Review of Cardiovascular Heart Disease using Data Mining Techniques and Neural Network

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ABSTRACT

Cardiovascular Heart Diseases have been the main reason for a large number of deaths in the world over the last few decades and have emerged as the most life-threatening disease not only in India but all over the world. It has been found that the most significant factors for diagnosing heart disease are age, gender, smoking, obesity, diet, physical activity, stress, chest pain type, previous chest pain, blood pressure diastolic, diabetes, ECG, and target. In this paper, the use of expert systems for heart disease using different Neural Network Techniques, including Feedforward, Backpropagation, Radial Basis function, Support Vector machine, and Generalized Regression Neural Network, is shown. In order to construct any kind of expert system based on symptoms, it is important to understand how data should be gathered and which factors are helpful. Many different kinds of strategies that are employed in constructing the expert system with technical features are among the factors highlighted. Another suggestion made in this article was to use data mining, Support Vector Machines (SVM), Genetic Algorithms, Rough Set Theory, Association Rules, and Neural Networks to identify cardiac disorders. The Proposed approach could be utilized as an assistant framework to predict cardiovascular heart disease at an early stage.

Keywords - Cardiovascular Heart Disease, Support Vector Machine, Radial Basis Function, Data Mining, Neural Network

1. INTRODUCTION

Data mining with intelligent algorithms can be used to tackle the said problem of prediction in medical dataset involving multiple inputs. Now a day's Artificial neural network has been used for complex and difficult tasks. The neural network is trained from the historical data with the hope that it will discover hidden dependencies and

that it will be able to use them for predicting. Feed forward neural networks trained by backpropagation have become a standard technique for classification and prediction tasks. The healthcare industry collects huge amounts of healthcare data and that need to be mined to discover hidden information for effective decision making. Discover of hidden patterns and relationships often go unexploited [1-5].

1.1 Overview of Data Mining and Expert System

Data mining is a process of extraction of useful information and patterns from huge data. It is also called as knowledge discovery process, knowledge mining from data, knowledge extraction or data /pattern analysis. Data mining is a logical process that is used to search through large amount of data in order to find useful data. [3-9]. Data mining methods may help the cardiologists in the predication of the survival of patients and the practices adapted consequently. The work [10-12] might be executed for each medical procedure or medical problem and it would be feasible to make a wise decision tree fast with the data of a service or a physician. Comparison of traditional analysis and data mining analysis have been illustrated the contribution of the data mining method in the sorting of variables and concluded the significance or the effect of the data and variables on the condition of the present study [13-15].

"Big Data refers to the massive amounts of data that collect over time that are difficult to analyze and handle using common database management tools. Big Data includes business transactions, e-mail messages, photos, surveillance videos and activity logs (see machine-generated data). Scientific data from sensors can reach mammoth proportions over time, and Big Data also includes unstructured text posted on the Web, such as blogs and social media." [16-18].

There are many different ways to imitate an expert's performance, but the following are similar to most or all of them:

- development of a so-called "knowledgebase" that employs a formalism for knowledge representation to record the expertise of a subject matter expert (SME); [6]
- Knowledge engineering process, which collects the information from the SME and codifies it in accordance with the formalism.

Expert systems (ES) are artificial intelligence-based computer programs that have received a great deal of attention during years. These programs have been used to solve an impressive array of problems in a variety of fields. The part of the expert system that stores the knowledge is called the knowledge base. The part that holds the specifics of the to-be-solved problem is calling the global database. The part that applies the knowledge to the problem is called the inference engine. Expert systems typically have friendly user interface to enable inexperienced users to specify problems

for the system to solve and to understand the system's conclusion. Although, there are many computer based diagnosis systems are developed for medicine.[17-19].

2. BACKGROUND

Recently neural networks have been used in many areas that require computational techniques such as pattern recognition, optical character recognition, outcome prediction and problem classification. In materials science and engineering fields, the researchers have used neural network techniques to develop prediction models for mechanical properties of materials. For instance, [20] published many papers for the prediction of fracture toughness in microalloy steel, corrosion fatigue behavior and fatigue crack growth in dual-phase (DP) steel, mechanical behavior of powder metallurgy steel, dry sliding wear in Fe2%Ni based PM alloy and the effect of heat treatment on mechanical properties in MIM alloy. Artificial neural networks consist of a large number of interconnected processing elements known as neurons that act as microprocessors. Each neuron accepts a weighted set of inputs and responds with an output.

The brain is a complex organ as it contains 50-100 billions neurons forming a gigantic network. Brain tumor is a group of abnormal cells that grows inside of the brain or around the brain. Brain tumor can be benign or malignant, benign being non-cancerous and malignant are cancerous. Malignant tumors are classified into two types, primary and secondary tumors benign tumor is less harmful than malignant as in malignant tumor it spreads rapidly invading other tissues of brain, progressively worsening the condition causing death. Brain tumor detection is very challenging problem due to complex structure of brain. [21-25].

Prediabetes. A condition in which blood sugar levels are higher than the normal blood sugar level but not high enough to be Type 2 diabetes (Type 2 because of the lifestyle of people, they are much likely to suffer from Type 2) and by precautions and medications can be normalized is known as prediabetes [26].

The term cardiovascular heart disease actually applies to a number of illnesses that affect the circulatory system, which consists of heart and blood vessels. It is intended to deal here only with the condition commonly called "Heart Attack" and the factors, which lead to such condition. Heart attack is the popular term for sudden pain in chest with breathing difficulty arising out of certain heart conditions. Heart attacks can be suddenly fatal, but the great majority- an estimated 85 percent are not. The patient recovers under proper treatment and goes on to live many useful years [27].

Coronary artery disease (CAD): This occurs when problems arise with the blood vessels due to high cholesterol, diabetes, smoking, high blood pressure and

inherit from parents. Angina is a symptom of CAD, which a chest pain and occurs discomfort in neck, arms, shoulders, back and pain even feels like indigestion [28].

Congestive heart failure (CHF): The function of the heart is to pump blood, CHF is found when heart is not pumping a normal level Abnormal heart rhythms This is a problem in the heart with electrical activity, which makes the heart beat too fast or too slow is called Tachycardia or bradycardia. Bad rhythm‘s stops pumping blood in the heart [29].

A feed-forward neural network is similar to the types of neural networks that we have already examined. Just like many other types of neural networks, the feed-forward neural network begins with an input layer. The input layer may be connected to a hidden layer or directly to the output layer. If it is connected to a hidden layer, the hidden layer can then be connected to another hidden layer or directly to the output layer [30].

The central nervous system's most anterior component is the brain. One of the leading causes of mortality in humans is a brain tumour. It is clear that if the tumour is identified and properly categorized at an early stage, the chances of survival can be enhanced. Currently, the study of the human brain relies heavily on the diagnostic imaging method known as magnetic resonance (MR) imaging. Using a variety of methods, computer-aided diagnostic systems for finding brain tumours for medical purposes have been studied. This review study aims to discuss and analyse the approaches for computer-aided detection systems' various phases for automatically detecting brain tumours using magnetic resonance imaging (MRI) (CAD). Various segmentation approaches are reviewed with an emphasis placed on revealing the benefits and drawbacks of these methods for medical imaging applications [31-33].

Support vector machine (SVM) is a novel learning machine introduced which is based on the Structural Risk Minimization principle from computational learning theory. Hearst et al. positioned the SVM algorithm at the intersection of learning theory and practice: “it contains a large class of neural nets, radial basis function (RBF) nets, and polynomial classifiers as special cases. Yet it is simple enough to be analyzed mathematically, because it can be shown to correspond to a linear method in a high dimensional feature space nonlinearly related to input space.” [34].

RBF is symmetrical about a given mean or center point in a multidimensional space. In the RBFN, a number of hidden nodes with RBF activation functions are connected in a feed forward parallel architecture. The parameters associated with the RBFs are optimized during the network training. These parameter values are not necessarily the same throughout the network nor are they directly related to or constrained by the actual training vectors [35].

Decision support systems was developed using a knowledge base. Knowledge discovery in database uses data mining process which extracts useful information

from data set and transforms it into a reasonable structure for further use. Data mining combines statistical analysis, machine learning and database technology to extract hidden patterns and relationships from large databases [36-38].

The Notable cause of short lifespan is heart disease. A sizable populace relies on the healthcare system so they can receive correct results quickly. The major objective of this work is to apply machine learning algorithms to a dataset that contains data that is regularly collected by a healthcare organization and the KVK research Lab. In order to improve classification accuracy, this article suggests predicting heart disease and categorizing unique attribute extraction methods. This sort of system greatly lowers the danger of mortality [39].

Pattern recognition classifies data based on already gained knowledge, it is a process of understanding the class to which an object/pattern belongs. Those patterns/objects can be 1D e.g. signals or 2D e.g. images. Biometrics is an application of pattern recognition regarding analyzation and measurements of human body characteristics. There are three types of biometrics: physical, behavioral and cognitive. Physical biometrics deal with the bodily parts like face, fingerprints, palm etc. Behavioral biometrics considers the activities of the body like gait, keystroke, and voice. Cognitive biometrics regard every human nervous tissue and its response to signals like electrocardiogram (ECG), electromyogram (EMG), electroencephalogram (EEG) and electrodermal response (EDR)[40].

3. PREPARATION OF MEDICINE DATA

Under the direction of Dr. Abdul Jabbar, the information is gathered from Sahara Hospital, Roshan Gate, and Aurangabad. Every day I went to the hospital for an OPD session to see the doctors examine the patients. The signs and symptoms of patients as well as information on their medical history, present situation, personnel history, physical examination, cardio-vascular system, respiratory rate, per abdominal, central nervous system, ECG, and blood analysis. The ECG is the key component since it makes it simple for patients to determine if they have a cardiac condition or not [28].

The information on 150 patients with heart disease was gathered, and it was organised in several Excel sheets with codes for each condition, each patient's medical history, and each symptom. For example, one sub-sheet has been taken and given the name "P1" for "Previous History," another sub-sheet has been taken and given the name "P2" for "Present History," and a third sheet has been taken and given the name "P3" for "Personnel History." There are a total of 13 different sheets for the various fields of information in one excel sheet. Dr. Abdul Jabbar, a cardiologist, is in charge of all the sectors. For experimental work, a code is assigned to each symptom, physical examination component, or illness. Pre-processing techniques, including as

normalization, coding, and decoding, are used on this data to provide the desired results. Previous History (P1) and the illnesses prevalent in P1 are represented by Codes in a single Excel sub-sheet. 150 distinct cardiac patients were identified, and 1 to 18 codes were designated for each ailment, such as code 1, which stands for hypertension, and code 2, which stands for diabetes. Several of these are depicted in Table 1 below. [15]

Table 1: Distinct cardiac patient's disease

Code	Name of Disease
6	Hypothyrodism
7	Old Ischaemic heart disease
8	Nil
9	Interstitial Lung disease (ILD)
10	Cerebrovascular Accident(CVA)

Present History (P2) and the data it contains are represented by Codes in the following Excel sub-sheet. Code 1 denotes discomfort or pain in the chest, and Code 2 denotes sternal pain, among other things. All patients have a total of 29 separate symptoms, with 1 to 29 codes assigned to each one. In table 2, a few of the symptoms are listed [27].

Table 2: Distinct cardiac patient's symptoms

Code	Symptoms
6	Perspiration
7	Giddiness
8	Nausea / Vomiting
9	Epigastric Pain
10	Left Arm pain

Personnel History (P3) and the data it contains are represented in the following excel sub-sheet by codes for various undesirable behaviours. These four separate undesirable habits are chosen and described by 1 to 4 codes, with Code 1 standing in for smoking and Code 2 for tobacco. Below are some of the personnel history parameters [29].

Table 3: Distinct cardiac patient's personal history

Code	Personnel History
1	Smoking
2	Tobacco

3	Alcohol
4	Nil

Physical Examination (P4) and the data in P4 are represented by codes for various physical parameters in the following excel sub-sheet (P4). The 25 various physical factors are described by 1 to 25 codes, with Code 1 standing for Consciousness and Code 2 for Orientation. Some are depicted in table 4 below [29].

Table 4: Distinct cardiac patient's physical examination

Code	Physical Examination
6	Normal Pulse rate
7	**High Pulse rate**
8	Low systolic Blood Pressure
9	Normal Blood Pressure
10	**High Blood Pressure**

The Cardio Vascular System (CVS) and the data it contains are represented in the following Excel sub-sheet by codes for various symptoms. Codes 1 through 8 are used to specify each of the eight symptoms, with Code 1 standing for Heart Sound and Code 2 indicating Normal Heart Rate. Some are displayed in table 5 below.

Table 5: Distinct cardiac patient's cardio vascular system

Code	Symptoms
4	Bradycardia
5	Regular Heart Rhythm
6	Irregular Heart Rhythm
7	Gallop sound
8	No Abnormality Detected (NAD)

The Respiratory System (RS) is represented in the following Excel sub-sheet by codes for various symptoms, along with the data included in the RS. In contrast to Code 1, which stands for retained breath sounds, Code 2 means reduced breath sounds. One to five codes are detected for each of the 5 distinct symptoms. Some are displayed in table 6 below.

Table 6: Distinct cardiac patient's respiratory system

Code	Symptoms
1	Breath Sounds Preserved
2	Breath Sound Reduced
3	Basal Crepts
4	No Abnormality Detected (NAD)

5	Ranchi

4. EXPERIMENTAL ANALYSIS

The suggested information is encoded in binary form for subsequent neural network processing (0 or 1). When a symptom is present in a patient in a specific area, it is indicated by one (1), and when it is absent at that site, it is indicated by zero (0). (0). For instance, if there are 29 symptoms listed in the field P2 (present history) and patient 1 has symptoms 1, 2, 5, and 13, then that location is designated as 1 (one), and all other symptoms are 0 (zero). All of the fields are specified in this fashion. All the parameter that we consider in medical prescription like Sr. No., ,age , P1, P2,P3,P4,CVS, RS,PA,CNS,ECG and BT that converted in binary number where this is used in neural network for train the neurons for better result

Symptoms and Patient Information Coding 1

The doctor prescribes a total of 52 medications for this system, and if a medication is present, it is defined by one (1), and if it is not, it is defined by zero (0), (0). The prescribed medications for patient one are defined by,

0 1 1 0 1 1 0 0 0 0 0 0 1 0 0 1 0 1 0 1 0 1 0 1 1 1 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0;

Medicine Coding of the patient 1

1. **Discussion of first five patients results with doctor**:

Original Medicines given by doctor:

A) 1,3,5,6,14.17,19,21,23,25,26,27,29,36
B) 2,3,5,6,14,16,17,21,23,25,26,27,28
C) 1,5,6,14,25
D) 3,5,7,10,11,13,14,17,19,30
E) 3,14,15,19 ……..[44]

Medicines given by the Expert system using FFBP

A) 1,3,5,6, 14, 16, 17,21,23,25,26,27,28
B) 1,3,5,6,14,25
C) 1,3,5,6,14,25
D) 1,3,5,6,14,25
E) 1,3,5,6,14,25……[45]

Medicines given by the Expert system using GRNN

A) 1,3,5,6, 16,1718,21,23,25,26,27,28,29
B) 1,3,5,6,16,17,18,21,23,25,26,27,28,29
C) 1,3,5,6,11,14,21,22,23,24,25,26,27
D) 1,3,5,6,13,14,17,2122,23,25,26,27,28
E) 1,2,3,5,14

Medicines given by the Expert system using SVM

A) 1,3,5,6, 16,1718,21,23,25,26,27,28,29
B) 1,3,5,6,16,17,18,21,23,25,26,27,28,29
C) 1,3,5,6,11,14,21,22,23,24,25,26,27
D) 1,3,5,6,13,14,17,2122,23,25,26,27,28
E) 1, 2,3,5,14

Medicines given by RBF :

A) 3,5,6,14,16,17,21,23,25,26,27,28,29
B) 1,3,5,6,11,14,16,17,21,22,23,24,25,26,27,28,36
C) 1,3,5,6,14,21,25
D) 1,3,5,6,11,13,14,17,21,25,30
E) 3,5,6,14,15

5. CONCLUSION

The neural network techniques such as GRNN, FFBP, RBF, SVM used in this study with total 152 parameters for patient and 52 medicines are used for total 300 patients to diagnose the heart disease. All the results are techniques were verified by the expert MD Medicine doctor; the testing data results employing GRNN and FFBP were not accurate. For patients with heart disease, the analytical model employing SVM and RBF of ANN provides superior results for medical prescription. According to the results verified by the MD Medicine doctor, the testing data result employing SVM, GRNN and FFBP is not satisfactory. Unsatisfactory, among all the above technique only Radial Basis Function results are satisfactory. In future this research work can be extended with big data.

REFERENCES

[1]. Singh, D., Mishra, P. M., Lamba, A., & Swagatika, S. (2020). Security issues in different layers of IoT and their possible mitigation. International Journal of Scientific & Technology Research, 9(04), 2762-2771.
[2]. Aqueel Ahmed, Shaikh Abdul Hannan, "Data Mining techniques to find out the heart disease: An Overview", International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol 1, Issue 4, 2012.
[3]. Kaur, T., & Pal, P. (2019). Cloud computing network security for various parameters, and its application. Int. J. Adv. Sci. Technol, 28(20), 897-904.
[4]. Shaikh Abdul Hannan, "An Overview of Big Data and Hadoop", International Journal of Computer Application", Volume 154, Number 10, ISSN – 0975-887, November, 2016, New York, USA.
[5]. M Ashfaque, S Tharewal, AS Shaikh, SS Banu, MA Sohail, SA Hannan, "Trends in education smart learning approach", International Journal of

Advanced Research in Computer Science and Software Engineering, Vol4, Issue 10, 2014.

[6]. Pal, P., Kaur, T., Sethi, D., Kumar, A., Kumar, S., Lamba, A., & Rastogi, U. (2020, February). Vertical handoff in heterogeneous mechanism for wireless lte network-an optimal approach. In 2020 International Conference on Emerging Trends in Communication, Control and Computing (ICONC3) (pp. 1-5). IEEE.

[7]. Shaikh Abdul Hannan, V. D. Bhagile, R. R. Manza, R. J. Ramteke, "Development of an Expert System for Diagnosis and appropriate Medical Prescription of Heart Disease UsingSupport Vector Machine and Radial Basis Function", International Journal of ComputerScience and Information Security, (IJCSIS) August issue (Vol. 8 No. 5), 2010.

[8]. Khan, M. J., & Pushparaj. (2021). A novel hybrid maximum power point tracking controller based on artificial intelligence for solar photovoltaic system under variable environmental conditions. Journal of Electrical Engineering & Technology, 16(4), 1879-1889.

[9]. Pal, P., & Pali, L. (2018). Congestion free analysis for emergency vehicles response in tri-city (Panchkula-Chandigarh Mohali) using LTE-A. Modelling, Measurement and Control A, 91(2), 66-72..

[10]. Anupriya Kamble, Shaikh Abdul Hannan, Yogesh Rajput and Ramesh Manza, "Prediction of Prediabetes, No Diabetes and Diabetes Mellitus-2 using Pattern Recognition", **Springer** FICR International Conference on Rising Threats in Expert Applications and Solutions. 2020.

[11]. Lamba, Anil and Pal, Pushparaj and Singh, Satinderjeet and Singh, Balvinder and Muni, Sivakumar Sai Rela, Quantum Computing Technology (QCT) - A Data Security Threat (2018). JETIR, Volume 5, Issue 4, April 2018, Available at SSRN: https://ssrn.com/abstract=3510580

[12]. Anupriya Kamble, Shaikh Abdul Hannan, Ramesh Manza and Mohammad EidAlzahrani, "Prediction of Prediabetes, No Diabetes and Diabetes Mellitus - 2 usnig Simple Decision Tree Classification" **Springer** FICR International Conference on Rising Threats in Expert Applications and Solutions, 2020.

[13]. Aggarwal, P., & Pal, P. (2014). Implementation of an efficient low complexity method for wireless CE using a BEM for the wireless channel taps. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 594-600.

[14]. Pal, P., & Verma, A. (2014). A survey to maximize retransmission of packets in WMSN. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 2, 575-581.

[15]. Kaur, A., Pal, P., & Pal, P. K. (2014). An Efficient Way of Broadcasting Response Message to Help Demanding Vehicle in VANET'. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 2, 546-548.
[16]. Santosh Maher, Shaikh Abdul Hannan, SumeghTharewal, K. V. Kale " HRV basedHuman Heart Disease Prediction and Classification using Machine Learning "December 2019, (Vol. 17 No. 2 International Journal of Computer Science and Information Sec Applicatiion (IJCA), New York, USA.
[17]. Shaikh Abdul Hannan, "Heart Disease Diagnosis by using FFBP and GRNN algorithm of Neural Network", International Journal of Computer Science and Information Security, Vol 12, Number 6, June 2014, ISSN 1945-5500, United States of America.
[18]. Walia, A., & Pal, P. (2014). An implemented approach of VANET using location information based technique for safe city and vehicle. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 2, 400-405.
[19]. Shaikh Abdul Hannan, Bharatratna P. Gaikwad, Ramesh Manza, "Brain Tumor from MRI Images: A Review". International Journal of Scientific and Engineering Research (IJSER), Volume 5, Issue 4, April-2014, ISSN 2229-5518, France.
[20]. Gulati, V., & Pal, P. (2014). Enhancement of ICA Algorithm Using MatLab for Change Detection in Hyperspectral Images. International Journal of Education and Science Research Review, 1(5), 1-9.
[21]. Shaikh Abdul Hannan, V. D. Bhagile, R. R. Manza, R. J. Ramteke, "Diagnosis and Medical Prescription of Heart Disease Using Support Vector Machine and Feed forward Backpropagation technique", International Journal on computer science and engineering, IJCSE –, Vol. 2, Issue 6, August 2010.
[22]. Chauhan, J., & Pal, P. (2014). A Review to Vho for Wimax and Wifi Networks.
[23]. Shaikh Abdul Hannan, R. R. Manza, R. J. Ramteke, "Generalized Regression Neural Networkand Radial Basis Function for Heart Disease Diagnosis", International Journal of ComputerApplications (IJCA) Vol. 7, No. 13, October 2010 Edition. New York, USA.
[24]. Gulati, V., & Pal, P. A. (2014). Survey on various change detection techniques for hyper spectral images. International Journal of Advanced Research in Computer Science and Software Engineering, 4(8), 2277.
[25]. Mohammad Eid Alzaharani, Shaikh Abdul Hannan, "Diagnosis and Medical Prescription of Heart Disease Using FFBP, SVM and RBF", Issue,1, Vol 5, , KKU Journal of Basic and Applied Sciences, Mar 2019 , Page 6-15.

[26]. Kapoor, S., Pal, P., Gupta, S., & Sharma, M. (2014). Stable AODV protocol in mobile Ad-Hoc network. Int. J. Adv. Res. Comput. Sci. Softw. Eng, 4(6).

[27]. Shaikh Abdul Hannan, R. R. Manza, R. J. Ramteke, "Generalized Regression Neural Network and Radial Basis Function for Heart Disease Diagnosis", International Journal of Computer Applications (IJCA) Vol. 7, No. 13, October 2010 Edition. New York, USA.

[28]. Miglani, E., Gupta, S., & Pal, P. (2014). Simulative Investigation on 3, 4 and 5 Level Discrete Wavelet Transform for Digital Video Watermarking. International Journal of Advanced Research in Computer Science and Software Engineering, 4(6), 2277.

[29]. Verma, A., & Pal, P. (2014). A survey to maximize retransmission of packets in WMSN. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 575-581.

[30]. Yogesh Rajput, Shaikh Abdul Hannan, "Design New Wavelet Filter for Detection and Grading of Non-proliferative Diabetic Retinopathy Lesions", International Conference on Recent Trends in Image Processing and Pattern Recognition, Jan 2020, Springer, Singpore.

[31]. Sagar Vakhare, Ramesh Manza, Abdul Hannan Shaikh and Anubha Jain, "Time Series Analysis and Forecasting of Temperatures Records in Aurangabad District of Maharashtra", **Springer** FICR International Conference on Rising Threats in Expert Applications and Solutions. 2020 at IIS University, 17-19 Jan, 2020 Jaipur.

[32]. Aggarwal, P., & Pal, P. (2014). Implementation of an efficient low complexity method for wireless CE using a BEM for the wireless channel taps. 2 (Xii), 594–600.

[33]. Santosh Maher, Shaikh Abdul Hannan, Sumegh Tharewal, K. V. Kale " HRV based Human Heart Disease Prediction and Classification using Machine Learning " December 2019, (Vol. 17 No. 2 International Journal of Computer Science and Information Applicatiion (IJCA), New York, USA.

[34]. Akram Ablsubari, Shaikh Abdul Hannan, Mohammed EidAlzaharani, Rakesh Ramteke, "Composite Feature Extraction and Classification for Fusion of Palmprint and Iris Biometric Traits", Engineering Technology and Applied Science Research, (ETASR) Volume 9, No 1, Feb 2019, ISSN: 2241-4487, Greece.

[35]. Aggarwal, P., & Pal, P. (2014). A Review of complexity method for wireless Channel Estimation using a BEM. 2 (Xii), 590–593.

[36]. Yogesh Rajput, Shaikh Abdul Hannan, Mohammed EidAlzaharani, D. Patil Ramesh Manza, Design and Development of New Algorithm for person identification Based on Iris statistical features and Retinal blood Vessels

Bifurcation points" " International Conference on Recent Trends in Image Processing & Pattern Recognition (RTIP2R), December 21-22, 2018, India.

[37]. Yogesh**,** Abdul Hannan, Rahul Sagar, KishorJave, Identification and Counting Trees from Oil Palm Plantations Using Digital Image Processing Techniques, International Journal of Engineering Research & Technology (IJERT), Vol. 6 Issue 05, May – 2017, ISSN: 2278-0181.

[38]. Chauhan, J., & Pal, P. (2014). Implementation of Vertical Handoff between Wimax and Wifi Networks.

[39]. Aqueel Ahmed, Shaikh Abdul Hannan, "Data Mining Techniques to Find Out Heart Diseases: An Overview", International Journal of Innovative Technology and Exploring Engineering (IJITEE), An ISO 9001:2008 Certified International Journal, Volume-1, Issue-4, September 2012, ISSN: 2278-3075, New Delhi, India.

[40]. Singh, A., Pal, P., Gupta, S., & Singh, H. (2014). Optimal Path Selection in Dynamic Source Routing. International Journal for Research in Applied Science & Engineering Technology (IJRASET).

[41]. Shaikh Abdul Hannan, Jameel Ahmed, Naveed Ahmed, Rizwan Alam Thakur, "Data Mining and Natural Language Processing Methods for Extracting Opinions from Customer Reviews", International Journal of Computational Intelligence and Information Security, pp 52-58, Vol. 3, No. 6, July 2012. (ISSN: 1837-7823).

[42]. Verma, A., & Pal, P. (2014). Simulation to maximize retransmission of packets in WMSN. vol, 2, 582-589.

[43]. Kadian, A. K., Pal, P., & Goyal, V. (2013). Concept of Dynamic Bandwidth Allocation and Scheduling Algorithms in Passive Optical Networks. International EJournal of Mathematics and Engineering, 224, 2195–2200.

[44]. Manwall, R., Mathuriya, A., Garg, S., & Pal, P. (2012). Performance evaluation of energy saving in wsn by using simulator ns2. vol, 1, 6-9.

[45]. Mathuriya, A., Pal, P., & Grover, L. (2003). Stability Aware Routing in Mobile Ad-Hoc Networks using multiple Route. International Journal of Computers & Technology, 2, 163-170.