt Analysis
LCA	Linear Crypt Analysis	CSA	Chaos Specific Attacks	EMS	Extraction Message Signal	ECC	Extraction of Chaotic Carrier Signal
ESP	Estimation of Secret Parameters	EA	Efficiency Analysis	AE	Avalanche Effect	ET	Encryption Time
NPCR	Number of Pixels Change Rate	UACI	Unified Average Changing Intensity	MSE	Mean Square Error	DMF	Deviation Measuring Factor

ACKNOWLEDGEMENTS

I cannot express enough thanks to my family members, my mentors and to my innumerable friends and colleagues within and outside Presidency College who have helped to nurture an environment of creativity and support.

My deepest gratitude goes to Dr. (Mrs.) N. Rama who listened with endless patience and enthusiasm to my thoughts and long stories. Without her this could not have been possible.

Finally I would like to thank Secretary, ITCCMA – 2015 and the reviewers for their help and support.

REFERENCES

[1] Gonzalo Alvarez and Shujun Li, "Some Basic Cryptographic Requirements for Chaos-Based Cryptosystems", International Journal of Bifurcation and Chaos, vol. 16, no. 8, pp. 2129-2151, 2006.

[2] Dongming Chen, Yunpeng Chang, "A Novel Image Encryption Algorithm based on Logistic Maps", Advances in Information Sciences and Service Sciences Issues, Vol. 03, No.7, August 2011, pp. 364-372.

[3] Hao B. 1993, "Starting with parabolas: an introduction to chaotic dynamics", Shanghai China: Shanghai Scientific and Technological Education Publishing House.

[4] Ni G. A. P. Harry Saptarini, YosuaAlberth Sir, "Digital Color Image Encryption Using RC4 Stream Cipher and Chaotic Logistic Map", Information Systems International Conference, December 2013, pp. 459-464.

[5] Huibin Lu, Xia Xiao," A Novel Color Image Encryption Algorithm Based on Chaotic Maps", Advances in information Sciences and Service Sciences(AISS), Volume3, Number11.

[6] Jianjiang CUI, Siyuan LI, DingyuXue, "A Novel Color Image Encryption Algorithm Based on Chaotic Maps"

[7] Joshi Rohit A, Joshi Sumit S, G. P. Bhole, "A Novel Color Image Cryptosystem Using Chaotic Cat and Chebyshev Map", International Journal of Computer Science Issues, Vol. 10, Issue 3, No.2, May 2013, pp. 63-69.

[8] Kamlesh Gupta, Sanjay Silakari, " New Approach for Fast Color Image Encryption Using Chaotic Map", Journal of Information Security, 2011, 2, 139-150.

[9] IgorMishkovski&Ljupcokocarev, 2011, Chaos-Based Public-Key Cryptography, Chaos-Based Cryptography, SCI 354, pp. 27-65, Springer-Verlag Berlin Heidelberg 2011.

[10] Lorenz EN. 1993, "The Essence of Chaos", University of Washington Press, Seattle, WA.

[11] Mao, Y., & Chen, G. 2005, "Chaos-based image encryption.", Handbook of Geometric Computing, 231-265.

[12] Musheer Ahmad and Hamed D Al-Sharari, "An Inter-Component Pixels Permutation Based Color Image Encryption Using Hyper-chaos"

[13] Nashwan A. Al-Romema, Abdulfatah S. Mashat, Ibrahim AlBidewi, "A New Chaos-Based Image Encryption Scheme for RGB Components of Color Image", Computer Sciences and Engineering, 2012, 2(5); pp. 77-85.

[14] Osama M. Abu Zaid, Nawal A. El-Fishawy, E. M. Nigm, "High Security Nested PWLCM Chaotic Map Bit-Level Permutation Based Image Encryption", International Journal of Communications, Network and System Sciences, 2012, 5, pp. 548-556.

[15] QassimNasir, Hadi H. Abdlrudha, "High Security Nested PWLCM Chaotic Map Bit-Level Permutation Based Image Encryption", International Journal of Communications, Network and System Sciences, 2012, 5, pp. 548-556.

[16] R. Raja Kumar, Dr. A. Sampath, Dr. P. Indhumathi, "Enhancement and Analysis of Chaotic Image Encryption Algorithms", Computer Science & Information Technology, Vol. 10, No.2, 2011, pp. 143-153.

[17] Ravindra K. Purwar, Priyanka, "An Improved Image Encryption Scheme Using Chaotic Logistic Maps", International Journal of Latest Trends in Engineering and Technology, Vol. 02, Issue.3, May 2013, pp. 220-224.

[18] Rui Liu, Xiaoping Tian, "New Algorithm For Color Image Encryption Using Chaotic Map and Spatial Bit-Level Permutation", Journal of Theoretical and Applied Information Technology, Vol. 43, No.1, 2012, pp. 89-93.
[19] K. Sakthidasan, B. V. Santhosh Krishna, "A New Chaotic Algorithms For Image Encryption and Decryption of Digital Color Images", International Journal of Information and Education Technology, Vol. 1, No.2, June 2011, pp. 137-141.
[20] S. Shyamsunder, Ganesan Kaliyaperumal, "Image Encryption and Decryption Using Chaotic Maps and Modular Arithmetic", American Journal of Signal Processing, 1(1), 2011, pp. 24-33.
[21] Wallace K. S. Tang and Ying Liu, "Formation of High-Dimensional Chaotic Maps and Their Uses in Cryptography", Chaos-Based Cryptography, SCI 354, pp. 27-65, Springer-Verlag Berlin Heidelberg 2011.
[22] William Stallings, "Cryptography and Network Security Principles and Practice", Prentice Hall, Fifth Edition.
[23] Zhaopin Su, Guofu Zhang and Jianguo,"Multimedia Security: A Survey of Chaos-Based Encryption Technology", Jiang School of Computer and Information, Hefei University of Technology China.
[24] Zonghua Liu, " Review Article Chaotic Time Series Analysis" , Hindawi Publishing Corporation Mathematical Problems in Engineering Volume 2010, Article ID 720190.
[25] http://en.wikipedia.org/wiki/Logistic_map

AUTHOR BIOGRAPHIES

K. S Tamilkodi received her B. Sc. (Mathematics) in 1992, M.C.A. in 1995 from University of Madras and M.Phil. (Computer Science) in 2001 from Mother Teresa University, Kodaikanal. She is now an Assistant Professor of Computer Science in PresidencyCollege, Chennai and Ph.D. student in Bharathiar University, Coimbatore. Her research is in the area of information security.

N Rama received her B.Sc.(Mathematics) in 1986, M.C.A. in 1989 and Ph.D. in 2003 from the University of Madras. Presently, she is an Associate Professor of Computer Science in Presidency College, Chennai and Guiding Ph. D. in various Universities. Her research is in the area of information security, image processing and compression. She is a co-author of about 12 research articles in national, international conference proceedings and journals. She has produced 5 Ph. D. scholars.

INTENTIONAL BLANK

FUZZY APPROACHES TO CONTEXT VARIABLES IN FUZZY GEOGRAPHICALLY WEIGHTED CLUSTERING

Nguyen Van Minh[1] and Le Hoang Son[2]

[1]Faculty of Science, Hanoi University of Natural Resources and Environment,
41A Phu Dien, Bac Tu Liem, Hanoi, Vietnam
nvminh@hunre.edu.vn
[2]VNU University of Science, Vietnam National University,
334 Nguyen Trai, Thanh Xuan, Hanoi, Vietnam
sonlh@vnu.edu.vn

ABSTRACT

Fuzzy Geographically Weighted Clustering (FGWC) is considered as a suitable tool for the analysis of geo-demographic data that assists the provision and planning of products and services to local people. Context variables were attached to FGWC in order to accelerate the computing speed of the algorithm and to focus the results on the domain of interests. Nonetheless, the determination of exact, crisp values of the context variable is a hard task. In this paper, we propose two novel methods using fuzzy approaches for that determination. A numerical example is given to illustrate the uses of the proposed methods.

KEYWORDS

Context Variables; Fuzzy Clustering; Fuzzy Geographically Weighted Clustering; Type-2 Fuzzy Sets.

1. INTRODUCTION

Geo-Demographic Analysis (GDA) is a major concentration of various interdisciplinary researches nowadays and has been being used in many decision–making processes involving the provision and distribution of products and services to communities. Results of GDA are often visualized on a map as several distinct groups that represent for different levels of a population's characteristic, e.g. "High density of chain-smokers" and "Low density of chain-smokers". Thus, they assist effectively for many decision–making processes involving the provision and distribution of products and services to communities, the determination of common population's characteristics and the study of population variation in terms of gender, ages, sex, ethnicity, etc. According to a review of typical examples of GDA in [11], GDA was proven to be one of the most promising researches in the scientific world nowadays. Some of the first methods applied to GDA are *Principal Component Analysis* (PCA) in [20] and *Self-Organizing Maps* (SOM) in [6] that rely one the basic principles of statistics and neural networks to determine the underlying demographic and socio-economic phenomena. However, the disadvantages of those methods are the requisition of large memory space and computational complexity. Indeed, clustering algorithms were opted instead. Two typical hard clustering methods used for GDA available in the literature are *Agglomerative Hierarchical Clustering* in [2] and *K-Means* in [9]. These

Sundarapandian et al. (Eds) : ITCCMA, FUZZY, SIGEM, DMDBS, NATL - 2015
pp. 21–30, 2015. © CS & IT-CSCP 2015 DOI : 10.5121/csit.2015.50503

algorithms classify geo-demographic datasets into clusters represented in forms of hierarchical trees and isolated groups. Data points in each group have similar ethnic and socio-economic characteristics. Nonetheless, using hard clustering for GDA often leads to the issues of ecological fallacy, which can be shortly understood that statistics accurately describing group characteristics do not necessarily apply to individuals within that group. For this fact, *Fuzzy C-Means* (FCM) and its variants were considered as the appropriate methods to determine the distribution of a demographic feature on a map as described in some articles such as [1, 5, 10, 12-19]. Since the results of FCM are independent to the geographical factors, some improvements of that algorithm were made by attaching FCM with a spatial model such as SIM in [3] and SIM-PF in [7, 16, 18]. The Fuzzy Geographically Weighted Clustering (FGWC) in [7] incorporated with SIM-PF is an effective algorithm for GDA. Nonetheless, the computing speed of FGWC is slow since the cluster membership modification process has to be done in each step. The authors in [18] introduced CFGWC using the context variable term to narrow the original dataset under some conditions of certain dimensions. Because only a subset of original dataset which has considerable meaning to the context is invoked, the velocity and efficiency of clustering can be improved considerably and the result focuses on the area that really has many relevant points. For example, if we want to look for a shopping area then a new context "shopping" will be put to the algorithm to reduce the search space. In case of little context variables, the speed of CFGWC is relatively faster than FGWC. However, the determination of exact, crisp values of the context variable is a hard task. Since this determination is quite important and affects the final clustering results so that it should be studied carefully.

Our contribution in this paper is the introduction of two novel fuzzy approaches for the determination of values of the context variable in CFGWC. The former named as CFGWC_F1 uses fuzzy clustering as a tool to determine the exact values of the context variable, and the later named as CFGWC_F2 calculate the values through type-2 fuzzy memberships. A numerical example is given to illustrate the uses of the proposed methods. The rest of the paper is structured as follows. Section 2 takes an overview of CFGWC algorithm and points out its limitations. Section 3 presents two novel algorithms CFGWC_F1 and CFGWC_F2. Section 4 shows a numerical example and the comparison of those algorithms. The conclusions and further works are summarized in Section 5.

2. CONTEXT FUZZY GEOGRAPHICALLY WEIGHTED CLUSTERING

2.1 Overview

Now, we summarize the principal ideas and details of CFGWC algorithm in [18]. Given a geo-demographic dataset of N attributes $X = \{X_1,..,X_N\}$ in r - dimension space ($X \in R^r$) with X_k being the k^{th} point. Supposed that missing data have been processed, the purpose of CFGWC is to classify the data into C clusters, and V_j is the center of j^{th} cluster. A context variable in $Y \in X$ is defined as follows.

$$A: Y \to [0,1] \qquad (1)$$

$$y_k \text{ a } \quad f_k = A(y_k).$$

f_k is the representation for the level of relation of the k^{th} point to the supposed context Y. There are some ways to define the relation between f_k and the membership of k^{th} point to the j^{th} cluster, for instance, using the sum operator (2) or maximum operator (3).

$$\sum_{j=1}^{C} u_{kj} = f_k , \tag{2}$$

$$\max_{j=1}^{C} u_{kj} = f_k , \tag{3}$$

where $k = \overline{1, N}$. The basic objective function is,

$$J = \sum_{k=1}^{N} \sum_{j=1}^{C} u_{kj}^{m} \left\| X_k - V_j \right\|^2 \to \min . \tag{4}$$

where m is the fuzziness and u_{kj} is an element of the partition matrix U below.

$$U(f) = \left\{ u_{kj} \in [0,1] : \sum_{j=1}^{C} u_{kj} = f_k, \forall k = \overline{1, N}, 0 < \sum_{k=1}^{N} u_{kj} < N, \forall j = \overline{1, C} \right\}. \tag{5}$$

Using the Lagranian method, the problem (4-5) is solved and details of the iteration scheme so-called CFGWC are shown as follows.

1. Initiate the matrix $U(t)$ at $t = 0$.

2. Re-calculate centers of each cluster according to equation (6).

$$V_j = \frac{\sum_{k=1}^{N} u_{kj}^{m} \times X_k}{\sum_{k=1}^{N} u_{kj}^{m}}, \ j = \overline{1, C} . \tag{6}$$

3. Re-calculate matrix $U(t+1)$.

$$u_{kj} = \frac{f_k}{\sum_{i=1}^{C} \left(\frac{\left\| X_k - V_j \right\|}{\left\| X_k - V_i \right\|} \right)^{\frac{2}{m-1}}}, \ k = \overline{1, N}, \ j = \overline{1, C} . \tag{7}$$

4. Adjust the partition matrix by the SIM-PF model.

$$u_{kj}' = \alpha \times u_{kj} + \beta \times \frac{1}{A} \times \sum_{i=1}^{c} w_{ij} \times u_{ki}, \ k = \overline{1, N}, \ j = \overline{1, C}, \tag{8}$$

$$\alpha + \beta = 1, \tag{9}$$

$$w_{ij} = \frac{\left(pop_i \times pop_j \right)^b}{d_{ij}^{\,a}}, \tag{10}$$

where u_{kj}' (u_{kj}) is the new (old) cluster membership of k^{th} point to the j^{th} cluster. Two parameters α and β are scaling variables, and A is a factor to scale the "sum" term to f_k as in (5). w_{ij} is the weight showing the influence of area i to j. pop_i (pop_j) is the population of area i (j). d_{ij} is the distance between those areas, and a and b are user definable parameters.

5. If the error of the partition matrix $\left\| U'(t+1) - U(t) \right\|$, defined through some analysis normal, is

less than a given threshold ε then the algorithm stops, else return to Step 2.

2.2 The limitation of CFGWC

In the article in [18], the authors used a random generator to create context values. As we can recognize in the description of CFGWC, it is hard to determine the exact value of f_k ($k = \overline{1,N}$) to the supposed context Y so that the quality of clustering outputs is not high as a result. For example, a person in the developed countries may assume 500,000 USD per year is "High" for the context "Income", but another in the developing countries can also state that 25,000 USD per year is "High". Misleading assessment of context values reduces the clustering quality of results, and therefore automatic determination of suitable values of the context variable should be done to handle this obstacle.

3. THE PROPOSED FUZZY APPROACHES

In this section, we present two fuzzy approaches to handle the limitation of CFGWC.

3.1 CFGWC_F1

The basic idea of CFGWC_F1 is using fuzzy clustering for the context variable and assigning the membership values of maximal context type to the context values. The number of clusters in this task is equal to that of the original problem. The reason for doing so is to handle the vagueness in the determination of exact, crisp values of the context variable. Fuzzy clustering, especially FCM algorithm is the most suitable tool to extract the knowledge behind an event or a context where the boundaries between clusters are unclear. Details of CFGWC_F1 are listed below.

1. Separate a subset of the original geo-demographic dataset containing the data of the supposed context Y only.
2. Use FCM to divide the subset into C clusters and get the partition matrix U_C .
3. For each $k = \overline{1,N}$:

a. Find the membership value of maximal context type in line k^{th} of U_C.

b. Assign it to the context value of X_k

4. For all context values that have been calculated, we use the CFGWC algorithm in Section 2 to determine the final centers and membership values.

Since the membership values of maximal context type of the partition matrix U_C reflects the maximal possibility of data points to given clusters, and the number of clusters in this task is equal to that of the original problem, thus those values can be used to orient the whole algorithm to the supposed context. In this case, their meanings are similar to those of the context variable.

3.2 CFGWC_F2

Now, we propose another way to determine the context values. Let us have a look at equation (1). The role of Y is similar to that of the traditional fuzzy set if we re-written Y as,

$$Y = \left\{ (y_k, f_k) \mid f_k \in [0,1], k = \overline{1,N} \right\}. \tag{11}$$

The limitations of the traditional fuzzy set were pointed out by Mendel in [8] including the definition of hard memberships so that fuzzy set cannot model some phenomena in real world. Such these sets cannot process some exceptional cases where the membership degrees are not the

crisp values but the fuzzy ones instead. For example, the possibility to get tuberculosis disease of a patient concluded by a doctor is from 60 to 80 percents after examining all symptoms. Even if some modern medical machines are provided, the doctor cannot give an exact number of that possibility. This shows the fact that crisp membership values cannot model some situations in the real world and should be replaced with the fuzzy ones. Using traditional fuzzy sets often results in bad clustering quality since its uncertainties such as distance measure, fuzziness, center, prototype and initialization of prototype parameters can create imperfect representations of the pattern sets. For example, it is difficult to choose the suitable value for fuzziness. In case of pattern sets that contain clusters of different volume or density, it is possible that patterns staying on the left side of a cluster may contribute more for the other rather than this cluster. Similarly, how to choose a distance measure for fuzzy clustering is worth considering. Bad selection can yield undesirable clustering results for pattern sets that include noises. In order to handle the limitation of the traditional fuzzy set, in [8] Mendel suggested using the type-2 fuzzy set defined through the equation bellows.

$$\tilde{\tilde{A}} = \left\{ \left(x, u, \mu_{\tilde{\tilde{A}}}(x,u) \right) \mid \forall x \in A, \forall u \in J_x \subseteq [0,1] \right\}. \tag{12}$$

The type-2 fuzzy set is a generalization of the traditional fuzzy set since we will get the traditional fuzzy set when there is no uncertainty in the third dimension. Based upon equation (12), equation (11) is re-written as,

$$\tilde{\tilde{Y}} = \left\{ \left(y_k, f_k, \mu_{\tilde{\tilde{A}}}(y_k, f_k) \right) \mid \forall y_k \in Y, \forall f_k \in [0,1] \right\}, \tag{13}$$

$$f_k = \exp\left(\frac{-(y_k - \mu_Y)^2}{\sigma_Y^{\,2}} \right), \tag{14}$$

$$\mu_{\tilde{\tilde{A}}}(y_k, f_k) = \frac{1}{1 + e^{-f_k}}, \tag{15}$$

Where μ_Y and σ_Y are the mean and the standard deviation of Y. Details of CFGWC_F2 are listed below.

1. For the supposed context Y, use equation (15) to calculate all context values.
2. For all context values that have been calculated, we use the CFGWC algorithm in Section 2 to determine the final centers and membership values.

3.3 Complexity

The time complexities of the context values calculation in both CFGWC_F1 and CFGWC_F2 are $O(N \times C)$ and $O(N)$, respectively.

4. A NUMERICAL EXAMPLE

We have implemented the proposed algorithms (CFGWC_F1 and CFGWC_F2) in addition to CFGWC in [18] in C programming language and executed them on a PC with configuration: Intel Pentium Dual Core 1.80 GHz, 1GB RAM. The objective of experiments is to verify the impacts of the context generation methods in CFGWC_F1 and CFGWC_F2 to the clustering quality of outputted results in comparison with the random context generation method in CFGWC in [18]. In the other words, we aim to answer whether or not the clustering qualities of CFGWC_F1 and CFGWC_F2 are better than that of CFGWC. The experimental dataset was taken from the articles in[16], [17] and a small part of it is described in Table 1. Parameters of CFGWC_F1 and CFGWC_F2 are set up similar to those of CFGWC as in [18]. Experimental results are listed step-by-step to illustrate the activities of the proposed algorithm. In Table 1, the chosen context

variable is “Income”. We would like to divide the dataset above into three clusters according to the context variable, which are “Low income”, “High income” and “Medium income”.

Table 1. The statistics of geo-demographic characteristics

Name	Occupation	Income	Age	Gender	Raise
Marry	Student	28,000	15	Female	4
Tom	Doctor	40,000	32	Male	2
David	Doctor	35,100	27	Male	6
Kim	Singer	65,000	19	Female	1
Jenny	Student	20,000	18	Female	3
Julia	Singer	52,520	23	Male	6
Xiao	Student	21,000	31	Male	3
Luka	Doctor	75,000	42	Female	2

Now we illustrate the activities of CFGWC_F1. The subset containing the data of the supposed context is:

$$Y = \{28{,}000;40{,}000;35{,}100;65{,}000;20{,}000;52{,}520;21{,}000;75{,}000\}. \tag{16}$$

Use FCM to divide Y into 3 groups, we receive the membership values U_C.

$$U_C = \begin{pmatrix} 0.830213 & 0.013943 & 0.155844 \\ 0.000256 & 0.000091 & 0.999653 \\ 0.145173 & 0.019431 & 0.835396 \\ 0.008823 & 0.965323 & 0.025853 \\ 0.979944 & 0.002928 & 0.017128 \\ 0.098034 & 0.319610 & 0.582355 \\ 0.991251 & 0.001213 & 0.007536 \\ 0.012425 & 0.959367 & 0.028209 \end{pmatrix}. \tag{17}$$

According to equation (17), we have a preliminary classification of all users according to the context “Income”. For example, in line 8^{th} of U_C, the second value 0.9599367 is the largest among all. Thus, the income of user “Luka” is considered as “High”. Similarly, in line 5^{th} of U_C, the first value 0.979944 is the largest among all. Thus, the income of user “Jenny” is considered as “Low”. Now, we take the membership values of “High income” as the context values and apply the CFGWC algorithm for them. The final membership values and centers are:

$$U^1 = \begin{pmatrix} 0.005391 & 0.003337 & 0.005303 \\ 0.000021 & 0.000037 & 0.000036 \\ 0.007412 & 0.004669 & 0.007410 \\ 0.364774 & 0.211715 & 0.378353 \\ 0.001169 & 0.000704 & 0.001136 \\ 0.088755 & 0.135399 & 0.121199 \\ 0.000465 & 0.000306 & 0.000455 \\ 0.349459 & 0.243099 & 0.352343 \end{pmatrix}, \tag{18}$$

$$V^1 = \begin{pmatrix} 2.53 & 68853.72 & 29.72 & 1.05 & 1.70 \\ 2.52 & 69129.90 & 30.13 & 1.05 & 1.71 \\ 2.52 & 68863.76 & 30.12 & 1.06 & 1.79 \end{pmatrix}. \tag{19}$$

Figure 1. describes the distribution of data points resulted by CFGWC_F1. Now we illustrate the activities of CFGWC_F2. Firstly, we calculate the mean and the standard deviation of Y as follows.

$$\mu_Y = \frac{\sum_{k=1}^{8} X_{kY}}{8} = 42077.5, \tag{20}$$

$$\sigma_Y = \sqrt{\frac{\sum_{k=1}^{8} \left(X_{ky} - \mu_Y \right)^2}{8}} = 19043.47. \tag{21}$$

Use the formulas in equations (14-15), we calculate the context values.

$$\mu_{\tilde{A}}^T = \begin{pmatrix} 0.64 & 0.73 & 0.7 & 0.56 & 0.56 & 0.68 & 0.57 & 0.51 \end{pmatrix}. \tag{22}$$

Use those context values in (22) for the CFGWC algorithm and get the final membership values and centers are.

$$U^2 = \begin{pmatrix} 0.26 & 0.24 & 0.14 \\ 0.46 & 0.24 & 0.03 \\ 0.3 & 0.26 & 0.14 \\ 0.19 & 0.2 & 0.17 \\ 0.21 & 0.2 & 0.15 \\ 0.2 & 0.23 & 0.25 \\ 0.22 & 0.21 & 0.14 \\ 0.17 & 0.18 & 0.16 \end{pmatrix}, \tag{23}$$

$$V^2 = \begin{pmatrix} 1.89 & 40671.23 & 25.7 & 1.58 & 3.58 \\ 1.97 & 42088.29 & 26.2 & 1.62 & 3.68 \\ 2.03 & 43297.50 & 27.1 & 1.68 & 3.81 \end{pmatrix}. \tag{24}$$

Figure 2 describes the distribution of data points resulted by CFGWC_F2.

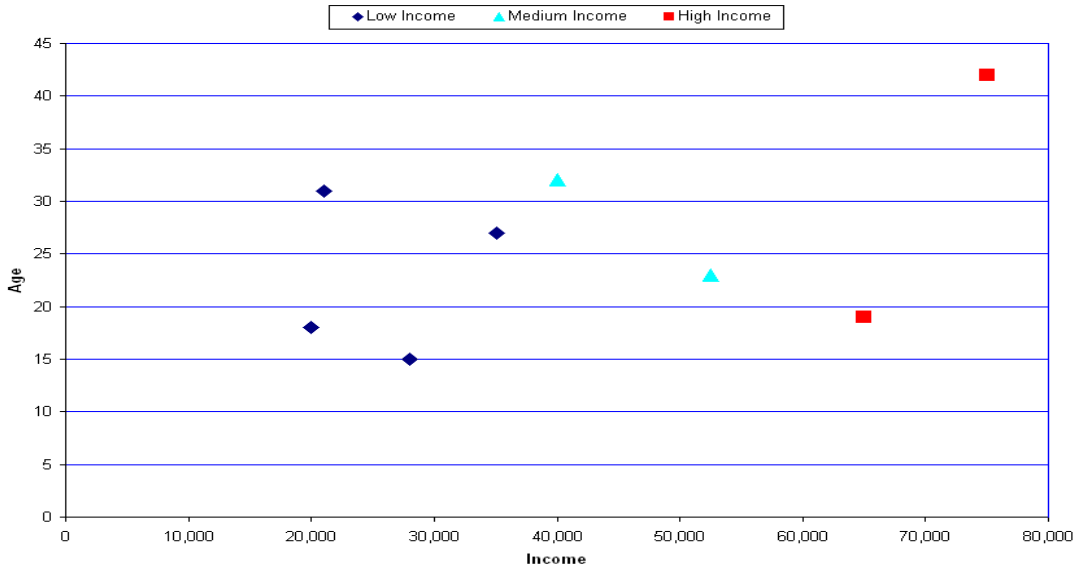


Figure 1. The results of CFGWC_F1

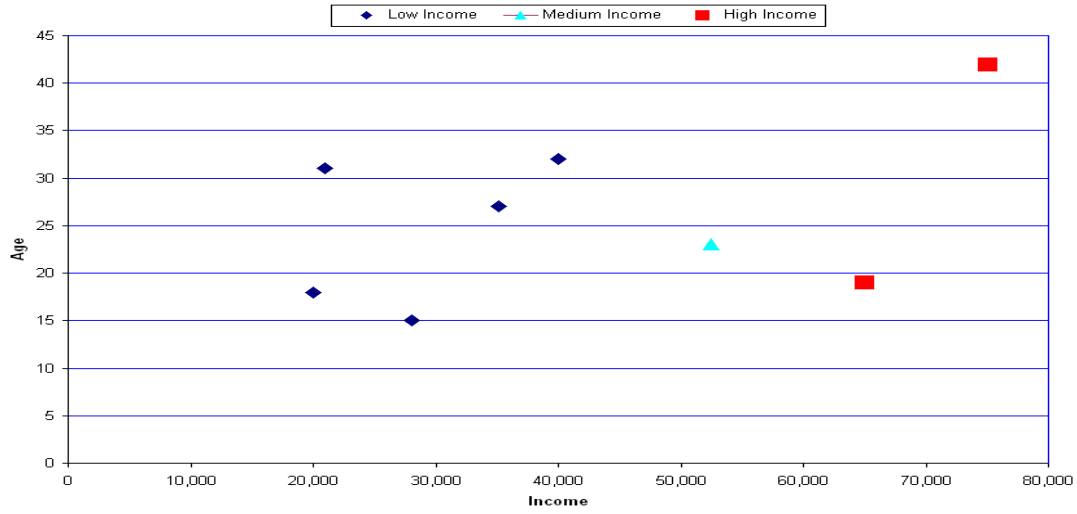


Figure 2. The results of CFGWC_F2

In order to investigate the effects of using various context generation methods to CFGWC, we make a comparison of the clustering quality between these algorithms using the validity function of fuzzy clustering for spatial data namely IFV in [4]. This index was shown to be robust and stable when clustering spatial data. The definition of this index is characterized below.

$$IFV = \frac{1}{C}\sum_{j=1}^{C}\left\{\frac{1}{N}\sum_{k=1}^{N}u_{kj}{}^{2}\left(\log_2 C-\frac{1}{N}\sum_{k=1}^{N}\log_2 u_{kj}\right)^{2}\right\}\times\frac{SD_{\max}}{\overline{\sigma_D}}\cdot \tag{25}$$

The maximal distance between centers is:

$$SD_{\max} = \max_{k\neq j}\left\|V_k - V_j\right\|^2. \tag{26}$$

The even deviation between each object and the cluster centre is:

$$\overline{\sigma_D} = \frac{1}{C}\sum_{j=1}^{C}\left(\frac{1}{N}\sum_{k=1}^{N}\left\|X_k - V_j\right\|^2\right). \quad (27)$$

When $IFV \to \max$, the value of IFV is said to yield the most optimal of the dataset.

From equations (18, 19, 23, 24), we calculate IFV values of CFGWC_F1 and CFGWC_F2.

$$IFV^{CFGWC\_F1} = 8.535490, \quad (28)$$

$$IFV^{CFGWC\_F2} = 8.321658. \quad (29)$$

Besides, we also calculate IFV value of CFGWC and receive the result in equation (30).

$$IFV^{CFGWC} = 7.553624. \quad (30)$$

From equations (28-30), we recognize that the clustering qualities of CFGWC_F1 and CFGWC_F2 are better than that of CFGWC. Additionally, CFGWC_F1 is better than CFGWC_F2. The distributions of data points in both methods are shown in Figure 1 and Figure 2

5. CONCLUSIONS

In this paper, we introduced two novel fuzzy approaches to determine suitable context values for fuzzy geographically weighted clustering. The former used fuzzy clustering as a tool to determine the exact values of the context variable, and the later calculated the values through type-2 fuzzy memberships. A numerical example was given to illustrate the uses of the proposed methods. The results showed that the clustering qualities of the proposed methods are better than that of the relevant one. Further works of this paper will investigate multiple contexts and their suitable orders in clustering algorithms.

ACKNOWLEDGEMENTS

This work is sponsored by a VNU project under contract No. QG.13.01

REFERENCES

[1] Cuong, B. C., Son, L. H., & Chau, H. T. M. (2010). Some context fuzzy clustering methods for classification problems. Proceedings of the 2010 ACM Symposium on Information and Communication Technology (pp. 34-40).

[2] Day, P., Pearce, J., & Dorling, D. (2008). Twelve worlds: a geo-demographic comparison of global inequalities in mortality. Journal of epidemiology and community health, 62(11), 1002-1010.

[3] Feng, Z. & Flowerdew, R (1998). Fuzzy geodemographics: a contribution from fuzzy clustering methods. Innovations in GIS, 5, 119-127.

[4] Hu, C., Meng, L., & Shi, W. (2008). Fuzzy clustering validity for spatial data.Geo-spatial Information Science, 11(3), 191-196.

[5] Ji, J., Pang, W., Zhou, C., Han, X., & Wang, Z. (2012). A fuzzy k-prototype clustering algorithm for mixed numeric and categorical data. Knowledge-Based Systems, 30, 129-135.

[6] Loureiro, M., Bação, F., & Lobo, V. (2006). Fuzzy classification of geodemographic data using self-organizing maps. Proceeding of 4th international conference of giscience (pp. 123-127).

[7] Mason, G. A., & Jacobson, R. D. (2007). Fuzzy geographically weighted clustering. Proceedings of the 9th international conference on geocomputation, Maynooth, Eire, Ireland.

[8] Mendel, J. M. (2007). Advances in type-2 fuzzy sets and systems. Information Sciences, 177(1), 84-110.

[9] Petersen, J., Gibin, M., Longley, P., Mateos, P., Atkinson, P., & Ashby, D. (2011). Geodemographics as a tool for targeting neighbourhoods in public health campaigns. Journal of Geographical Systems, 13(2), 173-192.

[10] Razavi Zadegan, S. M., Mirzaie, M., & Sadoughi, F. (2013). Ranked k-medoids: A fast and accurate rank-based partitioning algorithm for clustering large datasets. Knowledge-Based Systems, 39, 133-143.
[11] Rossmo, D. K. (2012). Recent developments in geographic profiling. Policing, 6(2), 144-150.
[12] Son, L.H. (2014). Enhancing Clustering Quality of Geo-Demographic Analysis Using Context Fuzzy Clustering Type-2 and Particle Swarm Optimization. Applied Soft Computing, 22, 566 – 584.
[13] Son, L.H. (2014). HU-FCF: A Hybrid User-Based Fuzzy Collaborative Filtering Method in Recommender Systems. Expert Systems With Applications, 41(15), 6861 – 6870.
[14] Son, L.H. (2014). Optimizing Municipal Solid Waste Collection Using Chaotic Particle Swarm Optimization in GIS Based Environments: A Case Study at Danang City, Vietnam. Expert Systems With Applications, 41(18), 8062–8074.
[15] Son, L.H. (2014). DPFCM: A Novel Distributed Picture Fuzzy Clustering Method on Picture Fuzzy Sets. Expert Systems With Applications, 42(1), 51–66.
[16] Son, L.H., Cuong, B.C., Lanzi, P.L., Thong, N.T. (2012). A novel intuitionistic fuzzy clustering method for geo-demographic analysis. Expert Systems with Applications, 39(10), 9848-9859.
[17] Son, L.H., Cuong, B.C., Long, H.V. (2013). Spatial interaction–modification model and applications to geo-demographic analysis. Knowledge-Based Systems, 49, 152-170.
[18] Son, L.H., Lanzi, P.L., Cuong, B.C., Hung, H.A. (2012). Data Mining in GIS: A Novel Context-Based Fuzzy Geographically Weighted Clustering Algorithm. International Journal of Machine Learning and Computing, 2(3), 235 – 238.
[19] Son, L.H., Linh, N.D., Long, H.V. (2014). A lossless DEM compression for fast retrieval method using fuzzy clustering and MANFIS neural network. Engineering Applications of Artificial Intelligence, 29, 33–42.
[20] Walford, N. (2011). An Introduction to Geodemographic Classification (Census Learning). Available at: http://cdu.mimas.ac.uk/materials/unit5/index.html.

AUTHORS

Msc**. Nguyen Van Minh** is a lecturer at the Faculty of Science, Hanoi University of Natural Resources and Environment. His research interests include Fuzzy Clustering, Recommender Systems, Soft Computing and Statistic. Office address: Faculty of Science, Hanoi University of Natural Resources and Environment, 41A, Phu Dien, Bac Tu Liem, Hanoi, Vietnam. Email: nvminh@hunre.edu.vn

Dr. **Le Hoang Son** obtained the PhD degree on Mathematics – Informatics at VNU University of Science, Vietnam National University. Currently, he is a researcher at the Center for High Performance Computing, VNU University of Science, Vietnam National University. His major field includes Soft Computing, Fuzzy Clustering, Recommender Systems, Geographic Information Systems and Particle Swarm Optimization. He is a member of IACSIT and also an associate editor of the International Journal of Engineering and Technology (IJET). He also served as a reviewer for various international journals and conferences such as PACIS 2010, ICMET 2011, ICCTD 2011, KSE 2013, BAFI 2014, NICS 2014, ACIIDS 2015, International Journal of Computer and Electrical Engineering, Imaging Science Journal, International Journal of Intelligent Systems Technologies and Applications, IEEE Transactions on Fuzzy Systems, Expert Systems with Applications, and International Journal of Electrical Power and Energy Systems. Dr. Son has got many publications in prestigious journals and undertaken some major research projects of Vietnam and international joint projects. Office address: VNU University of Science, Vietnam National University, 334 Nguyen Trai, Thanh Xuan, Hanoi, Vietnam. Email: sonlh@vnu.edu.vn

SURVEY OF SOFT COMPUTING TECHNIQUES IN NEURO SCIENCE

D.K. Sreekantha [1], T.M. Girish [2] and R.V.Kulkarni[3]

[1]Department of Computer Science & Engineering, NMAMIT, Nitte, Karnataka
sreekantha@nitte.edu.in
[2]Dept. of CS, Basaveshwar Science College, Bagalkot, Karnataka
girishtmath@gmail.com
[3]Head, Dept. of Computer Studies, CSIBER, Kolhapur, Maharastra
drrvkulkarni@siberindia.edu.in

ABSTRACT

The improvement of health and nutritional status of the society has been one of the thrust areas for social developments programmes of the country. The present states of healthcare facilities in India are inadequate when compared to international standards. The average Indian spending on healthcare is much below the global average spending. Indian healthcare Industry is growing at the rapid pace of more than 18%, the fastest in the world. The prospects for Indian healthcare are to the tune of USD 40 billion, while global market is USD 1660 trillion. India has all the prospects to become medical tourism destination of the world, because it has a large pool of low-cost scientifically trained technical personal and is one of the favoured counties for cost effective healthcare. As per the reports of Global Burden of Neurological Disorders Estimations and Projections survey there is big shortage of neurologist in India and around the world. So Authors would like to develop an innovative IT based solution to help doctors in rural areas to gain expertise in Neuro Science and treat patients like expert neurologist. This paper aims to survey the Soft Computing techniques in treating neural patient's problems used throughout the world

KEYWORDS

Neurology, Expert System, Soft Computing

1. INTRODUCTION

India is one of the favoured countries for cost effective healthcare and has all the potential to become medical tourism destination of the world. The hospital and nursing home industry is growing at rate of 20% annually. India is one of the top 3 countries, where companies plan to spend most research and development funds over the next 3 years. The Indian clinical community is populated with English speaking, western-trained graduates. Two thirds of healthcare spending to the tune of USD 20 billion is out of pocket in private spending. India has 280 million strong middle and upper middle class population with 10–12 million high income groups, which could afford the lifestyle of their western counterparts. (Source : Economist Intelligence Unit, World Industry Outlook – Healthcare and Pharmaceuticals, 2010 CAGR Compound annual growth rate). According to AAN2010 Practice Profile Form neurologists have devoted on average 42.3 hours a week in practice 2010. The number of visits to hospital has increased to 81.8 on average per week in 2010. These facts will signify the need for neurologist services in developing country like India

Sundarapandian et al. (Eds) : ITCCMA, FUZZY, SIGEM, DMDBS, NATL - 2015
pp. 31–41, 2015. © CS & IT-CSCP 2015 DOI : 10.5121/csit.2015.50504

around the world. Hence the researchers are focusing on building an innovative IT based solution to help novice doctors to treat neural patients in rural areas. During the last decade much research effort has been devoted to the development of expert systems to cope with complex medical decision-making.

An expert system is "an embodiment within a computer of a knowledge-based component, from an expert skill, in such a form that the system can offer intelligent advice or make an intelligent decision about a processing function." such a system uses expert knowledge to attain high levels of performance in a narrow problem area. In the process of diagnosis, neurologists collect historical data, neurologic signs, and symptoms to arrive at a "best guess" as to stroke type, which then forms the basis for performing further diagnostic procedures such as computed tomography (CT scan) or cardiologic or cerebrovascular tests.

2. SURVEY OF LITERATURE

The present work comprises an exhaustive survey of relevant literature of most relevant articles on Soft Computing techniques applied in Neuro Science from reputed journals from IEEE Transactions, Springer and Elsevier publishers and proceedings of international conferences. Some selected articles from this survey are discussed by way of illustration.

Klaus Spitzer, Andreas Thie, Louis R. Caplan and Klaus Kunze [1] (1989) have designed a prototype MICROSTROKE expert system to categorize and diagnose stroke type based on clinical information. The knowledge base of MICROSTROKE includes information from large stroke registries. The system first queries the physician-user for details of the patient's history, information about the onset of stroke, accompanying symptoms and pertinent neurologic findings and then sums the individual data items, factors in the a priori odds, and arrives at the probabilities of different stroke types for a given patient. Stroke type diagnoses by MICROSTROKE were correct in 72.8% of 250 cases in the Hamburg Stroke Data Bank, stroke types can be of prime importance. Authors presented MICROSTROKE, the prototype of an expert system for computer-supported stroke type diagnosis based only on clinical and historical patient data available at the bedside; MICROSTROKE serves as an aid in the diagnostic work-up of stroke as both a stroke patient data bank and as an educational tool in clinical teaching.

Cruz J, Barahona P, Figueiredo A.P, Veloso M and Carvalho M [2] (1994) have discussed a new knowledge-based system called DARE for the diagnosis of neuromuscular disorders that performs anatomic-physiological reasoning on a deep causal-functional model of the domain knowledge. These characteristics make the system more flexible and general than similar systems in this domain and favour its potential use in different local environments. This paper also discusses the preliminary evaluation of the system performed in the European project ESTEEM, as well as the work still required to make it a real clinical application. The current version of DARE already achieved a quite acceptable diagnostic performance and many improvements can done in the near future such as a need to extend the knowledge model either quantitatively (representing more anatomical structures and functionalities) or qualitatively (including explicitly the etiologic and temporal knowledge) and to support the adopted reasoning methods with more formalized models (allowing the formal definition of reasoning tasks for diagnosis, prognosis and patient treatment).

Leda Cosmides and John Tooby [3] (1997) have authored an article The Cognitive Neuroscience of Social Reasoning. Cognitive scientists needed theoretical guidance that is grounded in something beyond intuition. Authors need evolutionary biology's "adaptationist program", a research strategy in which theories of adaptive function are key inferential tools, used to identify and investigate the design of evolved systems. Using research on how human’s reason about

social exchange. The authors illustrated how theories of adaptive function can generate detailed and highly testable hypotheses about the design of computational machines in the human mind and reviewed research that tests for the presence of these machines. This research suggests that the human computational architecture contains an expert system designed for reasoning about cooperation for mutual benefit, with a subroutine specialized for cheaper detection.

By using a computational theory specifying the adaptive problems entailed by social exchange authors team were able to predict, in advance, that certain very subtle changes in the content and context would produce dramatic differences in how people reason. Authors concluded that the adaptationist program is cognitive neuroscience's best hope for achieving this goal.

Jean-Marc Fellous, Jorge L. Armony and Joseph E. LeDoux [4] (2000) have published the article Emotional Circuits and Computational Neuroscience. Emotion is clearly an important aspect of the mind, yet it has been largely ignored by the "brain and mind (cognitive) sciences" in modern times. However, there are signs that this is beginning to change. Authors discussed some issues about the nature of emotion, describe what is known about the neural basis of emotion and consider some efforts that have been made to develop computer-based models of different aspects of emotion. It is important to distinguish between emotional experiences and the underlying processes that lead to emotional experiences. One of the stumbling blocks to an adequate scientific approach to emotion has been the focus of the field on constructing theories of the subjective aspects of emotion. Studies of the neural basis of emotion and emotional learning have instead focused on how the brain detects and evaluates emotional stimuli and how, on the basis of such evaluations, emotional responses are produced. Computational approaches to emotional processing are both possible and practical. Although relatively few models currently exist, this situation is likely to change as researchers begin to realize the opportunities that are present in this too-long neglected area.

Blacksmiths, Neurons Mauro Adenzato and Francesca Garbarini [5] (2006) authored the paper Cognitive Science, Neuroscience and Anthropology - A Journey among Robots. In recent years, neurophysiological and psychological research has highlighted a pragmatic version of the theory of knowledge, a version in which the concept of simulation has been found to play a crucial role. In fact, research on canonical and mirror neurons has shown that *as if* simulative schema is required to perceive, categorize and understand the meaning of the external world. The present study compares the cognitive paradigm of embodied cognition with Pierre Bourdieu’s practice theory. Specifically, cognitive processes and cultural mechanisms are described as phenomena that emerge from the dynamic interaction that exists between people’s practical abilities and the structure of the local environment in which they act and live. A pragmatic conception of knowledge has also emerged in the field of ethnological investigation. Indeed, the concepts of resonance and empathy have proven to be essential instruments for ethnological knowledge. With this new view of the relationship between mind and body and between culture and nature, there are now greater opportunities for conducting interdisciplinary research in the natural sciences and social sciences, research aimed at reconstituting the fracture that has existed for too long now between humans as biological and cultural beings. As Jacob and Jeannerod (2005) observed, the mirror neuron system is well designed for representing an agent’s motor intention, but not the agent’s prior intention to execute an action. A discussion on the theoretical distinction between motor intention and prior intention goes beyond the aims of the present work. Authors referred to Becchio, Adenzato and Bara (2006) for a more exhaustive analysis of the issue.

Crina Grosan, Ajith Abraham and Stefan Tigan [6] (2007) authored Multicriteria programming in medical diagnosis and treatments, this paper deals with a special case of multicriteria optimization problems. The problems studied come from the medical domain and are of a very important practical relevance. One of the problems refers to the ranking of treatments for the Trigeminal Neuralgia. The second problem refers to a hierarchy of risk factors for Bronchial

Asthma. The most common way to deal with a multi objective optimization problem is to apply Pare to dominance relationship between solutions. The evolutionary approach obtains several solutions in one run. Also, the dominance concept (which is more than standard Pareto dominance relationship) is playing an important role in the final hierarchy.

Both genetic and environmental factors represent a risk for the Bronchial Asthma and their influence differs from one patient to another, from a world region to another, etc. Genetic susceptibility is both context dependent and developmentally regulated, and ignoring the environmental context will miss many important associations and clues to pathogenesis. That's why a right classification of the risk factors is very important in control and prevention of Bronchial Asthma.

Badri Adhikari, Md. Hasan Ansari, Priti Shrestha and Susma Pant [7] (2008) have developed a Neurology Diagnosis System, which is concerned about the construction of a web-based expert system. The objective of the system is to help the diagnosis process of neurology doctors. Neurology is a medical specialty that deals with disorders of the nervous system. Doctors will use the website as a helpful tool to diagnose their patients. The web application will collect rules of the neurology domain and cases of the patients. Integrating the techniques of rule-based reasoning and case-based reasoning a hybrid system can be constructed. The system will use the rules and cases to achieve the objective of assisting the decision making process of the domain experts. The proposed system will prove effective, efficient and will establish itself as a valuable asset of the department and the hospital. Precise analysis of return on investment (ROI) and breakeven analysis is difficult at this proposing stage of an academic project. It can be assured that the project will prove economically feasible.

Murad Alaqtash, Huiying Yu, Richard Brower, Amr Abdelgawad, Eric Spier, and Thompson Sarkodie-Gyan [8] (2010) have authored Application of Wearable Miniature Non-invasive Sensory System in Human Locomotion using Soft Computing Algorithm. The authors have designed and tested a wearable miniature non-invasive sensory system for the acquisition of gait features. The sensors are placed on anatomical segments of the lower limb, and motion data was then acquired in conjunction with electromyography (EMG) for muscle activities, and instrumented treadmill for ground reaction forces (GRF). A relational matrix was established between the limb-segment accelerations and the gait phases. This algorithm offers the possibility to perform functional comparisons using different sources of information. It can provide a quantitative assessment of gait function. This algorithm has clearly illustrated the possibility to perform functional comparisons by using different sources of information. The fuzzy similarity methodology depicts distinctions between the reference able-bodied and the randomized test subjects within with a membership grade of belonging. This novel algorithm may offer very reliable and efficient tools for the evaluation and assessment of gait function in several ways: By building a rule-based system depicts the strength of relation between muscle activities, limb-segment accelerations, and gait phases. By comparing the reference muscle activities within gait phases with a randomized input-matrix through a fuzzy similarity algorithm.

Youssouf EL ALLIOUI and Omar EL BEQQALI [9] (2010) have authored the article O'Neurolog – Building, an Ontology for Neurology in Mobile Environment, The (context aware services). A crucial requirement for the context-aware service provisioning is the dynamic retrieval and interaction with local resources, i.e., resource discovery. The high degree of dynamicity and heterogeneity of mobile environments requires rethinking and/or extending traditional discovery solutions to support more intelligent service search and retrieval, personalized to user context conditions. Authors research work aims at providing suitable answering mechanisms of mobile requests by taking into account user contexts (preferences, profiles, physical location, temporal information…). This paper proposes ontology, called O'Neurolog, to capture semantic knowledge a valuable in Neurology domain in order to assist

users (doctor, patient, administration …) when querying Neurology knowledge bases in mobile environment. First, authors designed a domain specific ontology, called O'Neurolog that incorporates concepts drawn from raw data and expert knowledge.

In fact, data and knowledge discovery is a crucial activity in pervasive environments where mobile users need to be provided with personalized results due to limited physical characteristics of portable devices. Another interesting future issue authors envision dealing which is the resolution of conflicts that may arise between value or priority preferences. Authors believe that a possible approach may be the definition of meta-preferences, as authors have began the formalization in section.

Faran Baig, M. Saleem Khan, Yasir Noor and M. Imran [10] (2011) have designed model of Fuzzy Logic Medical Diagnosis Control System, This research work addresses the medical diagnosis regarding the normality of a human function in human brain and the diagnosis of haemorrhage and brain tumour. It enhances the control strategies in the medical field to diagnose a disease. The simulation results are found in agreement with the design based calculated results. This research work proposes to develop a control system to enhance the efficiency to diagnose a disease related to human brain. Both the design model and simulation result are same. The designed system can be extended for any number of inputs. Normal, haemorrhage and the brain tumour all depend on the inputs protein, red blood cell, lymphocytes, neutrophils and eosinophils. Authors defined this system for any number of inputs. As the inputs are the blood cells and the designed system use five blood cells as inputs, similarly authors defined this system more than five Inputs to get more efficient human diagnose results. The design work was being carried out to design state of the art fuzzy logic medical diagnosis control system in future using FPGAs.

Dragan Simić, Svetlana Simić, and Ilija Tanackov [11] (2011) authored the article An Approach of Soft Computing Applications in Clinical Neurology, this paper briefly introduces various soft computing techniques and presents miscellaneous applications in clinical neurology domain. Authors presented applications of soft computing models of the cutting edge researches in neurology domain, specifically for EMG and EEG signals. This paper only indicates some researches based on hybrid soft computing and expert and decision support systems. Also, researches on implementation of different artificial intelligence techniques – hybrid soft computing methods can be applied to almost all medical domains, neurology included.

Rajdeep Borgohain and Sugata Sanyal [12] (2011) designed Rule Based Expert System for Cerebral Palsy Diagnosis. The use of artificial intelligence is finding prominence not only in core computer areas, but also in cross disciplinary areas including medical diagnosis. The expert system takes user input and depending on the symptoms of the patient, diagnoses and if the patient is suffering from Cerebral Palsy. The expert system also classifies the Cerebral Palsy as mild, moderate or severe based on the presented symptoms. Authors have discussed the design and implementation of a rule based Expert System for Cerebral Palsy Diagnosis. This expert system helps to diagnose Cerebral Palsy and classify it as mild, moderate or severe. In the implementation, authors have taken the most classical symptoms of Cerebral Palsy and given a weight age to each of the symptom and according to the feedback given by the user. The expert system can go a great deal in supporting the decision making process of medical professionals and also help parents having children with Cerebral Palsy to assess their children and to take appropriate measures to manage the disease.

Imianvan Anthony Agboizebeta and Obi Jonathan Chukwuyeni [13] (2012) have authored Cognitive analysis of multiple sclerosis utilizing fuzzy cluster means Multiple sclerosis, often called MS, is a disease that affects the central nervous system (the brain and spinal cord). Myelin provides insulation for nerve cells improves the conduction of impulses along the nerves and is important for maintaining the health of the nerves. In multiple sclerosis, inflammation causes the myelin to disappear. Genetic factors, environmental issues and viral infection may also play a role in developing the disease. MS is characterized by life threatening symptoms such as; loss of balance, hearing problem and depression. This paper presents a diagnostic fuzzy cluster means system to help in diagnosis of Multiple sclerosis using a set of symptoms. This advanced system which uses clustered data set is more precise than the traditional system. The classification, verification and matching of symptoms to the two groups of clusters (Relapsing/remitting multiple sclerosis and Primary Progressive Multiple Sclerosis) was necessary especially in some complex scenarios. This paper demonstrates the practical application of ICT (Information and communication technology) in the domain of diagnostic pattern appraisal in medicine by determining the extent of membership of individual symptoms. The model proposed allows for the classification of matching of cluster groups to multiple sclerosis symptoms. The fuzzy-cluster means model proposed in this paper appears to be a more useful.

Sujit Das, Pijush Kanti Ghosh and Samarjit Kar [14] (2012) have authored Hypertension Diagnosis: A Comparative Study using Fuzzy Expert System and Neuro Fuzzy System. Hypertension is called the silent killer because it has no symptoms and can cause serious trouble if left untreated for a long time. It has a major role for stroke, heart attacks, heart failure, aneurysms of the arteries, peripheral arterial diseases, chronic kidney disease etc. Then this paper presents a comparative study between fuzzy expert system (FES) and feed forward back propagation based neuro fuzzy system (NFS) for hypertension diagnosis. This paper also presents a comparison among the learning functions (LM, GD and BR) where Levenberg-Marquardt based learning function shows its efficiency over the others. Comparison between FES and NFS shows the effectiveness of using NFS over FES. Here, the input data set has been collected from 10 patients whose ages are between 20 and 40 years, both for male and female. It has shown that the neuro fuzzy system used in this study has the capacity to produce higher overall prediction accuracy than particular fuzzy expert system architecture. Based on this observation authors concluded that NFS represents a useful method for medical diagnostic task of finding hypertension risk factor. Different ANN training algorithms were shown to lead to different diagnostic results among which Levenberg- Marquardt is proved to be optimal. Development of NFS would be more helpful to medical experts and new coming practitioner for diagnosing the hypertension in proper order. For feed forward back propagation based neural network, authors have taken the membership values of related linguistic variables (low, medium and high) as input of age, BMI, BP and Heart Rate and as output (less, moderate and severe) for Hypertension risk evaluation. In this present study, FES shows hypertension risk is moderate for 5 patients and less for the other five patients. But NFS shows severe risk for 5 patients, less risk for 4 patients and moderate risk for 1 patient which is close to medical observation as released by a team of experts. Future goal of this study is to present the adaptive neuro fuzzy inference system (ANFIS) for diagnosis of Hypertension and to make a comparative study with the existing system. More rules and more symptoms might be added in the future research work for more precise diagnosis.

Vida Groznika, Matej Guida, Aleksander Sadikova, Martin Mozinaa, Dejan Georgiev, Veronika Kragelj, Samo Ribari, Zvezdan Pirtosek and Ivan Bratkoa [15] (2012) have authored the article Artificial Intelligence in Medicine. This paper describes the use of expert's knowledge in practice and the efficiency of a recently developed technique called argument-based machine learning (ABML) in the knowledge elicitation process.

Authors are developing a neurological decision support system to help the neurologists differentiate between three types of tremors: Parkinsonian, essential and mixed tremor (comorbidity). The system is intended to act as a second opinion for the neurologists and most importantly to help them reduce the number of patients in the "gray area" that require a very costly further examination (DaTSCAN). Authors strived to elicit comprehensible and medically meaningful knowledge in such a way that it does not come at the cost of diagnostic accuracy. 122 patients were enrolled into the study. The classification accuracy of the final model was 91%. Equally important, the initial and the final models were also evaluated for their comprehensibility by the neurologists. All 13 rules of the final model were deemed as appropriate to be able to support its decisions with good explanations. This paper demonstrates ABML's advantage in combining machine learning and expert knowledge. The accuracy of the system is very high with respect to the current state-of-the-art in clinical practice and the system's knowledge base is assessed to be very consistent from a medical point of view. Authors have also measured the net time involvement of the expert in building a knowledge base for the system. Authors believe ABML saves a significant amount of expert's time and the experts agreed that the process itself felt very natural and stimulating.

Rajdeep Borgohain and Sugata Sanyal [16] (2012) have discussed the implementation of a rule based expert system for diagnosing neuromuscular diseases. The proposed system is implemented as a rule based expert system in JESS for the diagnosis of Cerebral Palsy, Multiple Sclerosis, Muscular Dystrophy and Parkinson's disease. In this system, the user is presented with a list of questionnaires about the symptoms of the patients based on which the disease of the patient is diagnosed and possible treatment is suggested. This system can aid and support the patients suffering from neuromuscular diseases to get an idea of their disease and possible treatment for the disease. Author's presented an expert system for diagnosis of neuromuscular disorders, which is used to diagnose some of the most common neuromuscular diseases i.e. Cerebral Palsy, Muscular Dystrophy, Parkinson's disease and Multiple Sclerosis. The system is a rule based expert system implemented using the Java Expert System Shell using the backward chaining mechanism. The expert system can go a great deal in supporting the decision making process of medical professionals and also help patients with neuromuscular disorders and give an overview of the disease and treatment options.

Gayathri. P and N. Jaisankar [17] (2013) carried out Comprehensive Study of Heart Disease Diagnosis using Data Mining and Soft Computing Techniques. Heart disease diagnosis is a challenging task which can offer automated prediction about the heart disease of patient so that further treatment can be made easy. Due to this fact, heart disease diagnosis has received immense interest globally among medical community. Here artificial intelligence played an important role in diagnosis of heart disease with improved effectiveness. Accordingly, authors present a detailed survey of 47 articles published in the standard journals from the year 2005 to 2013. The survey of the papers related to heart disease and also the survey of many categories of heart disease such as coronary heart disease, coronary artery disease, heart failure, ischemic heart disease, cardiovascular disease, congenital heart disease, valvular heart disease and hypoplastic left heart syndrome are presented in this paper. From this survey, the finding is that neural network based techniques contribute more effectiveness and some techniques have obtained more than 90% accuracy.

Rami N. Khushaba, Chelsea Wise, Sarath Kodagoda, Jordan Louviere, Barbara E. Kahn and Claudia Townsend [18] (2013) have discussed Assessing the brain response to marketing stimuli using electroencephalogram (EEG) and eye tracking by application of neuroscience methods to analyze and understand human behaviour related to markets and marketing exchange has recently gained research attention. The basic aim is to guide design and presentation of products to optimize them to be as compatible as possible with consumer preferences.

This paper investigates physiological decision processes while participants undertook a choice task designed to elicit preferences for a product. The task required by participants to choose their preferred crackers described by shape (square, triangle, round), flavour (wheat, dark rye, plain) and topping (salt, poppy, no topping). The two main research objectives were (1) to observe and evaluate the cortical activity of the different brain regions and the interdependencies among the Electroencephalogram (EEG) signals from these regions; and (2) unlike most research in this area that has focused mainly on liking/disliking certain products, authors provide a way to quantify the importance of different cracker features that contribute to the product design based on mutual information. Authors have used the commercial Emotiv EPOC wireless EEG headset with 14 channels to collect EEG signals from participants. Authors also used a Tobii-Studio eye tracker system to relate the EEG data to the specific choice options (crackers). Subjects were shown 57 choice sets; each choice set described three choice options (crackers). Our analysis also showed that higher mutual information values were achieved by almost all EEG bands power with the flavour and topping labels in comparison to that of the shape. This in turn suggests that these attributes of the crackers initiated more cognitive processing in a way which caused the power of the different EEG bands to correlate well with the change in the factors making each of the flavour and topping attributes, i.e., wheat, dark rye, plain for flavour and salt, poppy, no topping for topping.

A.Sh.AMOOJI [19] (2013) has authored the article the application of expert systems in medical diagnosis, which is very interesting and it creates considerable importance system of diagnosis. The proposed system can help doctors and patients in providing decision support system, interactive training tools and expert skills. The system constitutes part of intelligent system for diagnosis of neurological diseases that used in one of the great hospital in Tehran. All of the neurological diseases diagnoses have been investigated in this project. The system constitutes part of intelligent system of diagnosis of neurological diseases. The present expert system is evolving and increasing efficiency for all neurological diseases. Therefore the work was aimed to design a system for the diagnosis of neurological diseases using FC (Fuzzy Cognitive) which is a successful application of Lotfizadeh's fuzzy set theory. It is a reasonable tool for dealing with uncertainty and imprecision and the knowledge of a physician can be modelled using an FC. Usefulness and power of a FC depends on its knowledge base which consists of a data base and a rule base. It is observed that the performance of a FC mainly depends on its rule base, and optimizing the membership function distributions stored in the data base is a fine tuning process. The proposed work can be further improved and lengthened for the automation of disease (cancer, heart disease, arthritis) prediction with the help of genetic algorithm and microarray gene expression. Real data from health care organizations and agencies needs to be collected and all the available techniques will be compared for the optimum accuracy.

Atul Krishan Sharma and Stuti Gupta [20] *(2014)* have developed Neurological Disorder Diagnosis System. This paper presents an account of Rule-Based Expert System (RBES) for Neurological Disorders, i.e., Alzheimer, Parkinson, Tetanus disease, Cerebral Palsy, Meningitis, Epilepsy, Multiple Sclerosis, Stroke, Cluster headache, Migraine, Meningitis. Neurological disorders are mainly concerned with the malfunctioning of nervous system. Detection and monitoring of neurological disorders at early stage is essential for quality life and facilitate necessary diagnosis and treatment of the diagnosed disease. The focus of this paper is the development of Neurological Disorder Diagnosis System (NDDS), which can act as home agent to detect the disorder with accuracy to that of an expert. The system consists of a knowledge base with some facts. On the basis of these facts the medical practitioner will fed symptoms as input. The system by applying inference procedures will return the output as results. More than 10 types of neurological diseases can be diagnosed and treated by the system. In this paper, Neurological Disorder Diagnosis System (NDDS) a rule based expert system is developed which helps in diagnosing a nervous system disorder by analyzing the observed symptoms.

This expert system is developed to be used as a consultation system for neurologists and researchers in order to reach a decision. The system developed is different from previously developed systems is in terms of accuracy. The system is developed to be near possible as accurate as a human expert. This system can be made advanced to deal with uncertainty using Fuzzy Based Reasoning Techniques. Fuzzy logic provides high accuracy for problems based on uncertainty. The system can also be developed as touch screen systems which can act as pocket systems to detect neurological disorders.

Maíra Junkes-Cunha, Glauco Cardozo, Christine F Boos and Fernando de Azevedo [21] (2014) have authored Implementation of expert systems to support the functional evaluation of stand-to-sit activity background, functional evaluation of sit-to-stand and stand-to-sit activities was often used by physiotherapists in patients with neurological and musculoskeletal disorders. The observation of the way these activities are executed is essential in identifying kinesiological problems. There are different methodologies used to describe the stand-to-sit activity and its evaluation is not yet standardized, which makes the practical application of resources on clinical observation difficult. The objective of this study is to automate the decision making process of an evaluation protocol, developed in previous study and facilitate its utilization by professionals in the area. The developed expert systems can support the physiotherapist in evaluating stand-to-sit activity through a conclusion suggestion about the "level of inadequacy" for the "degree of inadequacy" searched during its execution. Results of experts evaluation analyzed through statistical methods indicate that the automation of protocols contributed to the standardization of the evaluation of stand-to-sit activity and that it has application for teaching purposes.

3. CONCLUSIONS

This literature survey reveals that many researchers have applied soft computing techniques to neurology problems. At the outset authors concluded that even after having significant research in this field. The practical use of expert system by a neurologist in Indian hospitals is limited. Authors would like to conduct an field survey of this aspect and would like to explore why the use of research tools developed has not been/could not been applied in practice. This survey would help us to understand the difficulties and limitations of such tools/software in Indian context.

Authors would like develop an innovative solution which will suit our Indian neurologist doctors requirements particularly remote and rural areas.

ACKNOWLEDGEMENTS

The authors would like to express gratitude to NMAM Institute of Technology, Nitte and Basaveshwar Science College, Bagalkot for their support and funding present research. Authors would like to thank the Vision Group of Science and Technology, Government of Karnataka for sponsoring the project under K-Fist Level-1 Project Soft Computing Applications in Business and Industry sectors (GRD – 248, 2013-14)

REFERENCES

[1] Klaus Spitzer, Andreas Thie, Louis R. Caplan and Klaus Kunze (1989), The MICROSTROKE Expert System for Stroke Type Diagnosis, American Heart Association Print ISSN: 0039-2499. Online ISSN: 1524-4628 doi: 10.1161/01.STR.20.10.1353,Stroke.;20:1353-1356 http://stroke.ahajournals.org/content/20/10/1353

[2] Cruz J, Barahona P, Figueiredo A.P, Veloso M, Carvalho M. UNINOVA (1994), DARE: a Knowledge-Based System for the Diagnosis of Neuromuscular Disorders, Hospital Egas Moniz, Hospital Santa Maria, pp :1-12

[3] Leda Cosmides and John Tooby (1997), The Cognitive Neuroscience of Social Reasoning, The New Cognitive Neurosciences Second Edition, A Bradford Book The MIT Press Cambridge, Massachusetts London, England, Pp : 1259-1270

[4] Jean-Marc Fellous, Jorge L. Armony and Joseph E. LeDoux (2000), Emotional Circuits and Computational Neuroscience, Road Map: Connectionist Psychology Related Reading: Conditioning; Emotion-Cognition Interactions; Sparse Coding in the Primate Cortex, Pp : 1-6

[5] Blacksmiths, Mauro Adenzato and Francesca Garbarini (2006), The As If in Cognitive Science, Neuroscience and Anthropology A Journey among Robots and Neurons, Theory & Psychology, Sage Publications. Vol. 16(6): 747–759 DOI: 10.1177/0959354306070515 www.sagepublications.com University of Turin

[6] Crina Grosan, Ajith Abraham, Stefan Tigan (October 2007), Multicriteria programming in medical diagnosis and treatments, ASOC-416; No of Pages 11

[7] Badri Adhikari, Md. Hasan Ansari, Priti Shrestha and Susma Pant (September 25, 2008) "Neurology Diagnosis System", Module

[8] Murad Alaqtash, Huiying Yu, Richard Brower, Amr Abdelgawad, Eric Spier and Thompson Sarkodie-Gyan (2010), Application of Wearable Miniature Non-invasive Sensory System in Human Locomotion Using Soft Computing Algorithm

[9] H. Liu et al. (Eds.): ICIRA 2010, Part I, LNAI 6424, pp. 288–299, 2010. © Springer-Verlag Berlin Heidelberg 2010

[10] Youssouf EL ALLIOUI and Omar EL BEQQALI (September 2010), O'Neurolog– Building an Ontology for Neurology in Mobile Environment, IJCSNS International Journal of Computer Science and Network Security, VOL.10, No.9,

[11] Faran Baig, M. Saleem Khan, Yasir Noor, M. Imran, Faran Baig et al. (5 May 2011), Design Model of Fuzzy Logic Medical Diagnosis Control System, International Journal on Computer Science and Engineering (IJCSE) ISSN : 0975-3397 Vol. 3, Pp:2093-108

[12] Dragan Simić, Svetlana Simić, and Ilija Tanackov (2011), An Approach of Soft Computing Applications in Clinical Neurology E. Corchado, M. Kurzyński, M. Woźniak (Eds.): HAIS 2011, Part II, LNAI 6679, Pp. 429–436, 2011. © Springer-Verlag Berlin Heidelberg

[13] Rajdeep Borgohain, Sugata Sanyal (2011) Rule Based Expert System for Cerebral Palsy Diagnosis, Pp : 1-4

[14] Imianvan Anthony Agboizebeta and Obi Jonathan Chukwuyeni (January 2012), Cognitive Analysis of Multiple Sclerosis Utilizing Fuzzy Cluster Means, International Journal of Artificial Intelligence & Applications (Ijaia), Vol.3, No.1, Tripplejo2k2@Yahoo.Com

[15] Sujit Das, Pijush Kanti Ghosh and Samarjit Kar (2012), Hypertension Diagnosis: A Comparative Study using Fuzzy Expert System and Neuro Fuzzy System, Pp: 1-7.

[16] Vida Groznika, Matej Guida, Aleksander Sadikova, Martin Mozinaa, Dejan Georgiev, Veronika Kragelj, Samo Ribari, Zvezdan Pirtosek, Ivan Bratkoa(2012), Artificial Intelligence in Medicine Contents lists available at SciVerse ScienceDirect Artificial Intelligence in Medicine journal, No. of Pages 12

[17] Rajdeep Borgohain, Sugata Sanyal (2012) Rule Based Expert System for Diagnosis of Neuromuscular Disorders, Pp : 1-5

[18] Gayathri. P and N. Jaisankar Jul 2013, Comprehensive Study of Heart Disease Diagnosis Using Data Mining and Soft Computing Techniques, International Journal of Engineering and Technology (IJET), ISSN : 0975-4024 Vol 5 No 3 Jun-Jul 2013, Pp : 2947-2958

[19] Rami N. Khushaba, Chelsea Wise, Sarath Kodagoda, Jordan Louviere, Barbara E. Kahn, Claudia Townsend, R.N. Khushaba et al. (2013), Assessing the brain response to marketing stimuli using electroencephalogram (EEG) and eye tracking, at SciVerse Science Direct, Expert Systems with Applications 40 (2013) Pp: 3803–3812, www.elsevier.com/locate/eswaConsumer neuroscience:

[20] A.Sh. Amooji (2013) The Expert System for Diagnosis of Neurological Diseases Using Fuzzy Cognitive, Baki Universitetinin Xəbərləri, №3 Fizika-Riyaziyyat Elmləri Seriyası 2013 İnformatika, Pp:95-102, It_Iranian@Yahoo.Co

[21] Atul Krishan Sharma , Stuti Gupta Neurological Disorder Diagnosis System www.ijraset.com Vol. 2 Issue VI, June 2014 ISSN: 2321-9653, International Journal for research in applied science and engineering technology (ijraset)

[22] Maíra Junkes-Cunha, Glauco Cardozo, Christine F Boos and Fernando de Azevedo, (2014) Implementation of expert systems to support the functional evaluation of stand-to-sit activity, Bio Medical Engineering On Line 2014, 13:98 http://www.biomedical-engineering-online.com/content/13/1/98

AUTHORS

Prof. Dr. D.K.Sreekantha is serving as Professor in the Dept. of Computer Science & Engineering, NMAM Institute of Technology, Nitte. His areas of interest are Soft Computing, Expert Systems, Knowledge Management, Risk Management, Banking, Finance and Business Applications. He has completed two funded research projects

Mr. T.M.Girish is a faculty in the Dept. of Computer Science in Basaveshwar Science College, Bagalkot. His areas of Interest are Soft Computing and Medical Applications

Prof. Dr. R.V.Kulkarni is the Head, Dept. of Computer Studies, CSIBER institute, Kolhapur, 8 students have been awarded Ph.D under his guidance. He has authored more 60 papers in International journals

INTENTIONAL BLANK

SENSORLESS VECTOR CONTROL OF BLDC USING EXTENDED KALMAN FILTER

Y.Lavanya[1a], N.P.G.Bhavani[1b], Neena Ramesh[2], K.Sujatha[3]

PG Student[1a], Assistant Professor[1b], Professor[2, 3]
[1a,1b,2]Electrical and Electronics Department,
Meenakshi College of Engineering
Chennai, Tamil Nadu.
[3]Dr .M.G.R. Educational and Research Institute, Chennai, Tamil Nadu, India
[1a]lavanyay73@gmail.com
[1b]sbreddy9999@gmail.com

ABSTRACT

This Paper mainly deals with the implementation of vector control technique using the brushless DC motor (BLDC). Generally tachogenerators, resolvers or incremental encoders are used to detect the speed. These sensors require careful mounting and alignment, and special attention is required with electrical noises. A speed sensor need additional space for mounting and maintenance and hence increases the cost and size of the drive system. These problems are eliminated by speed sensor less vector control by using Extended Kalman Filter and Back EMF method for position sensing. By using the EKF method and Back EMF method, the sensor less vector control of BLDC is implemented and its simulation using MATLAB/SIMULINK and hardware kit is implemented.

KEYWORDS

Brushless DC Motor (BLDCM), Current controller, Extended kalman filter (EKF), Vector control.

1. INTRODUCTION

Permanent magnet AC motors has been classified in two categories: BLAC and BLDC. The first type has a sinusoidal current and back-EMF while the second's waveforms are rectangular. Brushless DC motor has good advantages such as large torque, high efficiency and high power density so that it has been used extensively in industries and is a appropriate motor for high performance applications [1]. Use of sensors for detection of position and speed is an important defect of control systems because of cost, weight and reduction of reliability. Many researches have been carried out for elimination of speed mechanical sensor. A wide variety of method has been proposed for speed estimation but kalman filter because of its good performance, has been used in drive systems [2]. The Kalman filter is an observer based on least square method and estimates system states optimally. The EKF has been derived from Kalman filter and used for

Sundarapandian et al. (Eds) : ITCCMA, FUZZY, SIGEM, DMDBS, NATL - 2015
pp. 43–55, 2015. © CS & IT-CSCP 2015 DOI : 10.5121/csit.2015.50505

nonlinear problems. This estimator has been applied to various motors [3]. In this paper, a novel scheme for EKF has been proposed. This paper develops to remove the drawbacks associated with sensored control and use of traditional controllers by using zero crossing point (ZCP) based on Back electromotive force (Back-EMF) sensorless control with fuzzy logic controller. The sensorless control requires good reliability and various speed ranges with the high starting torque for BLDC motor drive system. To satisfy these requirements, this paper proposes an efficient sensorless speed control to avoid high energy prices.

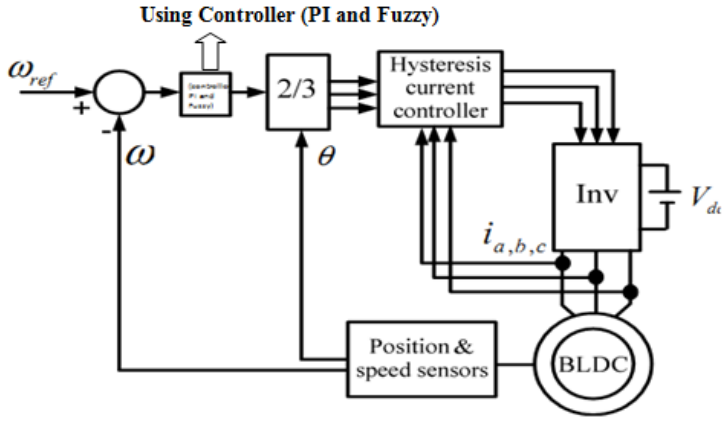


Fig 1:Block diagram.

2. PRINCIPLES OF SENSORLESS BLDC MOTOR CONTROL

BLDC motor drives have need of rotor position information for appropriate operation to execute phase commutation. Position sensors are generally used to provide the position information for the driver. So this type of position sensors is not used in sensorless drives. The advantage of sensorless drives comprises of less hardware cost, increased system reliability, decreased system size and reduced feedback units. And also they are free from mechanical and environmental constraints [2].

Various control methods arises for sensorless drive, in which a back-EMF is the most cost effective method to obtain the commutation sequence in the star wound motors and current sensing provides enough information to estimate with sufficient rotor position to drive the motor with synchronous phase currents. BLDC motor drives that do not require position sensors but it contains electrical dimensions are called a sensorless drive. The BLDC motor provides sensorless operation based on the nature of its excitation intrinsically suggest a low-cost way to take out rotor position information from motor-terminal voltages. In the excitation of a 3 phase BLDC motor, apart from the phase-commutation periods, two of the three phase windings are functioning at a time and no conducting phase carries in the back-EMF as shown in Fig. 1. Since back-EMF is zero at standstill and proportional to speed, the measured terminal voltage that has large signal-to-noise ratio cannot detect zero crossing at low speeds. That is the reason why in all back-EMF-based sensorless methods the low-speed performance is limited, and an open-loop starting strategy is required [11,8].

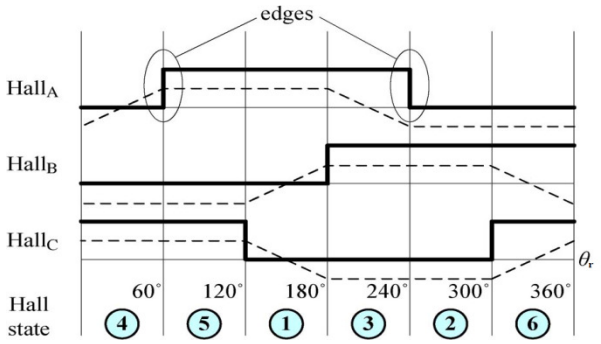


Fig. 2 (Thick solid line) Signals of the three phase Hall-effect sensors and (dotted line) ideal trapezoidal back EMF.

In BLDC motor the stator iron has a non-linear magnetic saturation features that is the fundamental from which it is feasible to find out the initial position of the rotor. When a stator winding is energized, then DC voltage is applied for a particular time and a magnetic field with a fixed direction will be recognized. Then, the stator current responses are changed owing to the inductance variation and this variation of the stator current responses which comprises of the information of the rotor position.

A. Back-EMF Zero Crossing Detection Method

The zero-crossing detection method is an easiest method of back-EMF sensing approach and it is based on finding the instantaneous at which unexcited phase crosses zero due to back-EMF [4]. This zero crossing activates a timer that might be as easy as an RC time constant; accordingly the next sequential inverter commutation take place at the end of timing interval.

For a distinctive operation of a BLDC motor, the back-EMF and phase current should be associated to generate constant torque. Fig. 2 shows the waveform for current commutation point which can be attained by the zero crossing point of back-EMFs and a six-step inverter commutation design for driving the BLDC motor [7,9].

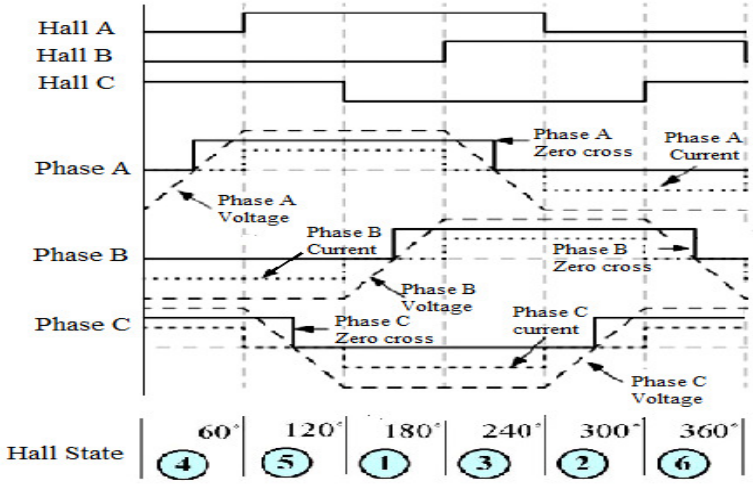


Fig. 3 Waveform of Back EMF and phase current with respect to Hall state.

As a result the interval for every phase of a BLDC motor is conducted at 120 electrical degrees. Hence, in BLDC motor only two phases conduct current at whichever time. The third phase is called floating phase. In order to produce greatest torque, the inverter is to be commutated at every 60° by calculating zero crossing of back-EMF on the floating phase of the motor, therefore the current is in phase with the back-EMF.

3. MATHEMATICAL MODELLING OF BLDC MOTOR

BLDC motor modelling is similar to three-phase synchronous machine modelling. The model is developed, in which the permanent magnet enclosed with the rotor and it contains different dynamic characteristics. Fig. 3 shows the Inverter BLDC motor-drive model. The BLDC motor is fed to a three-phase voltage source is not necessary to be sinusoidal or square wave can be applied. The peak voltage produced over there should not exceed the maximum voltage of the motor.

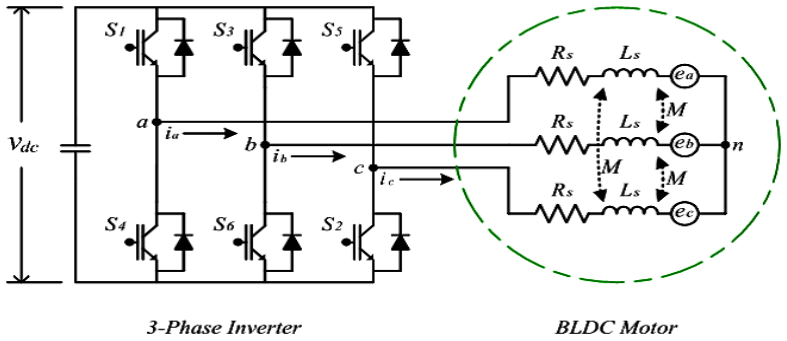


Fig. 4 Inverter with BLDC Motor drive model.

The fundamental model of the armature winding for the BLDC motor is defined as [3],

$$V_a = Ri_a + L\,\frac{di_a}{dt} + e_a \tag{1}$$

$$V_b = Ri_b + L\,\frac{di_b}{dt} + e_b \tag{2}$$

$$V_c = Ri_c + L\,\frac{di_c}{dt} + e_c \tag{3}$$

Where, L and R are the armature self-inductance [H] and armature resistance [Ω] of the stator phase winding respectively, Va, V*b*, Vc are terminal phase voltage [V], *i*a, *i*b, *i*c are motor input current [A] and *e*a, *e*b, *e*c are trapezoidal motor back emf [V] of respective phases.

Therefore the circuit equations of the three windings in phase variables are,

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \begin{bmatrix} R & 0 & 0 \\ 0 & R & 0 \\ 0 & 0 & R \end{bmatrix} \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} + \begin{bmatrix} L_a & L_{ab} & L_{ac} \\ L_{ba} & L_b & L_{bc} \\ L_{ca} & L_{cb} & L_c \end{bmatrix} p \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} + \begin{bmatrix} e_a \\ e_b \\ e_c \end{bmatrix} \tag{4}$$

As it has been considered that motor is not saturated and negligible iron losses, the stator resistances of all the windings are equal, self-inductance are constant and mutual inductance are zero

$$L_a = L_b = L_c = L \tag{5}$$

$$L_{ba} = L_{bc} = L_{ca} = M = 0 \tag{6}$$

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = R \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} + Lp \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} + \begin{bmatrix} e_a \\ e_b \\ e_c \end{bmatrix} + \begin{bmatrix} V_n \\ V_n \\ V_n \end{bmatrix} \tag{7}$$

The trapezoidal Back EMF of no conducting phases,

$$e_a = K_e f(\theta_e)\omega_r \tag{8}$$

$$e_b = K_e f(\theta_e - \tfrac{2\pi}{3})\omega_r \tag{9}$$

$$e_c = K_e f(\theta_e + \tfrac{2\pi}{3})\omega_r \tag{10}$$

The electromagnetic torque is given by,

$$T_e = \frac{e_a i_a + e_b i_b + e_c i_c}{\omega_r} \tag{11}$$

The equation of a motor for a simple system with inertia J, friction co-efficient B and load torque T_L is given by,

$$T_e = T_L + J\frac{d\omega}{dt} + B\omega \tag{12}$$

$$T_e = K_t I \tag{13}$$

The output power is given by,

$$P = T_e \omega_r \tag{14}$$

The parameters R, B, J are influence the speed response of the Brushless DC motor.

5. EXTENDED KALMAN FILTER FOR SPEED ESTIMATION

It is all order stochastic observer for the recursive optimum state estimation of a non-linear dynamic system in real time by single signal that are corrupted by noise. The EKF can also be used for unknown parameter estimation or joint state and parameter estimation. The speed adaptive flux observer is a deterministic observer in comparision with the EKF, and is applicable to linear time invariant system.

6. PROPOSED SENSORLESS SPEED CONTROL OF BLDC MOTOR

The proposed method is based on the fact that rotor position can be detected by using a trapezoidal Back-EMF of BLDC motors. Since Back-EMF of the BLDC motor is not measured directly, it is estimated by the comparator with ZCP detection technique and fuzzy logic intelligent controller is used for efficient speed control as shown in the Figure 4.

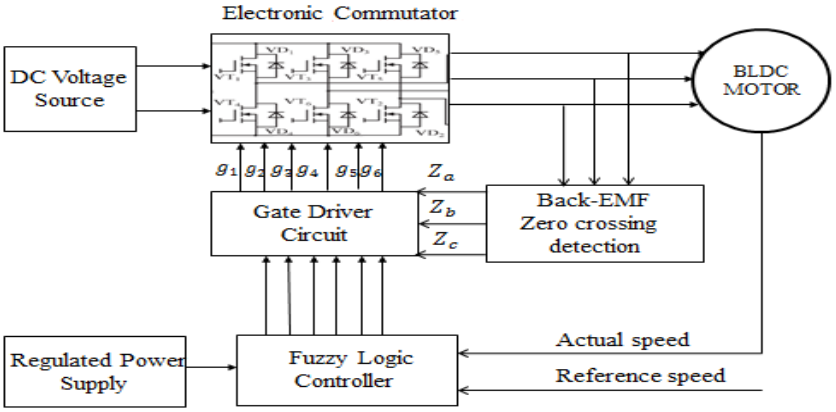


Fig. 5 Proposed block diagram of sensorless speed control of BLDC motor.

A. *Sensing Back EMF*

The comparator with zero cross detection technique is achieved by sensing the back EMF. The back EMF sensing is based on the information that only two phases of a BLDC motor are connected at a time and the third phase is presented to note the back EMF voltage. Consider phase C as floating for a particular step,

$$V_c = e_c + V_n \tag{15}$$

Where, V_c is the terminal voltage of the phase C, e_c is the phase Back EMF and V_n is the neutral voltage of the motor.

From phase A, the term for neutral voltage is expressed as,

$$V_n = V_{dc} - V_{MOS} - R_i - L\frac{di}{dt} - e_a \tag{16}$$

From phase B, the equation turns out to be,

$$V_n = V_{MOS} + R_i + L\frac{di}{dt} - e_a \tag{17}$$

Where, V_{MOS} is the voltage drop on MOSFET.

From equation (16) and (17),

$$V_n = \frac{V_{dc}}{2} - \frac{(e_a + e_b)}{2} \tag{18}$$

Considering a three-phase system by neglecting the third harmonics,

$$e_a + e_b + e_c = 0 \tag{19}$$

And the terminal voltageV_c,

$$V_c = \frac{3e_c}{2} + \frac{V_{dc}}{2} \tag{20}$$

From equation (15) to (20), it is to be noted that the terminal voltage of the floating phase of PWM is directly proportional to the back EMF voltage plus the half of dc bus voltage.

In proposed method, the comparators are used for generating the gating signals, by comparing V_a,V_b and V_c to V_n. If V_a is greater thanV_n, then the comparator outputs high level, else the comparator outputs low level, which is expressed as Z_a as shown in Fig. 4. At the rising edge of Z_a, the MOSFET Q_1 should be ON, and the MOSFET Q_5 should be OFF, at the falling edge of Z_a, the MOSFET Q_4 should be ON, and the MOSFET Q_2 should be OFF. Similarly, according to the rising and falling edge of Z_b and Z_c respectively, the other commutation instants should be obtained. The gating signals Z_a Z_b and Z_c are generated from the every commutation instants. Consequently, the BLDC motor could work normally on the prior state which is obtained from the switching table.

Design of Fuzzy Controller

The generated signals are employed in fuzzy controller and reference current controller which in gate driver circuit is produced for control system as shown in Fig. 4. The current control loop regulates the BLDC motor current to the reference current value generated by the speed controller. Fig. 5 shows the basic structure of a fuzzy logic controller. The fuzzy controller is composed of the following four elements fuzzification, fuzzy rule-base, fuzzy inference engine and defuzzification.

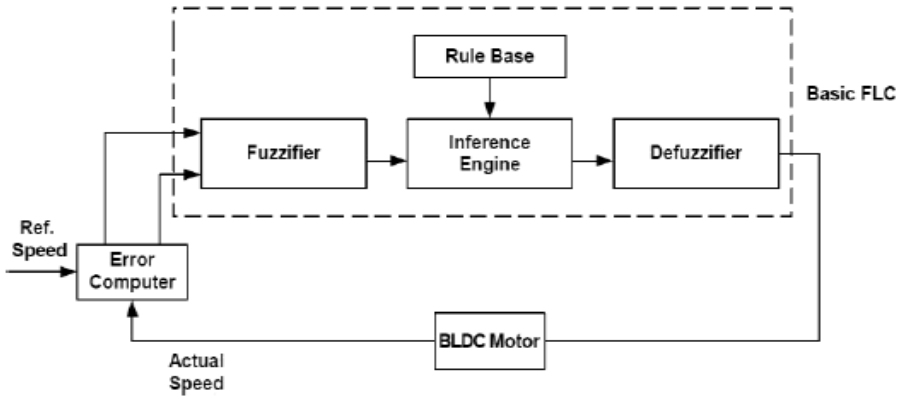


Fig. 6 Basic structure of FLC with BLDC motor.

Error (e) and change in error (ce) are the inputs for the fuzzy controller whereas the output of the controller is change in duty cycle (Δdc). The error is defined as the difference between the reference speed and actual speed, the change in error is defined as the difference between the present error and previous error and the output, the Change in duty cycle which **c**ould be either positive or negative and added with the existing duty-cycle to determine the new duty-cycle.

Fuzzy logic uses linguistic variables instead of numerical variables. The process of converting a numerical variable in to a linguistic variable is called fuzzification. Fuzzy logic linguistic terms are most often expressed in the form of logical implications, such as If-Then rules. These rules define a range of values known as fuzzy membership functions [7]. Fuzzy membership functions may be in the form of a triangle, a trapezoid or a bell.

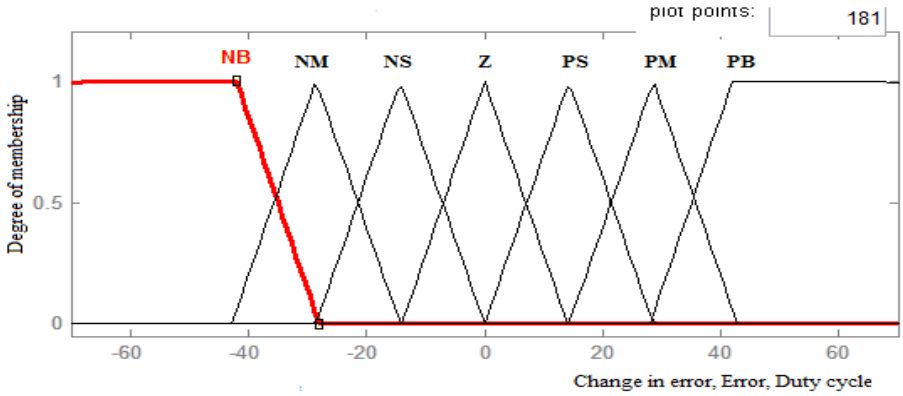


Fig. 7 Membership functions of fuzzy controller.

Fig. 7 illustrates the membership function of fuzzy logic controller that used in fuzzification of two input values and defuzzification output of the controller. There are seven clusters in the membership functions, with seven linguistic variables defined as Negative Big (NB), Negative Medium (NM), Negative Small (NS), Zero (Z), Positive Small (PS), Positive Medium (PM), and Positive Big (PB). Fig 8 shows the MATLAB simulation diagram of fuzzy logic controller.

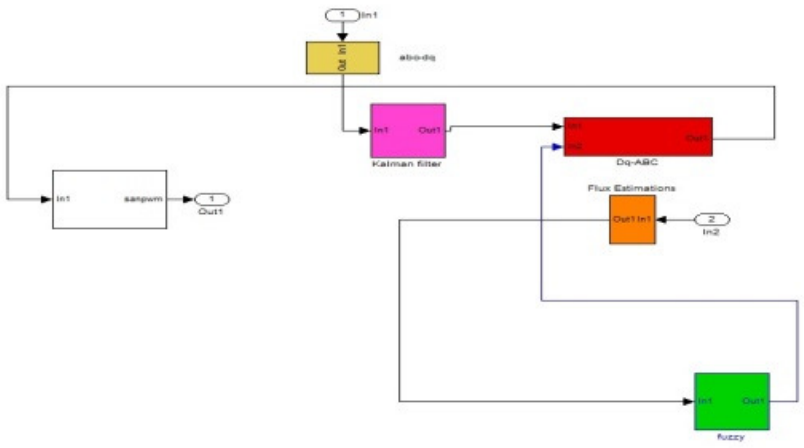


Fig. 8 Matlab simulation diagram of fuzzy logic control.

A sliding mode rule-base, used in the fuzzy logic controller is given in Table I. The fuzzy inference operation is implemented by using the 49 rules.

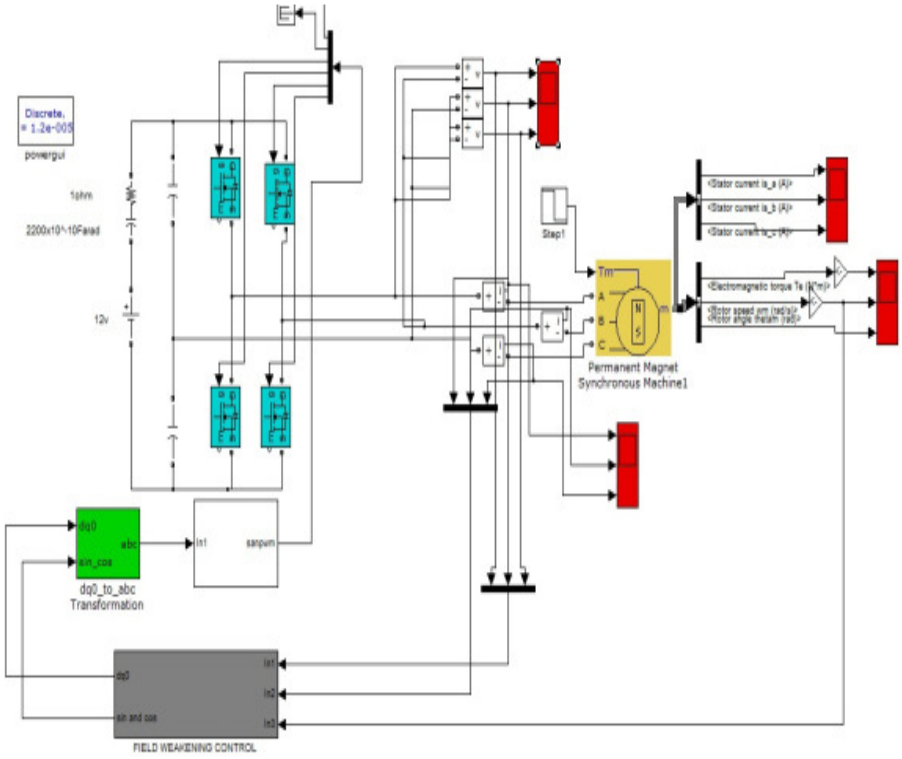


Fig. 9 Simulation diagram of proposed sensorless speed control of BLDC motor

The min-max compositional rule of inference and the center of gravity method have been used in the defuzzification process. The developed MATLAB model shown in the Fig. 8 is use to observe the phase current waveforms, back-EMF, speed and torque to assigned motor specification shown in Table II

TABLE I FUZZY RULE BASE

Change in error	**Error**						
	NB	**NM**	**NS**	**Z**	**PS**	**PM**	**PB**
NB	NB	NB	NB	NB	NM	NS	Z
NM	NB	NB	NB	NM	NS	Z	PS
NS	NB	NB	NM	NS	Z	PS	PM
Z	NB	NM	NS	Z	PS	PM	PB
PS	NM	NS	Z	PS	PM	PB	PB
PM	NS	Z	PS	PM	PB	PB	PB
PB	Z	PS	PM	PB	PB	PB	PB

TABLE II MOTOR SPECIFICATIONS FOR SIMULATION

SIMULATION PARAMETERS	VALUES
BLDC MOTOR PARAMETERS	
Power	3hp
Voltage	12v
Current	0.8a
Speed	1500rpm
Frequency	60hz
Pole pairs	1
Inertia	$8x10^{-3}$ kg m^2
Stator phase resistance	2.8750 ohm
Stator phase inductance	$8.5x10^{-3}$henrys
Flux linkage	0.175 vs
PI CONTROLLER PARAMETERS	
Proportional gain	0.1
Integral gain	1
FUZZY CONTROLLER PARAMETERS	
Proportional gain	180
Integral gain	3200

7. SIMULATION RESULTS AND DISCUSSIONS

In order to validate the control strategies as described, digital simulations were carried out on a converter for the BLDC motor drive system using MATLAB/SIMULINK, where the parameters used for the DC motor drive system is given in Table II. Simulation studies were carried out to evaluate the performance of sensorless based speed control of BLDC motor. Here the speed is controlled without sensors.

Fig 10(a) represents about speed response using PI controller here the speed achieved is 1500rpm and where as in fuzzy 900 rpm is achieved , by keeping fuzzy as conventional pi is used as proposed controller. Fig 11(a) represents torque using PI, Fig 11(b) represents torque using Fuzzy .

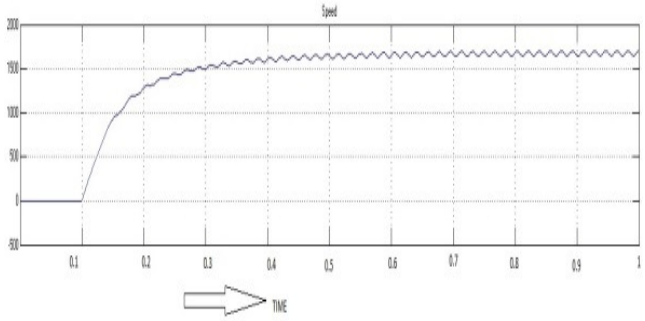


Fig. 10(a) Speed response using PI

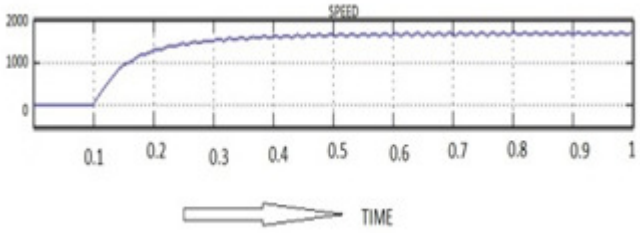


Fig. 10(b) Speed response using Fuzzy.

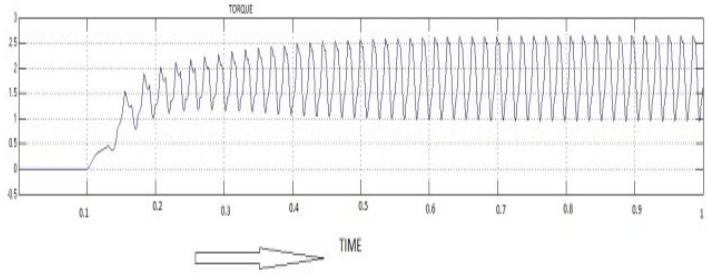


Fig. 11(a) Torque response using PI with reference set speed 1500rpm.

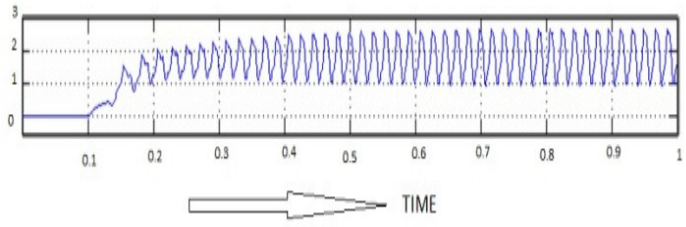


Fig. 11(b) Torque response using Fuzzy with reference set speed 1500rpm.

Comparison results:

PARAMETER	TIME	PI	FUZZY
Speed (rpm)	0.4	1500	900
Torque(nm)	0.175	0.2	1.5

Comparative study analysis:

SPEED USING PI			
Set speed	Settling time	Rising time	Output speed
1500	0.4	0.3	1500
500	0.3	0.2	480
100	0.25	0.1	100
SPEED USING FUZZY			
1500	0.2	0.25	800
500	0.25	0.15	500
100	0.27	0.1	100

TORQUE USING PI		
1500	0.4	0.1
500	0.35	0.15
100	0.1	0.17
TORQUE USING FUZZY		
1500	0.3	0.15
500	0.2	0.1
100	0.1	0.005

8. CONCLUSIONS

Sensorless speed control of BLDC motor drive with PI logic implementation based on comparator with zero crossing detection have been experimented using MATLAB and evaluation of results are observed. The simulation results have shown that speed response of the BLDC motor can be controlled without sensors and also reduces the torque ripple. The results obtained from sensorless speed control of BLDC motor demonstrates that the system is less cost compared to sensored control and also good dynamic performance is obtained. This makes the motor suitable in application such as fuel pump, robotics and industrial automation. The proposed speed control scheme is robust, efficient and easy to implement in place of sensored applications.

REFERENCES

[1] Nobuyuki Matsui, “Sensorless PM Brushless DC Motor Drives”, IEEE Trans. on Industrial Electronics, Vol.43, No.2,pp.300-308, April 1996.

[2] Champa.P, Somasiri.P, Wipauramonton.P and Nakmahachalasint.P, “Initial Rotor Position Estimation for Sensorless Brushless DC Drives”, IEEE Trans. on Ind. Applications, Vol.45,No.4, pp.1318-1324,July 2009.

[3] Somanatham.R, Prasad.P.V.N, Rajkumar.A.D, "Modelling and Simulation of Sensorless Control of PMBLDC Motor Using Zero Crossing Back EMF Detection" IEEE SPEEDAM 2006 International Symposium on Power Electronics, Drives, Automotive and Motion.
[4] Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia 2002.
[5] Miller. T.J.E., "Brushless permanent magnet and reluctance motor drives ", Clarendon Press, Oxford, 1989.
[6] Ramesh.M.V, Amarnath.J, Kamakshaiah.S and Rao.G.S, "Speed control of Brushless DC Motor by using Fuzzy Logic PI Controller", ARPN Journal of Engineering and Applied Sciences, Vol.6, No.9, September 2011.
[7] Yan Wei-Sheng, Lin Hai, Li Hong,Yan Wei, "Sensorless Direct Torque Controlled Drive of Brushless DC Motor based on Fuzzy Logic", IEEE Trans. on Ind. Elec. and Appl., Vol.23, No.4, July 2009.
[8] Taeyeon Kim, Chungil Kim, Joon Lyou, "A New Sensorless Scheme for a BLDC Motor Based on the Terminal Voltage Difference" IEEE Trans. on Industrial Applications, Vol.6, No.7, pp.1710-1715, September 2011.
[9] Anjali A.R, Calicut University, "Control of Three Phase BLDC Motor Using Fuzzy Logic Controller", International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181, Vol.2, Issue 7, July 2013.
[10] Bindu V, Unnikrishnan A, Gopikakumari R, "Fuzzy logic based sensorless vector control of Induction motor", IEEE Trans. Ind. Appl., Vol.39, No. 6, Feb 12, 2012.

INTENTIONAL BLANK

DATA MINING THROUGH NEURAL NETWORKS USING RECURRENT NETWORK

Gaurab Tewary

MCA , GGSIPU,New Delhi
tewary.gaurab@gmail.com

ABSTRACT

With the development of database, the data volume stored in database increases rapidly and in the large amounts of data much important information is hidden. If the information can be extracted from the database they will create a lot of profit for the organization. The question they are asking is how to extract this value. The answer is data mining. There are many technologies available to data mining practitioners, including Artificial Neural Networks, Genetics, Fuzzy logic and Decision Trees. Many practitioners are wary of Neural Networks due to their black box nature, even though they have proven themselves in many situations. This paper is an overview of artificial neural networks and questions their position as a preferred tool by data mining practitioners.

KEYWORDS

ANN- Artificial Neural Networks, ESRNN- Extraction of Symbolic Rules from ANN's, data mining, symbolic rules

1. INTRODUCTION

Data mining is the term used to describe the process of extracting value from a database. A data-warehouse is a location where information is stored. The type of data stored depends largely on the type of industry and the company. Following example of a financial institution failing to utilize their data-warehouse. Income is a very important socio-economic indicator. If a bank knows a person's income, they can offer a higher credit card limit or determine if they are likely to want information on a home loan or managed investments. Even though this financial institution had the ability to determine a customer's income in two ways, from their credit card application, or through regular direct deposits into their bank account, they did not extract and utilize this information [1,2]

An artificial neural network (ANN), usually called neural network (NN), is a mathematical model or computational model that is inspired by the structure or functional aspects of biological neural networks. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. ANN is an adaptive system that changes its structure based on external or internal information that flows through the

Sundarapandian et al. (Eds) : ITCCMA, FUZZY, SIGEM, DMDBS, NATL - 2015
pp. 57–74, 2015. © CS & IT-CSCP 2015 DOI : 10.5121/csit.2015.50506

network during the learning phase. They are used to model complex relationships between inputs and outputs or to find patterns in data. Example Facial or Handwriting or Voice Recognition[3].

The Recurrent Structure is also known as Auto associative or Feedback Network, they contain feedback connections Contrary to feed forward neural network. It regards Competitive model etc., and mainly used for associative memory and optimization calculation[5,6].

In this paper we discuss a data mining scheme, referred to as ESRNN (Extraction of Symbolic Rules from ANNs) to extract symbolic rules from trained ANNs. A three-phase training algorithm. In the first and second phases, appropriate network architecture is determined using weight freezing based constructive and pruning algorithms. In the third phase, symbolic rules are extracted using the frequently occurred pattern based rule extraction algorithm by examining the activation values of the hidden nodes[10].

2. INTRODUCTION OF DATA MINING

Data mining is the term used to describe the process of extracting value from a database. A data-warehouse is a location where information is stored. The type of data stored depends largely on the type of industry and the company. Example of a financial institution failing to utilize their data-warehouse is in cross-selling insurance products (e.g. home, life and motor vehicle insurance). By using transaction information they may have the ability to determine if a customer is making payments to another insurance broker. This would enable the institution to select prospects for their insurance products.[1,2]

2.1 Need of Data Mining

Finding information hidden in data is as theoretically difficult as it is practically important. With the objective of discovering unknown patterns from data, Companies have been collecting data for decades, building massive data warehouses in which to store it. Even though this data is available, very few companies have been able to realize the actual value stored in it. The question these companies are asking is how to extract this value. The answer is Data mining[1,2]

2.2 Techniques/Functionalities of Data Mining

There are two fundamental goals of data mining: prediction and description. Prediction makes use of existing variables in the database in order to predict unknown or future values of interest, and description focuses on finding properties that describe the existing data.[3].There are several data mining techniques fulfilling these objectives. Some of these are associations, classifications, sequential patterns and clustering. Another approach of the study of data mining techniques is to classify the techniques as: user-guided or verification-driven data mining and, discovery-driven or automatic discovery of rules.

A. Association Rules:

An association rule is an expression of the form X => Y, where X and Y are the sets of items. The meaning of such a rule is that the transaction of the database, which contains X tends to contain Y. Given a database, the goal is to discover all the rules that have the support and confidence greater than or equal to the minimum support and confidence, respectively.

Support means how often X and Y occur together as a percentage of the total transactions. Confidence measures how much a particular item is dependent on another. Patterns with a combination of intermediate values of confidence and support provide the user with interesting and previously unknown information.

B. Classification Rules:

Classification involves finding rules that partition the data into disjoint groups. The input for the classification data set is the training data set, whose class labels are already known. Classification analyses the training data set and constructs a model based on the class label, and aims to assign class label to the future unlabelled records. Since the class field is known, this type of classification is known as supervised learning. There are several classification discovery models. They are: the decision tree, neural networks, genetic algorithms and some statistical models.

C. Clustering :

Clustering is a method of grouping data into different groups, so that the data in each group share similar trends and patterns. The goal of the process is to identify all sets of similar examples in the data, in some optimal fashion If a measure of similarity is available, then there are a number of techniques for forming clusters. It is an Unsupervised classification.

Heuristic Clustering Algorithm[10]

The process of grouping a set of physical or abstract objects into classes of similar objects is called clustering. A cluster is a collection of data objects that are similar within the same cluster and are dissimilar to the objects in other clusters. A cluster of a data objects can be treated collectively as one group in many applications. There exist a large number of clustering algorithms, such as, k-means, k-menoids. The choice of clustering algorithm depends both on the type of data available and on the particular purpose and applications.

After applying pruning algorithm in ESRNN, the ANN architecture produced by the weight freezing based constructive algorithm contains only important nodes and connections. Therefore, rules are not readily extractable because the hidden node activation values are continuous. The separation of these values paves the way for rule extraction. It is found that some hidden nodes of an ANN maintain almost constant output while other nodes change continuously during the whole training process Figure shows output of three hidden nodes where a hidden node maintains almost constant output value after some training epochs but output value of other nodes are changing continually. In ESRNN, no clustering algorithm is used when hidden nodes maintain almost constant output value. If the outputs of hidden nodes do not maintain constant value, a heuristic clustering algorithm is used.

The aim of the clustering algorithm is to separate the output values of the hidden nodes. Consider that the number of hidden nodes in the pruned network is H. Clustering the activation values of the hidden node is accomplished by a simple greedy algorithm that can be summarized as follows:

1. Find the smallest positive integer d such that if all the network activation values are rounded to d decimal places, the network still retains its accuracy rate

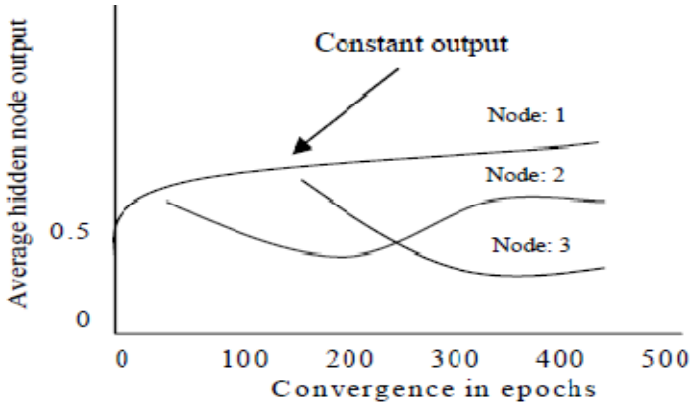


Figure 1. Output of the hidden nodes.

2. Represent each activation value α by the integer closest to α × 10d. Let *Hi* = <*hi,1, hi,2, .., hi,k*> be the k-dimensional vector of these representations at hidden node i for patterns *x1, x2* , . . . , *xk* and let *H* = (*H1, H2, . . . , HH*) be the *k* × *H* matrix of the hidden representations of patterns at all H hidden nodes.

3. Let P be a permutation of the set {*1, 2, . . . , H*} and set *m* = *1*.

4. Set *i* = *P(m).*

5. Sort the values of the ith column (*Hi*) of matrix H in increasing order.

6. Find a pair of distinct adjacent values *hi,j* and *h i,j+1* in *Hi* such that if *h i,j+1* is replaced by *hi,j* no conflicting data will be generated.

7. If such a pair of values exists, replace all occurrences of *i, j 1 h + in* Hi by *i, j h* and repeat Step 6. Otherwise, set *m* = *m+1*. If *m* ≤ *H,* go to Step 4, else stop.

The activation value of an input pattern at hidden node *m* is computed as the hyperbolic tangent function, it will have a value in the range of [−1, 1]. Steps 1 and 2 of the clustering algorithm find integer representations of all hidden node activation values. A small value for *d* in step 1 indicates that relatively few distinct values for the activation values are sufficient for the network to maintain its accuracy.

The array *P* contains the sequence in which the hidden nodes of the network are to be considered. Different ordering sequences usually result in different clusters of activation values. Once a hidden node is selected for clustering, the separated activation values are sorted in step 5 such that the activation values are in increasing order. The values are clustered based on their distance. We implemented step 6 of the algorithm by first finding a pair of adjacent distinct values with the shortest distance. If these two values can be merged without introducing conflicting data, they will be merged. Otherwise, a pair with the second shortest distance will be considered. This process is repeated until there are no more pairs of values that can be merged. The next hidden node as determined by the array *P* will then be considered.

2.3 Challenges of Data Mining

1) The whole Data Mining process consumes a large amount of time.

2) Data Mining is Expensive. .

3) Classification in Data Mining.

4) The whole Data Mining process depends on a proper valid input, without a proper input Data Mining process cannot produce a proper valid output.

3. INTRODUCTION OF NEURAL NETWORKS

An Artificial Neuron is basically an engineering approach of biological neuron. It has device with many inputs and one output. ANN is consist of large number of simple processing elements that are interconnected with each other and layered alsoIn human body work is done with the help of neural network. Neural Network is just a web of inter connected neurons which are millions and millions in number. With the help of this interconnected neurons all the parallel processing is done in human body and the human body is the best example of Parallel Processing. Example Facial or Handwriting or Voice Recognition[6] A neuron is a special biological cell that process information from one neuron to another neuron with the help of some electrical and chemical change. It is composed of a cell body or soma and two types of out reaching tree like branches: the axon and the dendrites. The cell body has a nucleus that contains information about hereditary traits and plasma that holds the molecular equipments or producing material needed by the neurons. The whole process of receiving and sending signals is done in particular manner like a neuron receive signals from other neuron through dendrites. The Neuron send signals at spikes of electrical activity through a long thin stand known as an axon and an axon splits this signals through synapse and send it to the other neurons.[6]

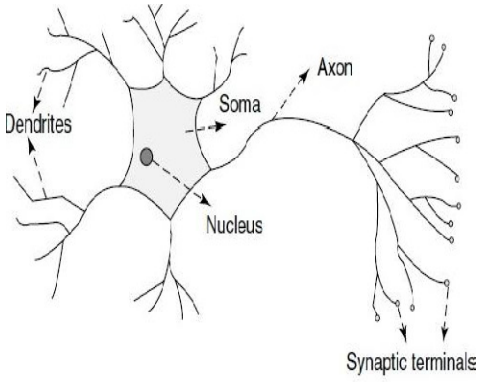


Fig 2 Human Neurons

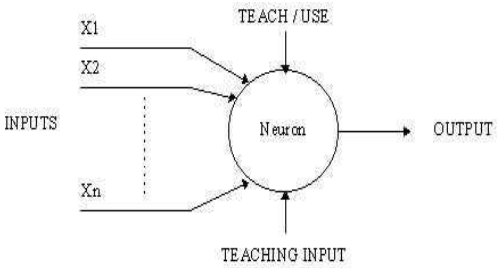


Fig 3 Artificial Neuron

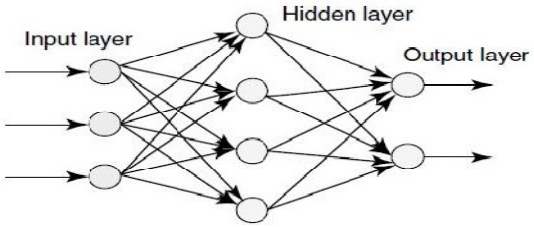


Fig 4 Multilayered ANN

3.1 Characteristics of Neural Networks

The Characteristics are basically those which should be present in intelligent System like robots and other Artificial Intelligence Based Applications. There are six characteristics of Artificial Neural Network which are basic and important for this technology which are showed with the help of diagram:-

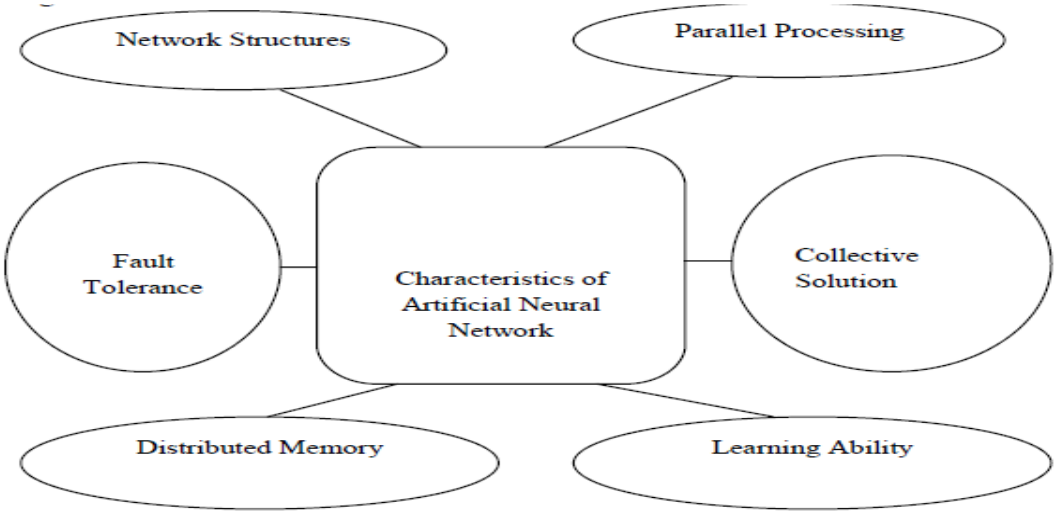


Fig 5 Characteristics

A. The Network Structure:-

There are basically two types of structures recurrent and non recurrent structure. The Recurrent Structure is also known as Auto associative or Feedback Network and the Non Recurrent Structure is also known as Associative or Feed forward Network. In Feed forward Network, the signal travel in one way only but in Feedback Network, the signal travel in both the directions by introducing loops in the network.The Recurrent Structure is also known as Auto associative or Feedback Network, they contain feedback connections Contrary to feed forward neural network. It regards Competitive model etc., and mainly used for associative memory and optimization calculation[5,6].

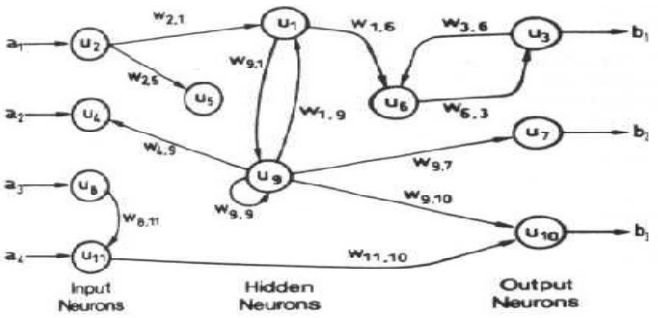


Fig 6 Feed Back Network

Unsupervised Training.[7]

In unsupervised training, the network is provided with inputs but not with desired outputs. The system itself must then decide what features it will use to group the input data. This is often referred to as self-organization or adaption. It is of two types Hebbian & Competitive.

Competitive Networks [6,8]

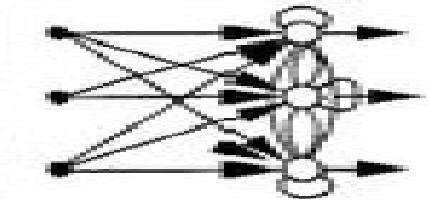


Fig 7 competitive networks

In it output units compete among themselves for activation. As a result, only one output unit is active at any given time. This phenomenon is known as winner-take-all. It has been found to exist in biological neural network. Competitive learning often clusters or categorizes the input data. Similar patterns are grouped by the network and represented by a single unit. This grouping is done automatically based on data correlations. The simplest competitive learning network consists of a single layer of output units.

Hebbian Rule. [8,9]

The oldest learning rule is Hebb's 1earning(1949).Hebb based it on the following observation from neurobiological experiments: If neurons on both sides of a synapse are activated synchronously and repeatedly, the synapse's strength is selectively increased.

The Hebbian rule can be described as

wi(new) = wi(old) + xio,

where *o* is the desired output for

i = 1 to *n(*inputs*).*

An important property of this rule is that learning is done locally,i.e., the change in synapse weight depends only on the activities of the two neurons connected by it.

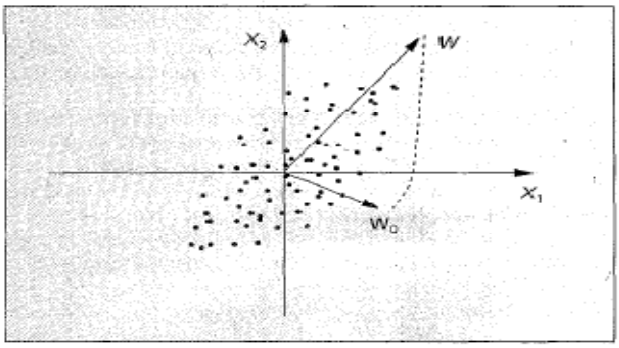


Figure 8. Orientation selectivity of a single neuron trained using the Hebbian rule.

A single neuron trained using the Hebbian rule exhibits an orientation selectivity. Figure 10 demonstrates this property. The weight vector of the neuron is initialized tow, as shown in the figure. As the learning proceeds, the weight vector moves progressively closer to the direction w of maximal variance in the data. In fact, **w** is the eigenvector of the covariance matrix of the data corresponding to the largest eigen value. Unfortunately, plain Hebbian learning continually strengthens its weights without bound (unless the input data is properly normalized).

B. Parallel Processing Ability:-

Parallel Processing is done by the human body in human neurons are very complex but by applying basic and simple parallel processing techniques we implement it in ANN like Matrix and some matrix calculations.

C. Distributed Memory:-

ANN is very huge system so single place memory or centralized memory cannot fulfill the need of ANN system so in this condition we need to store information in weight matrix which is form of long term memory because information is stored as patterns throughout the network structure.

D. Fault Tolerance Ability:-

ANN is a very complex system so it is necessary that it should be a fault tolerant. Because if any part becomes fail it will not affect the system as much but if the all parts fails at the same time the system will fails completely.

E. Collective Solution:-

ANN is a interconnected system the output of a system is a collective output of various input so the result is summation of all the outputs which comes after processing various inputs.

F. Learning Ability:-

In ANN most of the learning rules are used to develop models of processes, while adopting the network to the changing environment and discovering useful knowledge. These Learning methods are Supervised, Unsupervised and Reinforcement Learning.

4. IMPLEMENTATION OF NEURAL NETWORKS IN DATA MINING

Effective Combination of Neural Network and Data Mining Technology:

The technology almost uses the original ANN software package or transformed from existing ANN development tools, the workflow of data mining should be understood in depth, the data model and application interfaces should be described with standardized form, then the two technologies can be effectively integrated and together complete data mining tasks. Therefore, the approach of organically combining the ANN and data mining technologies should be found to improve and optimize the data mining technology.[4]

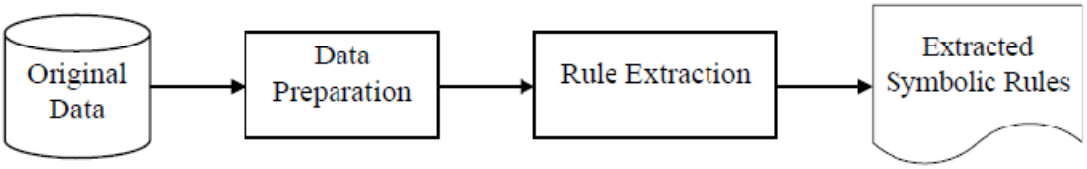


Figure 9. Data mining technique using ANNs.[10,11]

The planned data processing theme consists of two steps: data preparation and rule extraction.

1) Data Preparation

One must prepare quality information by pre-processing the data. The input to the data mining algorithms is assumed to be distributed, containing incorrect values or no missing wherever all options square measure vital. The real-world data could also be noisy, incomplete, and inconsistent, which might disguise helpful patterns. data preparation could be a method of the first information to form it acceptable a particular data mining technique.The data mining using ANNs can only handle numerical data. There are different kinds of attributes that must be representing input and output attributes.

Real-valued attributes square measure sometimes rescaled by some function that maps the value into the range 0…1 or −1…1

Integer-valued attributes square measure most often handled as if they were real-valued. If the amount of various values is only small, one among the representations used for ordinal attributes may additionally be applicable.

Ordinal attributes with m different prices are either mapped onto an equidistant scale creating them pseudo-real-valued or are represented by $m-1$ inputs of that the leftmost k have value 1 to represent the k-th attribute value whereas all others are 0.

5. ANALYSIS OF EXISTING WORK

There are many different approaches for the rule extraction from ANNs that has been developed in the last two decades.[10,11]

Two methods for extracting rules from neural network are described by Towell and Shavlik. The first method is the subset algorithm, which searches for subsets of connections to a node whose summed weight exceeds the bias of that node. The most important downside with subset algorithms is that the price of finding all subsets increases as the size of the ANNs increases. The second method, the M of N algorithm, is an improvement of the set methodology that's designed to expressly seek for M-of-N rules from information based mostly ANNs. Instead of considering an ANN connection, groups of connections are checked for their contribution to the activation of a node, which is done by clustering the ANN connections.

Liu and Tan planned X2R in, an easy and quick algorithmic rule which is be applied to each numeric and discrete data, and generate rules from datasets. It generates good rules within the sense that the error rate of the principles isn't worse than the inconsistency rate found within the original knowledge. The problem of the rules generated by X2R, are order sensitive, *i.e.*, the rules should be fired in sequence.

Afterwards, Setiono presented M of N3, a new method for extracting M-of-N rules from ANNs. The topology of the ANN is the standard three-layered feed forward network. Nodes in the input layer are connected only to the nodes in the hidden layer, while nodes in the hidden layer are also connected to nodes in the output layer. Given a hidden node of a trained ANN with N incoming connections, show how the value of M can be easily computed. In order to facilitate the process of extracting M-of-N rules, the attributes of the dataset have binary values –1 or 1.

The limitations of the existing rule extraction algorithms are summarized as follows:

- Use predefined and fixed number of hidden nodes that require human experience and prior knowledge of the problem to be solved,
- Clustering algorithms used to separate the output values of hidden nodes are not efficient,
- Computationally expensive,
- Could not produce concise rules, and
- Extracted rules are order sensitive.

6. IMPLEMENTATION OF ESRNN IN NEURAL NETWORKS

Although Artificial Neural Networks (ANNs) have been successfully applied in a wide range of machine learning applications, they are often regarded as “black box”, that means predictions cannot be explained. To enhance the explanation of neural network, a novel algorithm is used known as ESRNN (Extraction of Symbolic Rules from ANNs) to extract symbolic rules from trained ANNs.[10,11]

Extracting symbolic rules from trained ANN is one of the promising areas that are commonly used to explain the functionality of neural network. It is difficult to find the explicit relationship between the input tuples and the output tuples. A number of reasons contribute to the difficulty of extracting rules from a pruned network.

First, even with a pruned network, the links may be still too many to express the relationship between an input tuples and its class label in the form of *if* . . . *then* ... rules. If a network still has *n* input links with binary values, there could be as many as 2, distinct input patterns. The rules could be quite lengthy or complex even for a small *n.*

Second, a standard ANN is the basis of the proposed ESRNN algorithm. The hyperbolic tangent function, which may take any worth in the interval [−1, 1] is used as the hidden node activation function. Rules are extracted from near optimal neural network by using a new rule extraction algorithm. The aim of ESRNN is to search for simple rules with high predictive accuracy.

The major steps of ESRNN are summarized in Figure:

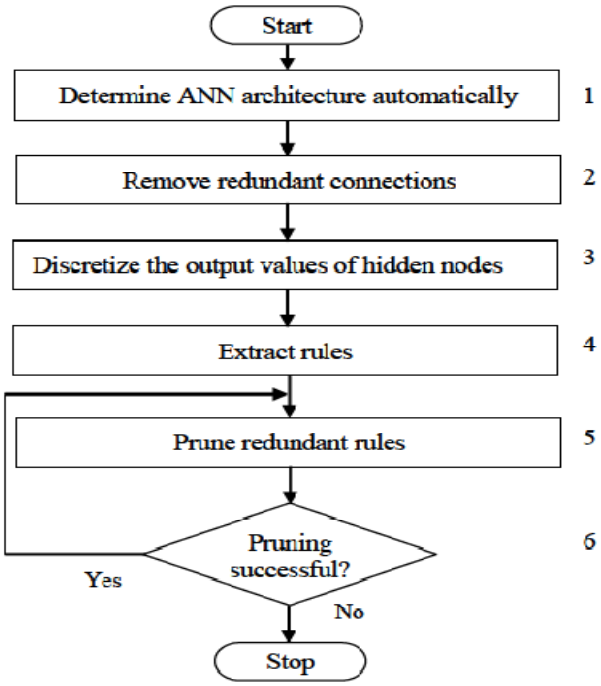


Figure 10. Flow chart of the proposed ESRNN algorithm.

The rules extracted by ESRNN are compact and understandable, and do not involve any weight values. The accuracy of the principles from pruned networks is as high because the accuracy of the original networks. The important features of the ESRNN algorithm are the principles extracted by rule extraction algorithm is recursive in nature and is order insensitive, that is the rules need not to be required to fire sequentially.

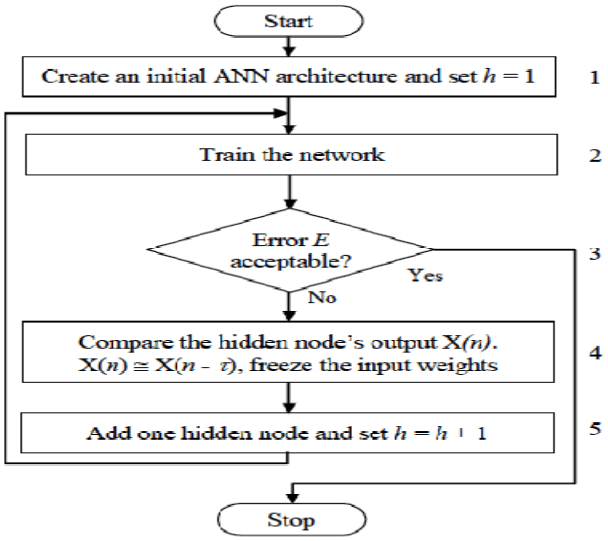
6.1 Weight Freezing Based Constructive Algorithm[10,11]

One drawback of the traditional back propagation algorithm is the need to determine the quantity of nodes within the hidden layer prior to training. To beat this issue, several algorithms that construct a network dynamically have been proposed such as DNC,FNNC,CC. However, it is impractical to urge 100% classification accuracy for many of the benchmark classification issues. & higher classification accuracy on the coaching set does not guarantee the higher generalization ability that is classification accuracy on the testing set. The training time is an important issue in designing neural network. One approach for reducing the quantity of weights to be trained is to train few weights rather than all weights during a network and keep remaining weights mounted, commonly referred to as weight freezing.

The thought behind the weight freezing-based constructive algorithm is to freeze input weights of a hidden node once its output does not modification abundant within the consecutive few training epochs. This weight freezing method should be considered as combination of the two extremes: for training all the weights of neural network and for training the weights of only the newly added hidden node of ANNs. In algorithm, it has been proposed that the output of a hidden node can be frozen when its output does not change much in the successive training epochs. The major steps of weight freezing based constructive algorithm are :

Figure 11

Flow chart of the weight freezing based constructive algorithm.



6.2 Pruning Algorithm[10,11]

The pruning algorithm aims at removing redundant links and units without increasing the classification error rate of the network. A small quantity of units and links left in the network after pruning enable us to extract concise and comprehensible rules. Pruning offers an approach for dynamically determinant associate degree acceptable constellation. Pruning techniques begin by training a larger than necessary network and then eliminate weights and nodes that are deemed redundant. The nodes of the hidden layer are determined by weight freezing based constructive

algorithm, the aim of this pruning algorithm used here is to get rid of as several supernumerary nodes and connections as potential. A node is pruned if all the connections to and from the node are pruned. Typically, ways for removing weights from the network involve adding a penalty term to the error function. It is hoped that by add a penalty term to the error function, supernumerary connections can have small weights, and thus pruning will reduce the complexity of the network considerably. The simplest and most commonly used penalty term is the sum of the squared weights. It has been suggested that faster convergence can be achieved by minimizing the cross entropy function instead of squared error function. This pruning algorithm removes the connections of the ANN according to the magnitudes of their weights. As the eventual goal of the ESRNN algorithm is to get a set of simple rules that describe the classification method, it's vital that every one uncalled-for nodes and connections should be removed. In order to get rid of several connections as possible, the weights of the network should be prevented from taking values that are too large. At an equivalent time, weights of irrelevant connections ought to be inspired to converge to zero. The penalty function is appropriate for these purposes.

The steps of the pruning algorithm are explained as follows:

- **Step 1** Train the network to meet a Pre-specified accuracy level with the condition satisfied by all correctly classified input patterns.

$$\max_{p} \left| e_{pi} \right| = \max_{p} \left| S_{pi} - t_{pi} \right| \leq \eta_1, \; p = 1, 2, \ldots, C. \tag{1}$$

  Let n1 and n2 be positive scalars such that (n1 + n2) < 0.5 (n1 is the error tolerance, n2 is a threshold that determines if a weight can be removed), where n1 [0, 0.5). Let (*w*, *v*) be the weights of this network.

- **Step 2** Remove connection between input nodes and hidden nodes, and also remove connection between hidden nodes and output nodes. The task is accomplished in two phases. In first phase, connection between input nodes and hidden nodes are removed. For each *ml w* in the network, if

$$\max_{p} \left| v_{pm} w_{ml} \right| \leq 4\eta_2, \tag{2}$$

  then remove *ml w* from the network. In the second phase, connections between hidden nodes and output nodes are removed. For each *pm v* in the network, if

$$\left| v_{pm} \right| \leq 4\eta_2 \leq 4\eta_2, \tag{3}$$

  then remove *pm v* from the network.

- **Step 3** Remove connections between input nodes and hidden nodes further. If no weight satisfies condition (2) or condition (3), then for each *ml w* in the network,

$$w_{ml} = \max_{p} \left| v_{pm} w_{ml} \right| \quad (4)$$

Remove *ml w* with smallest *ml w* . Continue, otherwise stop.

- **Step 4** Train again the network and calculating accuracy of the network in classification.
- **Step 5** If classification accuracy of the network falls below an appropriate level, then stop and use the previous setting of the network weights. Otherwise, head to **Step 2**.

6.3 (RE) Rule Extraction Algorithm[10,11]

Classification rules are sought in several areas from automatic knowledge acquisition to data mining and neural network rule extraction because some of their attractive options. They are understandable, explicit and verifiable by domain consultants, and may be modified, extended and passed on as standard knowledge. The rule extraction algorithm, will be applied to each numeric and discrete data, consist of three major functions:

a) Rule Extraction(RE): This function initialize the extracted rule list to be empty and sorts the examples according to example frequency. Then it picks the frequent occurring example as the base to generate a rule then it will add the rule to the list of extracted rules. Then it find all the example, that are covered by the rule and remove from the example space. It will repeats the above process iteratively and continuously adds the extracted rules to the rule list until the example space becomes empty.

b) Rule Clustering: The rules are clustered in terms of their category levels. Rules of the same category are clustered together as one group of rules.

c) Rule Pruning: Redundant(repeat) or more specific rules in each cluster are removed. In every clusters, more than one rule may cover the same example. For examples, the rule "if (color = green) and (height < 4) then grass" is already contained in a more general rule "if (color = green) then grass", and thus the rule "if (color = green) and (height < 4) then grass" is redundant. Rule extraction eliminates these redundant rules in each cluster to further reduce the size of the best rule list.

The steps of the rule extraction(RE) algorithm are explained as follows:

• **Step 1** Extract Rule
The core of this step contains greedy algorithm that finds the shortest rule based on the primary order information, which may differentiate the pattern into consideration from the patterns of alternative classes. It then extracts shortest rules and take away the patterns covered by every rule until all patterns are coated by the rules.

• **Step 2** Cluster Rule: Cluster rules according to their category levels. Rules extracted in Step one are grouped in terms of their class levels.

• **Step 3** Prune Rule: Replace specific rules with more general ones; Remove noise rules; Eliminate redundant rules;

• **Step 4** Check whether all patterns are coated by any principle on extraction. If affirmative then stop, otherwise continue.

• **Step 5** Determine a default rule on extraction. A default rule is chosen if no rule can be applied to a pattern.

7. PERFORMANCE EVALUATION[10,11]

This section evaluates the performance of the ESRNN algorithm on a set of well-known classification problems including diabetes, wine, iris that are widely used in data mining research and machine learning. The datasets representing all the issues were real world data.

7.1 Dataset Description

This section briefly describes the datasets utilized in this study. The datasets are summarized

Table 1. Characteristics of datasets.

Sl No.	Datasets	No. of Examples	Input Attributes	Output Classes
1	Diabetes	768	8	2
2	Iris	150	4	3
3	Wine	178	13	3
4	Season	11	3	4
5	Golf Playing	14	4	2
6	Lenses	24	4	3

The diabetes dataset*:* The Pima Indians Diabetes information consists of 768 data pairs with eight attributes normalized between zero and one. The eight attributes are number of pregnancies (*A*1), plasma glucose concentration (*A*2), blood pressure (*A*3), triceps skin fold thickness (*A*4), Two hour serum insulin (*A*5), body mass index (*A*6), diabetes pedigree function (*A*7), and age (*A*8). In this database, 268 instances are positive (output equals 1) and 500 instances are negative (output equals 0).

The iris dataset*:* This is perhaps the best known database to be found within the pattern recognition literature. The set contains three classes of fifty instances each, where every class refers to a type of Iris plant. 4 attributes are used to predict the iris class, *i.e.*, sepal length (*A*1), sepal width (*A*2), petal length (*A*3), and petal width (*A*4), all in centimetres. Among the 3classes, class one is linearly separable from the other two classes, and classes two and three are not linearly separable from one another. To ease data extraction, we reformulate the data with three outputs, where class 1 is represented by{1, 0, 0}, class 2 by{0, 1, 0},and class 3 by{0, 0,1}.

The season data*:* The season dataset contains separate data only. There are eleven examples within the dataset, every of that consisted of three-elements. These are tree, weather and temperature. This was a four-class problem.

The golf playing data*:* The golf playing dataset contains both numeric and discrete data. There are 14 examples in the dataset, each of which consisted of four-elements. These are outlook, temperature, humidity and wind. This is a two-class problem.

7.2 Extracted Rules

The number of rules extracted by ESRNN algo. and the accuracy of the rules is Presented here in table.

Number of extracted rules and rules accuracies.

Sl No.	Datasets	No. of Extracted Rules	Accuracy
1	Diabetes	2	76.56%
2	Iris	3	98.67%
3	Wine	3	91.01%
4	Season	4	100%
5	Golf Playing	3	100%
6	Lenses	8	100%

The diabetes data

Rule 1: If Plasma glucose concentration (*A*2) <= 0.64 and Age (*A*8) <= 0.69 then tested negative.
Default Rule: tested positive.

The iris data

Rule 1: If Petal-length (*A*3) <= 1.9 then iris setosa
Rule 2: If Petal-length (*A*3) <= 4.9 and Petal-width (*A*4) <= 1.6 then iris versicolor
Default Rule: iris virginica.

The season data

Rule 1:If Tree (A2) = yellow then autumn
Rule 2:If Tree (A2) = leafless then autumn
Rule 3:If Temperature(A3) = low then winter
Rule 4:If Temperature(A3) = high then summer
Default Rule: spring.

The golf playing data:

Rule 1: If Outlook (A1) = sunny and Humidity >=85 then don't play
Rule 2: Outlook (A1) = rainy and Wind= strong then don't play
Default Rule: play.

7.3 Performance Comparisons[10]

This section compares experimental results of the ESRNN algorithm with the results of other works. The primary aim of this work is not to evaluate ESRNN in order to gain a deeper understanding of rule generation without an exhaustive comparison between ESRNN and all other works. Table 1 compares ESRNN results of the diabetes data with those produced by PMML, NN RULES, C4.5 , NN-C4.5 , OC1 , and CART algorithms. ESRNN achieved 76.56% accuracy although NN-C4.5 was closest second with 76.4% accuracy. Due to the high noise level, the diabetes problem is one of the most challenging problems in our experiments. ESRNN has outperformed all other algorithms.

Performance comparison of the ESRNN with other algorithms for the diabetes data.

Dataset	Feature	ESRNN	PMML	NN RULES	C4.5	NN-C4.5	OC1	CART
Diabetes	No. of Rules	2	2	4	–	–	–	–
	Avg. No. of Conditions	2	1	3	–	–	–	–
	Accuracy (%)	76.56	75	76.32	70.9	76.4	72.4	72.4

Table 2 compares ESRNN results of the iris data with those produced by PMML , NN RULES , DT RULES , BIO RE , Partial RE , and Full RE algorithms. ESRNN achieved 98.67% accuracy although NN RULES was closest second with 97.33%accuracy. Here number of rules extracted by ESRNN and NN RULES are equal.

Performance comparison of the ESRNN algorithm with other algorithms for the irish data.

Dataset	Feature	ESRNN	PMML	NN RULES	DT RULES	BIO RE	Partial RE	Full RE
Irish	No. of Rules	3	3	3	4	4	6	3
	Avg. No. of Conditions	1	1	1	1	3	3	2
	Accuracy (%)	98.67	91.3	97.33	94.67	78.67	78.67	97.33

Table 3 compares the ESRNN results of the season data with those produced by RULES and X2R . All three algorithms achieved 100% accuracy. This is possible because the number of examples is low. ESRNN extracted five rules, whereas RULES extracted seven and X2R six.

Performance comparison of ESRNN with other algorithms for season data.

Dataset	Feature	ESRNN	RULES	X2R
Season	No. of Rules	5	7	6
	Avg. No. of Conditions	1	2	1
	Accuracy (%)	100	100	100

Table 4 compares ESRNN results of golf playing data with those produced by RULES , RULES-2 , and X2R [25]. All four algorithms achieved 100% accuracy because the lower number of examples. Number of extracted rules by ESRNN are 3 whereas these were 8 for RULES and14 for RULES-2.

Performance comparison of ESRNN with other algorithms for golf playing data.

Dataset	Feature	ESRNN	RULES	RULES-2	X2R
Golf Playing	No. of Rules	3	8	14	3
	Avg. No. of Conditions	2	2	2	2
	Accuracy (%)	100	100	100	100

8. CONCLUSION

In this paper, We present research on data mining based on neural network. At present, data mining is a new and important area of research, and neural network itself is very suitable for solving the problems of data mining because its characteristics of good robustness, self-organizing adaptive, parallel processing, distributed storage, high degree of fault tolerance & network structure i.e. recurrent network. The combination of data mining and neural network can greatly improve the efficiency of data mining, and it has been widely used & we have presented

neural network based data mining scheme to mining classification rules from given databases. This work is an attempt to apply the approach to data mining by extracting symbolic rules. An important feature of the rule extraction algorithm is its recursive nature. A set of experiments was conducted to test the approach using a well defined set of data mining problems. The results indicate that, using the approach, high quality rules can be discovered from the given data sets. The extracted rules are concise, comprehensible, order insensitive, and do not involve any weight values. The accuracy of the rules from the pruned network is as high as the accuracy of the fully connected networks. Experiments showed that this method helped a lot to reduce the number of rules significantly without sacrificing classification accuracy. In almost all cases ESRNN outperformed the others. With the rules extracted by the method here, ANNs should no longer be regarded as black boxes. Since, black boxes are diminished & more researchers use them. Thus, neural networks are becoming very popular with data mining practitioners.

REFERENCES

[1] M. Charles Arockiaraj "Applications of Neural Networks In Data Mining", Arakkonam, (Research Inventy: International Journal Of Engineering And Science Vol.3, Issue1),May 2013.

[2] Dr. Yashpal Singh ,Alok Singh Chauhan "Neural Networks In Data Mining", India, (Journal of Theoretical and Applied Information Technology)2005.

[3] K. Amarendra, K.V. Lakshmi & K.V. Ramani "Research on Data Mining Using Neural Networks" , India

[4] Xianjun Ni "Research of Data Mining based on Neural Networks" ,China , (World Academy of Science, Engineering and Technology Vol:2) ,2008.

[5] Sonalkadu, Prof.Sheetal Dhande "Effective Data Mining Through Neural Network", (International Journal of Advanced Research in Computer Science and Software Engineering Volume 2, Issue 3) ,March 2012

[6] Vidushi Sharma ,Sachin Rai ,Anurag Dev "A Comprehensive Study of Artificial Neural Networks", India (International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 10) ,October 2012

[7] Ms. Sonali. B. Maind ,Ms. Priyanka Wankar "Research Paper on Basic of Artificial Neural Network", Wardha ,(International Journal on Recent and Innovation Trends in Computing and Communication Volume: 2 Issue: 1),January 2014.

[8] Ani1 K. Jain, Jianchang Mao, K.M. Mohiuddin "Artificial Neural Networks : A Tutorial" , Michigan ,March 1996

[9] Ajith Abraham "Artificial Neural Networks" Oklahoma State University, Stillwater, USA 2005.

[10] S. M. Kamruzzaman and A. M. Jehad Sarkar "A New Data Mining Scheme Using Artificial Neural Networks", Korea , 28 April 2011.

[11] Mrs.Maruthaveni.R, Mrs. Renuka Devi.S.V " Efficient Data Mining For Mining Classification Using Neural Network"(International Journal Of Engineering And Computer Science Volume 3 Issue 2) February , 2014.

AUTHORS

The author Gaurab Tewary is an MCA from Northern India Engineering College, New Delhi. Under GGSIP University, New Delhi.

FACEBOOK IMPLEMENTATION IN DEVELOPING ENGLISH WRITING SKILS : A CASE STUDY OF FIRST YEAR STUDENTS PROGRAM IN ENGLISH FOR INTERNATIONAL COMMUNICATION (EIC) AT RAJAMANGALA UNIVERISITY OF TECHNOLOGY ISAN, (RMUTI), SURIN CAMPUS

Pisutpong Endoo

Linguistics Department, Faculty of Management Technology, Rajamangala University of Technology Isan, Surin Campus, Thailand
http://www.surin.rmuti.ac.th/surin
guy_promise@hotmail.com

ABSTRACT

The objectives of this were research to study FB implementation and attitudes in developing English writing skills of the first year students program in EIC academic year 1/2014 at RMUTI, Surin Campus. The Purposive sampling was designed for data collecting. There were 53 students studying of the first year program in EIC academic year 1/2014 at RMUTI, Surin Campus. The instruments for this research were questionnaires. The data analysis was analyzed by the Descriptive statistics to find out the value of the frequency and percentage.

KEYWORDS

Facbook, implementation, attitudes, writing Skills

1. INTRODUCTION

At the present, internet is very influential and important for the people until it becomes their part of life. It is used for education, working, communication, entertainment, and recreation etc. Internet is telecommunication system connecting with all computers in order to communicate between internet users. It can be said that now it is the widest network [1]. The communication is connection between messengers consisting of remained context or information with message receivers via online social network system. Messengers and message receivers belong to this network. Now this system has continuously grown in the Thai society and international countries; for example, FB, Twitter, YouTube, Google Plus, Instagram etc. All of these have become new media and source used for information searching [2].

Sundarapandian et al. (Eds) : ITCCMA, FUZZY, SIGEM, DMDBS, NATL - 2015
pp. 75–86, 2015. © CS & IT-CSCP 2015 DOI : 10.5121/csit.2015.50507

With the modern technology innovated very quickly and lifestyle of the city people, it has changed very much. Most of people use technology all the time. They can very easily used internet to share new update knowledge and to communicate with freedom through the social network. FB is a part of those networks used for communication. It is very popular network because it can be used with the both synchronous activities and none synchronous activities. FB can be also used for supporting knowledge activities for teachers [3]. Social network had originated since 1969 and become very popular for American teenagers since 1997. Later members of users have continuously increased until now there are 85 % of the population around the world can access the social network system especially FB [4]. FB was found by Mark Zuckerburg with his close friends, Dustin Moskowitz and Christ Hughes on February 4, 2004. It was released for general users in 2006 and in 2010 there were users about 400 billion per a month and become the biggest online social network in the world now [5].

According to the survey of FB usage in Thailand, it was found that there were Thai people used it 16.1 million in 2008 [2]. A group very much used FB was the both male and female teenagers during 18-25 years old, and the later the both male and female adults during 26-34 years old respectively. However, the teenagers during 13-17 years old were the most skillful in digital technologies. Now FB has becomes very necessary network and main factor in the university. The students, teachers and other staffs have own account users and they access it to search information and use it for class teaching implementation [6]. FB network system is very easy to use and has varieties of functions implemented for working and teaching in the university. With this reason, it becomes very impact for staffs in the university [2].

Regarding to the information above, so the researcher was interested to study FB Implementation in Developing English Writing Skills: A Case Study of First Year Students Program in EIC academic Year 1/2014 at RMUTI, Surin Campus. The objectives of this study aimed to study FB implementation and attitudes in developing English writing skills of the first year students program in EIC academic year 1/2014 at RMUTI, Surin Campus.

2. MEDOLOGY

This research was class research. The objectives of this were research to study FB implementation and attitudes in developing English writing skills of the first year students program in EIC academic year 1/2014 at RMUTI, Surin Campus. The Purposive sampling was designed for data collecting. There were 53 students studying of the first year program in EIC academic year 1/2014 at RMUTI, Surin Campus. The instruments for this research were questionnaires. The questionnaire was divided into three parts consisted of part 1: The General demographics of population, Part 2: FB implementation in developing English writing skills of population and Part 3: Attitudes on FB implementation in developing English writing skills and recommendation of population. The data analysis was analyzed by the Descriptive statistics to find out the value of the frequency and percentage.

3. RESULTS & DISCUSSION

3.1. Results of the Study

From the study, the findings were found as these followings:

Figure 1: General demographics of population's age

The bar graph 1 showed the general demographics of population's age. There were 94.3 % of populations during 18-20 years old, 3.8 % of population during 21-23 years old and 1.9 % of population during 21-23 years old. There were not students during over 26 years old.

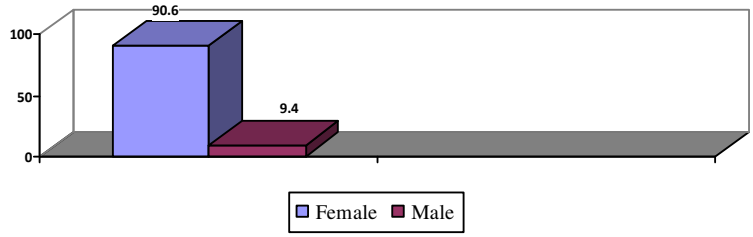


Figure 2: General demographics of population's sex.

The bar graph 2 showed the general demographics of population's sex. 90.6 % of populations were female and 9.4 of populations were male respectively.

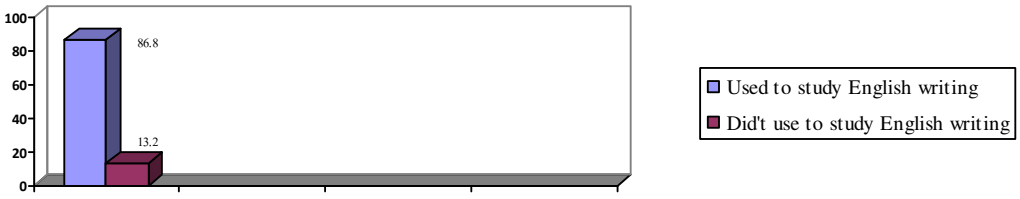


Figure 3: Experiences studying English writing

The bar graph 3 showed result of FB implementation in developing English writing skills of population about the experiences studying English writing at former school before they become the students in the university. According to this bar graph, there were 86.6 % of populations used to study English writing and 13.2 % of populations did not study English writing before respectively.

Figure 4: Populations' English writing capability

The bar graph 4 showed result of FB implementation in developing English writing skills of population about the populations' English writing capability. According to this bar graph, 60.4 % was fair, 37.7 % was good and 1.9 % was very good in English writing capability respectively.

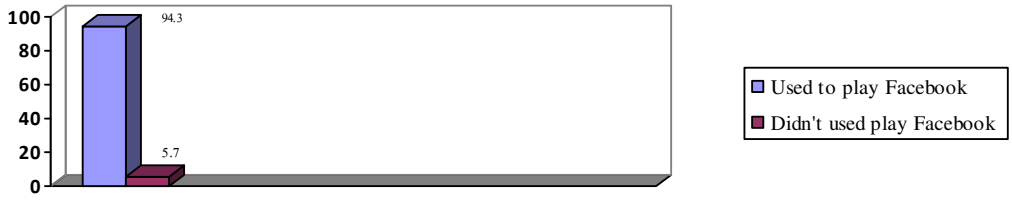


Figure 5: Experiences of playing FB

The bar graph 5 showed result of FB implementation in developing English writing skills of population about the experiences of playing FB at former school before they become the students in the university. According to this bar graph, there were 94.3 % of populations used to play FB and 5.7 % of populations did not use FB before respectively.

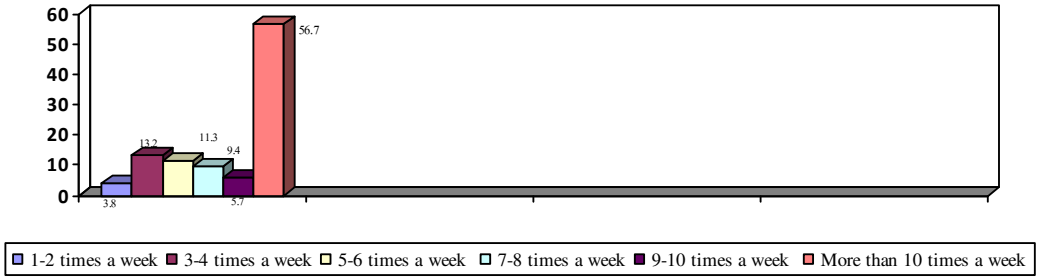


Figure 6: The frequency of FB playing

The bar graph 6 showed result of FB implementation in developing English writing skills of population about the frequency of FB playing per a week. According to this bar graph, there were three highest level identified the frequency of FB playing per a week. There were 56.7 % of populations identified that they played FB more than 10 times a week, 13.2 % played 3-4 times a week, 11.3 % played 5-6 times a week used to play FB and 5.7 % of populations did not use FB before respectively.

Figure 7: The place of population's FB playing

The bar graph 7 showed result of FB implementation in developing English writing skills of population about the place of population's FB playing. According to this bar graph, there were

three highest level identified the place of FB playing. There were 83.7 % of populations identified that they played FB through their private mobile phone, 15.1 % played internet at their houses and 1.9 % played at internet café.

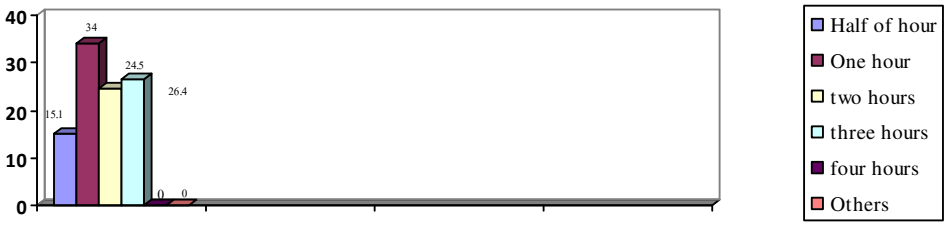


Figure 8: Number of hours of populations' playing FB

The bar graph 8 showed result of FB implementation in developing English writing skills of population about number of hours the population played FB. According to this bar graph, there were three highest level identified the number of playing FB of populations. There were 34.7 % of populations identified that they played FB one hour a time, 26.4 % played FB 3 hours a time and 24.5 % played FB 2 hours a time respectively.

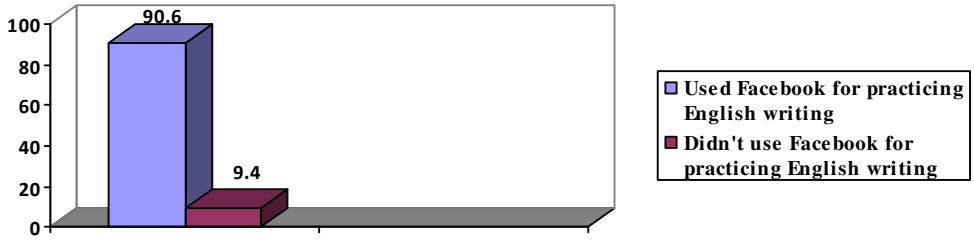


Figure 9: Using Fecebook for practicing English writing

The bar graph 9 showed result of FB implementation in developing English writing skills of population about using Fecebook for practicing English writing. According to this bar graph, there were 90.6 % of populations identified that they used FB for practicing English writing and 9.4 % didn't use it for practicing English writing respectively.

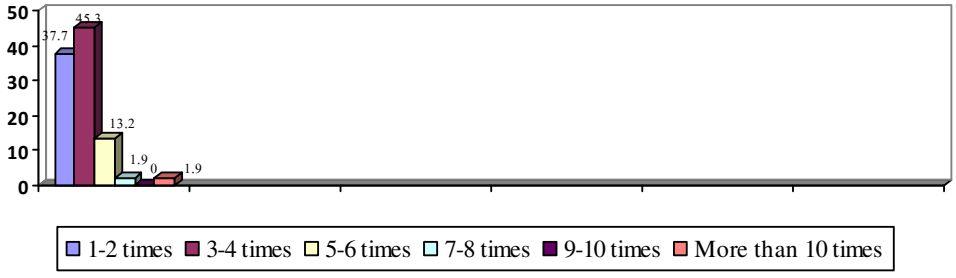


Figure 10: The number of time using FB implementation in developing English writing skills per a week

The bar graph 10 showed result of FB implementation in developing English writing skills of population about the number of time using FB implementation in developing English writing

skills per a week. According to this bar graph, there were three highest level identified the number of time using FB implementation in developing English writing skills of populations per a week. There were 45.3 % of populations identified that they played FB 3-4 times a week, 37.7 % played if 1-2 times a week and 13.2 % played it 5-6 times a week respectively.

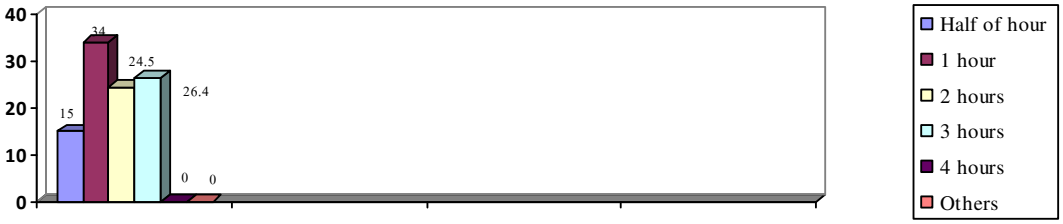


Figure 11: The number of hours using FB implementation in developing English writing skills per a week.

The bar graph 11 showed result of FB implementation in developing English writing skills of population about the number of hours using FB implementation in developing English writing skills per a week. According to this bar graph, there were three highest level identified the number of hours using FB implementation in developing English writing skills of populations per a week. There were 34 % of populations identified that they played FB 1 hour a week, 26.4% played it 3 hours a week and 24.5 % played 2 it per a week respectively.

Figure 12: FB implementation in developing populations' English writing skills

The bar graph 12 showed result of FB implementation in developing English writing skills of population can develop English writing skills. According to this bar graph, there were 50.9 % of populations agreed with using FB implementation can develop English writing skills, 41.5 % didn't agree with this and 7.5 % was unsure respectively.

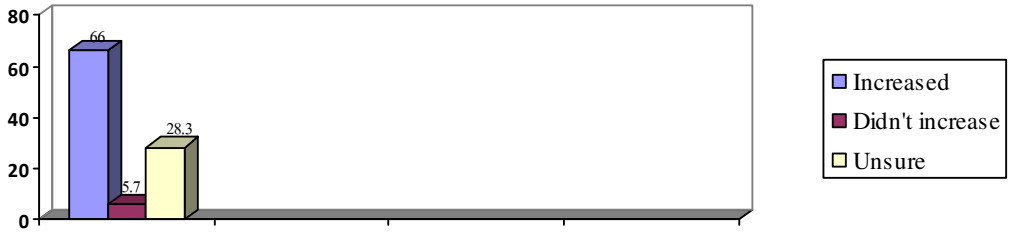


Figure 13: Increasing capability of English punctuation skill

The bar graph 13 showed result of FB implementation in developing English writing skills of population can increase the capability of English punctuation skill. According to this bar graph, there were 66 % of populations increased, 28.3% was unsure and 5.7 didn't increase the capability of English punctuation skill respectively.

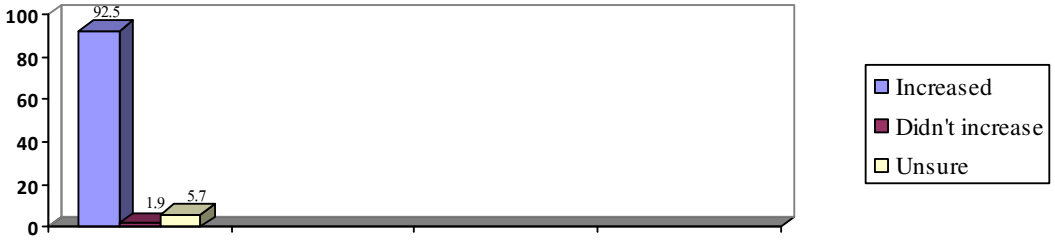


Figure 14: Increasing new English vocabularies

The bar graph 14 showed result of FB implementation in developing English writing skills of population can increase new English vocabularies. According to this bar graph, there were 92.5 % of populations increased, 5.7% was unsure and 1.9 % didn't increase the capability of new English vocabularies respectively.

Figure 15: Practice to use the English structures of Tense

The bar graph 15 showed result of FB implementation in developing English writing skills of population can practice using the English structures of Tense. According to this bar graph, there were both 39.6 % agree and disagree with this point and 20.8 % was unsure respectively.

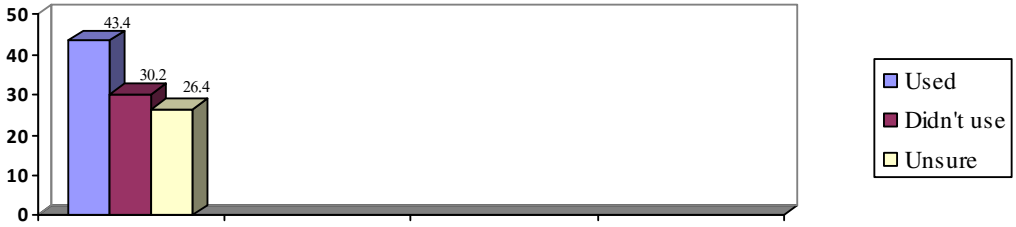


Figure 16: Spelling Check while FB implementation in developing English writing skills

The bar graph 16 showed result of using Spelling Check while FB implementation in developing English writing skills of population. According to this bar graph, there were 43.4 % used it, 30.2 % didn't used it and 26.4 % was unsure respectively.

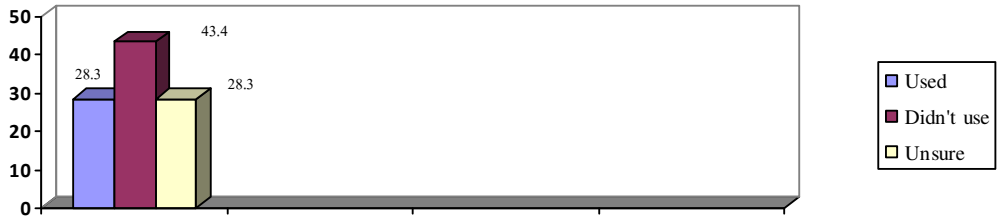


Figure 17: Using Grammar Check

The bar graph 17 showed result of using Grammar Check while FB implementation in developing English writing skills of population. According to this bar graph, there were 43.4 % didn't use it, 28.3 % used it and 28.3 % was unsure respectively.

Figure 18: using Dictionary Check

The bar graph 18 showed result of using Dictionary Check while FB implementation in developing English writing skills of population. According to this bar graph, there were 67.9 % used it, 17 % didn't use it and 15.1 % was unsure respectively.

Figure19: Using new modern technology skill

The bar graph 19 showed result of FB implementation in developing English writing skills of population can increase using new modern technology skill. According to this bar graph, there were 86.8 % of populations increased, 11.3% didn't increase and 1.9 % was sure respectively.

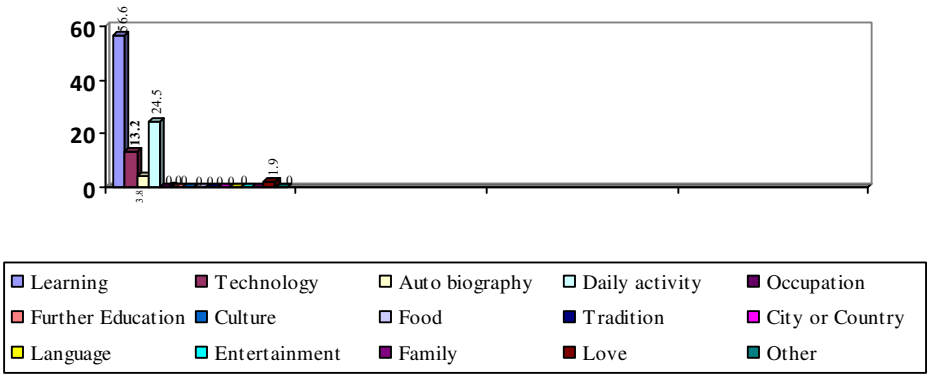


Figure 20: Used topics for FB implementation in developing English writing skills

The bar graph 20 showed result of type of topics the populations used FB implementation in developing English writing skills per a time. According to this bar graph, there were three highest topics the populations used FB implementation in developing English writing skills of populations. There were 56.6 % of populations identified that they liked to write about Learning, 24.5 % about Daily Activity and 13.2 % about Technology respectively.

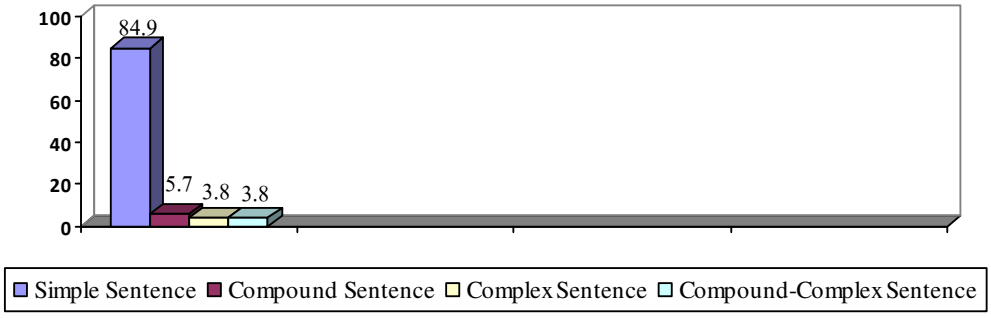


Figure 21: Types of sentences which were very often used

The bar graph 21 showed result of sentences types the populations very often used FB implementation in developing English writing skills of population per a time. According to this bar graph, there were three highest sentence types the populations very often used FB implementation in developing English writing skills. There were 84.9 % of populations very often used Simple sentence, 5.6 % used Compound Sentence and 3.8 % used Complex Sentence and Compound-Complex Sentence respectively.

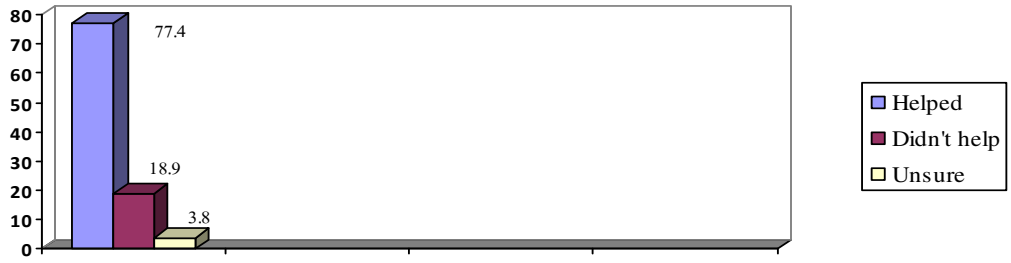


Figure 22: FB can develop English writing skills

The bar graph 22 showed result of attitudes on practicing English writing through FB can develop English writing skills. According to this bar graph, there were 77.4 % of populations could help, 18.9 % couldn't help and 3.8 % was unsure that practicing English writing through FB could develop English writing skills.

Figure 23: FB helped to like better English writing

The bar graph 23 showed result of attitudes on practicing English writing through FB helped to like better English writing. According to this bar graph, there were 77.4 % of populations helped, 7.5 % couldn't help and 15.1 % was unsure that practicing English writing through FB could help them like English writing.

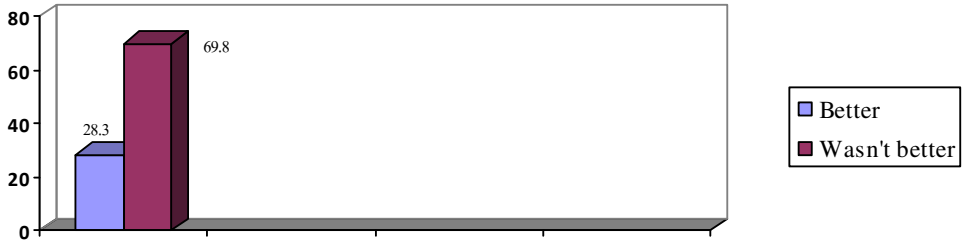


Figure 24: Practicing English writing through FB was better than practicing English writing with handwriting

The bar graph 25 showed result of attitudes on practicing English writing through FB was better than practicing English writing with handwriting. According to this bar graph, there were 69.8% of populations felt that it wasn't better and 28.3 % felt that practicing English writing through FB wasn't better than practicing English writing with handwriting

4.2 Discussion of the Result Study

According to results of the study, there was some point not relative with the research found by some scholar such as Supasapon's research [5]. She studied Secondary School Students' Internet Consuming Behavior in Daily Life: A Study of Traim-Udom Patanakarn School and found that most students used internet at their home spending 2 hours a time. However, this research was found that most populations used for this study used smart phones or their private mobile phones and spent an hour per time. There were 34 % of all populations used for this study.

Another very important point, most populations used for this study didn't agree with practicing English writing through FB network can be better skill than practicing it with their hand writing. From this result, it made us know that most students like to practice English writing with handwriting better than practicing writing through Fecebook network. There were 69.8 of all populations identified and supported this idea.

Lastly 92.5 % of populations identified that they were very confident and believable that FB implementation in developing English writing could increase new English vocabularies and they could receive a lot of knowledge in English. By the way this FB implementation will develop their English writing skill in the future.

5. CONCLUSION

There were 53 students studying of the first year program in EICacademic year 1/2014 at RMUTI, Surin Campus. The instruments for this research were questionnaires. They were 90.6 % of female and 9.4 % of male. Most of their age was during 18-20 years old. The data analysis was analyzed by the Descriptive statistics to find out the value of the frequency and percentage.

The findings were found these followings:

1. The overall result of FB implementation in developing English writing skills of the first year students program in EICacademic year 1/2014 at RMUTI, Surin Campus was found that the background of FB implementation before being the students in the university was at the highest level (94.3 %), the later was FB implementation in developing English writing made the students learn new English vocabularies (92.5%) and FB implementation in developing English writing made the students improve English writing skill (90.6 %) respectively.

2. The overall result of attitudes on FB implementation in developing English writing skills of the first year students program in EICacademic year 1/2014 at RMUTI, Surin Campus was found that the students agreed that the FB implementation in developing English writing skills could improve their English writing skill, the later was FB implementation in developing English writing skills was better than practical writing through books (69.8%) and were at the highest level (77.4%), the FB implementation in developing English writing skills could integrate tense study in the future (37.7 %) respectively.

6. RECOMMENDATION

In a brief suggestion, although this research is completed, there are many interesting points to do the future research. And this research is only the first step to receive the basic data about the population. This will lead to create next lessons for them to practice English though Feacbook.

ACKNOWLEDGEMENTS

This work was supported by Rajamangala University of Technology Isan (RMUTI) funding academic year 2014. I would like to say a lot of thanks for this university's financial support.

REFERENCES

[1] Wimonpun and group,(2011) Communication Behavior on FB of Students at Rajamangala University of Technology Phra Nakorn, Bankok:Thailand.

[2] Anna Imjumlong & Wiliwan Jongwilikasem (2013, July-December) The Use of FB as a Media Channel for Studying the Communication Arts, Communication Arts Journal Dhurakij Pundit University, 7th year, Issue 2, Page 75-93, Bangkok: Thailand.

[3] Paratee Noosung, (2013) A Report of Class Research on The effective Usage of Fecebook Communication for Learning Activities with Social Constructivist for Information and Technology 2 : Creating Website with Adobe Dreamweaver cs4 for M.4/1 Students, Class Research, Faculty of Education, Kasetsart University, Bangkok:Thailand.

[4] Anthony Curtis, Dr., (2013) The Brief History of Social Media: Where people interact freely, sharing and discussing information about their lives, (Online), Available: http://www2.uncp.edu/home/acurtis/NewMedia/SocialMedia/SocialMediaHistory.htm 1 (December 17, 2014).

[5] Supasapon Preedasutti, (2010) Secondary School Students' Internet Consuming Behavior In Daily Life: A Study of Traim-Udom Patanakarn School. Master Degree Research, Master Degree of Arts (Social Development), Faculty of Social Development, Institute of Development Administration (NIDA.), (Online), Available: http://www.riclib.nrct.go.th/scripts/wwwi32.exe/[in=book2.par]/?^t2006=131082&^t20... 27/4/2552.

[6] Patra Ruengsawat.,(2010) SOCIAL NETWORKS USAGE OF WORKING PEOPLE IN BANGKOK, Master Degree Research, Faculty of Jonarlism and Mass Communication, Thammasat University, Bankok: Thailand.

AUTHOR

Pisutpong Endoo is a head and lecturer of Linguistics Department, Faculty of Management Technology, Rajamangala University of Technology Isan, Surin campus, Thailand. He received his B.A. in English from Mahachulalongkornrajavidyalaya University, Chiang Mai campus in 2006, M.A. in 2008 and PhD. in 2012 in Linguistics respectively from University of Mysore, Karnataka, India. His areas of interest include English teaching, Linguistics, sociolinguistics, folk linguistics, anthropological linguistics in Thailand, and Thai cultural terms etc.

AUTHOR INDEX