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AN EXAMINATION OF EXPERT SYSTEM NEURAL NETWORK AND DATA MINING FOR CARDIAC DISEASES

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Abstract*:* Now a day's neural network are being used successfully in an increasing number of application areas. Expert system is used comprehensively in several research domains. Heart disease diagnosis is a complicated process and requires high level of expertise. This paper examines and aiming to study a expert system for diagnosing of heart disease using support vector machine, feed forward Back propagation technique, Radial Basis Function, Generalized Regression Neural Network etc with other Data mining techniques that are used for diagnosis for heart diseases. This paper studies the analysis and examines the different approaches used for the detection of heart disease using different neural network techniques and data mining techniques.
Keywords: Neural Network, Data Mining, Support Machine, Radial Basis function, FFBP, GRNN.

I. INTRODUCTION

Nowadays the use of computer technology in the fields of medicine area diagnosis and treatment of illnesses and patient pursuit has highly increased. Despite the fact that these fields, in which the computers are used, have very high complexity and uncertainty, the use of intelligent systems such as fuzzy logic, artificial neural network and genetic algorithm have been developed. Heart diseases factor is the most common diseases in human beings. For this reason, heart disease in necessary medical research area. Early heart diseases problem is very critical. Heart diseases may is suspected if the heart sound heard through stethoscope are abnormal this usually the first step in diagnosing a heart diseases to further define the type of heart diseases physician may use Electro Cardio Gram **(**ECG), Chest X-ray Cardiac catheterization, Magnetic resonance Imaging (MRI) all these methods based on experience and information of physician. In this manner, the cardiologist can understand the output of examination system more easily and the diagnose the problem more accurately [1-4]. Expert systems (ES) are artificial intelligence-base 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. [5-6]. Knowledge discovery in databases is well-defined process consisting of several distinct steps. Data mining is the core step, which results in the discovery of hidden but useful knowledge from massive databases. A formal definition of Knowledge discovery in databases is given as follows: "Data mining is the non trivial extraction of implicit previously unknown and potentially useful information about data" [7]. Data mining technology provides a user-oriented approach to novel and hidden patterns in the data. The discovered knowledge can be used by the healthcare administrators to improve the quality of service. The discovered knowledge can also be used by the medical practitioners to reduce the number of adverse drug effect, to suggest less expensive therapeutically equivalent alternatives. Anticipating patient's future behaviour on the given history is one of the important applications of data mining techniques that can be used in health care management.[8] The examination of study uses neural network techniques such as Radial Basis Function, Support Vector Machine, GRNN, FFBP etc and other data mining techniques for detection of heart disease for diagnosis and medical prescription on the basis of symptoms. Moreover, we compared and discussed the results of various techniques such as Support Vector Machine, Radial Basis Function, FFBP, GRNN with original medicines provided by the doctor.

The paper is organized as following section as, in Section 1 describes introduction, Section 2, a brief overview on previous related works on neural network and data mining and in section 3, Introduction of various neural network techniques such as Support Vector Machine and Radial Basis Function, FFBP and GRNN is described. Section 4, discussion and results of all the techniques. And finally we concluded in Section 5.

II. LITERATURE SURVEY

Up to now, various classification algorithms have been employed on Turkoglu's valvular heart disease data set and high classification accuracies have been reported in the last decade. Turkoglu's valvular heart disease data set was obtained from Firat Medical Center. A detailed description for the data set will be given in the next section. The valvular heart disease data set was firstly utilized in [9] where Turkoglu et al. fulfilled an expert diagnosis system which uses Backpropagation artificial neural networks (BPANN) classifier. The performance evaluation of the realized system was evaluated by classification accuracy and the correct classification rate was about 94% for normal subjects and 95.9% for abnormal subjects. Later, Turkoglu et al. suggested an intelligent system for detection of heart valve disease based on wavelet packet neural networks (WPNN) [10]. Artificial neural networks (ANN) have emerged as a result of simulation of biological nervous system, such as the brain, on a computer. On the other hand, biological neural networks are much more complicated than the mathematical models used for ANNs. ANN was founded by McCulloch and co-workers beginning in the early 1940s [11]. They built simple neural networks to model simple logic functions. Since it is customary to drop the ''A'' or the ''artificial'', NN and ANN will be used interchangeably throughout the rest of the paper to refer to an artificial neural network. Nowadays, neural networks can be applied to problems that do not have algorithmic solutions or problems for which algorithmic solutions are too complex to be found. In other words, it is not easy to formulate a mathematical model that does not have a clear relationship between inputs and outputs for some systems. To overcome this problem, ANN uses the samples to obtain the models of such systems. Their ability to learn by example makes neural networks (NN) very flexible and powerful. Therefore, neural networks have been intensively used for solving regression and classification problems in many fields. In short, neural networks are nonlinear processes that perform learning and classification [12]. To diagnose the heart failure cause different popular methods used are MRI, Doppler and Expert System. MRI can provide clear three dimensional images of the heart. Doppler technique has gained much more interest since Satomura first demonstrated the application of the Doppler effect to the measurement of blood velocity in [13]. However the factor such as calcified disease or obesity often results in a diagnostically unsatisfactory. Doppler techniques assessment and therefore, it is sometimes necessary to assess the spectrogram of the Doppler Shift signals to elucidate m the degree of the disease [14]. Many studies have been implemented the classify Doppler signals in the pattern recognition field [15-16]. Heart function is to pump blood around the body. The heart is a key factor of the human body, and acting as filter of blood and transfers oxygenated and deoxygenated blood around the body [17]. World Health Organization has estimated 12 million deaths occur worldwide, every year due to Heart diseases. Half the deaths in the United States and other developed countries are due to cardio vascular diseases. The World Health Organization (WHO) estimates that by 2030, 23.6 million people worldwide will die from heart disease [18]. Nowadays many projects are developing under social media, sensor data, stock exchange, Transport data, and in the field of science where data is most important factor to store and retrieve. So we need new technology which is Big data and Hadoop to handle this huge amount of data which is not possible to handle by RDBMS. Big data has very basic important characteristics such as volume, variety, veracity and velocity. Big data handles the large amount of data with management, analysis, storage and processed data very fast within the time span [19]. The automated detection of the disorder will help doctors to reduce the time spent on the test also it will be helpful for patient to take precautions much early if in case a subject is suffering from the disorder. The present analysis concludes that PD, NODB or DM2 is classified 100% using the simple decision tree classification technique [20-21]. The proposed filter gives the good extraction result as compare to exiting wavelet filter. In proposed algorithm, we have extract the micro aneurysms, haemorrhages, exudates and retinal blood vessels. After extraction of lesions, grading is done by using feed forward neural network. The proposed algorithm achieves sensitivity of 98%, specificity of 92% and accuracy of 98%.[22] Diabetic Retinopathy caused by leakage of blood or fluid from the retinal blood vessels and it will damage the retina. For detection and extraction of non-proliferative diabetic retinopathy lesion we have invent the new wavelet filter. The proposed filter give the good extraction result as compare to exiting wavelet filter [23]. Numerous techniques were useful to enhance the strength of the emotion recognition systems using electroencephalogram (EEG) signals particularly the problem of spatiotemporal features. Automatic emotion recognition founded on EEG signals has received increasing attention in current years. The human being is blessed inquisitiveness has always wondered how to make machines feel, and, at the same time how a machine can detect emotions.[24] The brain is the anterior most part of the central nervous system. Brain tumor is one of the major causes of death among people. It is evident that the chances of survival can be increased if the tumor is detected and classified correctly at its early stage. Magnetic resonance (MR) imaging is currently an indispensable diagnostic imaging technique in the study of the human brain. Computer aided diagnosis systems for detecting Brain tumor for medical purpose have been investigated using several techniques. In this Review paper, it is intended to summarize and compare the methods of automatic detection of brain tumor through Magnetic Resonance Image (MRI) used in different stages of Computer Aided Detection System (CAD) [25].

A rule-based system is a system to store and manipulate knowledge to interpret information in a useful way. They are often used in artificial intelligence applications and research. Rule-based programming attempts to derive execution instructions from a starting set of data and rules, which is a more indirect method than using a imperative programming language which lists execution steps straightforwardly [26-28].

III. METHODOLOGIES USED FOR CARDIAC DISEASES

1. Support Vector Machine :

Support Vector Machines (SVMs) are state of the art pattern recognition techniques whose foundation stem from statistical learning theory. However, the scope of SVMs goes beyond pattern recognition because they can also handle two more learning problems i.e. regression estimation and density estimation. An SVM is a general algorithm based on guaranteed risk bounds of statistical learning theory i.e. the so called structural risk minimization principle. It is a learning machine capable of implementing s set of functions that approximate best the supervisor's response with an expected risk bounded by the sum of the empirical risk and Vapnik – Chevonenkis (VC) confidence. Recent advances in statistics, generalization theory, computational learning theory, machine learning and complexity have provided new guidelines and deep insights into the general characteristics and nature of the model building/learning/fitting process [29-30]. Support vector machine (SVM) is a novel learning machine introduced first by Vapnik [31]. It is based on the Structural Risk Minimization principle from computational learning theory. Hearst et al. [32] 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.

2. Radial Basis Function

Radial basis function (RBF) networks were introduced into the neural network literature by Broom head and Lowe [33]. The RBF network is similar to a general feed forward neural network trained using the back-propagation scheme. It has three layers of neurons, namely input, hidden and output. However it uses only one hidden layer, each neuron in which operates as the Gaussian transfer function, as against the sigmoid function [34-35]

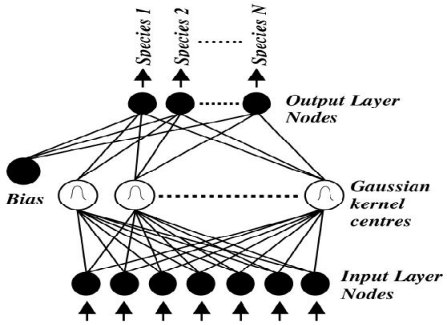

Figure 1. Schematic diagram of RBF

The major task of RBF network design is to determine centers. The easiest way to do so is to choose the centers randomly from the training set. Another approach is to use the k-means technique consisting of clustering the input training set into groups and choose the mean of each group as the center. Also, the centers can be treated as a network parameter along with wi and adjusted through error-correction training. After the center is determined, the connection weights wi between the hidden layer and output layer can be obtained through ordinary back-propagation-based training [36].

3. A Feed-forward Backpropagation algorithm:-

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. There can be any number of hidden layers, as long as there is at least one hidden layer or output layer provided. In common use, most neural networks will have one hidden layer, and it is very rare for a neural network to have more than two hidden layers [37-38].

4. Generalized Regression Neural Network

A GRNN is a variation of the radial basis neural networks, which is based on kernel regression networks [39-40]. A GRNN does not require an iterative training procedure as back propagation networks. It approximates any arbitrary function between input and output vectors, drawing the function estimate directly from the training data. In addition, it is consistent that as the training set size becomes large, the estimation error approaches zero, with only mild restrictions on the function. The number of input units in input layer depends on the total number of the observation parameters. The first layer is connected to the pattern layer and in this layer each neuron presents a training pattern and its output. The pattern layer is connected to the summation layer. The summation layer has two different types of summation, which are a single division unit and summation units. The summation and output layer together perform a normalization of output set [41].

IV. DATA MINING TECHNIQUES

Classification is the most commonly applied data mining technique, which employs a set of pre-classified examples to develop a model that can classify the population of records at large. Fraud detection and credit risk applications are particularly well suited to this type of analysis. This approach frequently employs decision tree or neural network-based classification algorithms. The data classification process involves learning and classification. In Learning the training data are analyzed by classification algorithm. In classification test data are used to estimate the accuracy of the classification rules. If the accuracy is acceptable the rules can be applied to the new data tuples.

For a fraud detection application, this would include complete records of both fraudulent and valid activities determined on a record-by-record basis.

Association rule

Association and correlation is usually to find frequent item set findings among large data sets. This type of finding helps businesses to make certain decisions, such as catalogue design, cross marketing and customer shopping behavior analysis. Association Rule algorithms need to be able to generate rules with confidence values less than one. However the number of possible Association Rules for a given dataset is generally very large and a high proportion of the rules are usually of little (if any) value.

Types of association rule

- Multilevel association rule
- Multidimensional association rule
- Quantitative association rule [42].
- The present study is of patients suffering from Type 1 DM. In Type 1 diabetes a patient has to take external insulin to maintain the blood glucose level (BGL). Insulin is a hormone produced in the pancreas which maintains the BGL of a person. BGL is responsible for a person's daily activity. Within a specified target range the blood glucose level has to be maintained.[43-44].

Classification via clustering:

Clustering is the process of grouping similar elements. This technique may be used as a preprocessing step before feeding the data to the classifying model. The attribute values need to be normalized before clustering to avoid high value attributes dominating the low value attributes. Further, classification is performed based on clustering. Experiments were conducted with Weka 3.6.0 tool. Data set of 909 records with 13 attributes. All attributes are made categorical and inconsistencies are resolved for simplicity. To enhance the prediction of classifiers, genetic search is incorporated. Observations exhibit that the Decision Tree data mining technique outperforms other two data mining techniques after incorporating feature subset selection but with high model construction time. Naïve Bayes performs consistently before and after reduction of attributes with the same model construction time. Classification via clustering performs poor compared to other two methods.

3.8 Association Rule Discovery:

Association rules represent a promising technique to improve heart disease prediction. Unfortunately, when association rules are applied on a medical data set, they produce an extremely large number of rules. Most of such rules are medically irrelevant and the time required to find them can be impractical., four constraints were proposed to reduce the number of rules: item filtering, attribute grouping, maximum item set size, and antecedent/consequent rule filtering. When association rules are applied on a medical data set, they produce an extremely large number of rules. Most of such rules are medically irrelevant and the time required to find them can be impractical. A more important issue is that, in general, association rules are mined on the entire data set without validation on an independent sample. To solve these limitations, the author has introduced an algorithm that uses search constraints to reduce the number of rules, searches for association rules on a training set, and finally validates them on an independent test set. Instead of using only Support and confidence, one more parameter i.e. lift have been used as the metrics to evaluate the medical significance and reliability of association rules. Medical doctors use sensitivity and specificity as two basic statistics to validate results. Sensitivity is defined as the probability of correctly identifying sick patients, whereas specificity is defined as the probability of correctly identifying healthy individuals. Lift was used together with confidence to understand sensitivity and specificity. To find predictive association rules in a medical data set the algorithm has three major steps. First, a medical data set with categorical and numeric attributes is transformed into a transaction data set. Second, four constraints mentioned above are incorporated into the search process to find predictive association rules with medically relevant attribute combinations. Third, a train and test approach is used to validate association rules[45-48].

IV. RESULT AND DISCUSSION

1. Preparation of Medicine Data

In this study, the author has collected from Hospital, under supervision of Doctor. The author has collected the symptoms and information about patients' details like Previous History, Present History, Personnel History, Physical Examination, Cardio Vascular System, Respiratory rate, Per Abdomen, Central Nervous system, ECG, and Blood Investigation. The collected data contains all the information about the patient such as patient's previous disease, present condition, some personnel bad habits (smoking, tobacco, alcohol), physical examination (blood pressure, respiratory rate) etc. and the main point is ECG from which the patient can easily diagnose whether the patient is having heart problem or not. In ECG we have taken 21 different points which we have represented by codes. For each finding of the ECG doctor is deciding the patient is having which type of heart problem. The all 150 data collected regarding heart patients and all the data are prepared in different Excel Sheets which contains codes of each individual disease, history and symptoms. In one excel sheet I have taken 13 sub-sheets for each field of information such as for Previous History one sub-sheet has taken and given the name is given (P1), for Present History the second sub-sheet and the name is given (P2), for Personnel History the third sheet is taken and the name is given (P3), like this we have taken 13 different sheet for different fields.

All the fields are taken under the supervision of the expert Cardiologist. The table 1 represents the all collected data with symptoms number. All this data is then converted in 0 and 1 format as 0 represents the absence of code and 1 represents the present symptoms. For further training of neural network process the proposed information is coded in binary form (0 or 1). If the symptom is present in the patients at particular position at that point it is defined by one (1) and if the symptoms or disease is not present at that position it is placed by Zero (0). Suppose for example in the field P2 (present history) there are total 29 symptoms present and the patient no 1 is having the symptom 1,2,5 and 13 so these locations are defined by 1 (one) and all other symptoms are 0 (zero). In such a way all the fields are defined. All the parameter that we consider in medical prescription like Sr. No., ,age , P1, P2,P3,P4,CVS, RS, PA, CNS, ECG and BT are converted in binary number where this is used in neural network for train the neurons for achieving better result.

Sr. No.	Patient Name	Symptoms and Findings										
		Age	P1	P2	P3	P4	CVS	RS	PA	CNS	ECG	BT
1	A	33M	8	1,4	1	6,10	8	4	5	4	3	2
2	B	60 M	1	15,3,4	4	6,10,12	8	4	5	4	9	14
3	C	60M	1,7	1,17	4	6,9	6	4	5	4	9	9
4	D	50M	7	18	4	3,7,9,16	3	3	1	4	11,3	14
5	E	60F	9,2,3	4	4	7,9,13,18	3	3,5	5	4	11.3	9,10,4

Table 1: collection of different details of the individual Heart Patients & Table 2 represents the if A is having the symptoms the corresponding medicine will be prescribed by the expert system as shown below.

Sr. No.	Patient Name	MID 1	MID 2	MID 3	MID 4	MID 5	MID 6	MID 7	MID 8	MID 9	MID 10	MID 11	MID 12	MID 13
1	A	25	6	3	29	5	17	1	21	16				
2	B	14	3	5	6	1	26							
3	C	29	1	3	5	25	17	16	27	24				
4	D	32	11	20	11	14	33							
5	E	14	11	34	3	5	33	35	24					

Table 2 : All the Medicine codes provided by the doctor to the individual patients.

V. CONCLUSION

In these study, around 300 patient's information is collected from Hospital, under supervision of Doctor. Using 250 patients data is trained by using RBF, SVM, GRNN and FFBP. Around 50 samples were tested with these two techniques. If the more data set is used for the training the NN model gives more robust results. The analysis model by using SVM and FFBP of ANN gives less appropriate result for medical prescription for heart disease patient. However, there are several techniques that can improve the speed and performance of the back propagation algorithm, weight initialization, use of momentum and adaptive learning rate. So we can conclude that, the result of testing data by using GRNN, SVM and FFBP is not satisfactory but using Radial Basis function the result is satisfactory but by using data mining techniques the result is not satisfactory. So in future these techniques can be used for detection of different disease on the basis of symptoms.

VI. REFERENCES

1. Abdulkadir Sengur, "An expert system based on linear Discriminant analysis and adaptive neuro-fuzzy inference system to diagnosis heart valve diseases", ELSEVIER, Expert Systems with Applications 35, 214-222, 12 June 2007. https://doi.org/10.1016/j.eswa.2007.06.012
2. Jain Yu, "General C-Means Clustering Model", IEEE Transactions on Pattern Analysis And Machine Intelugence, VOL. 27, NO. 8, August 2005.
3. Meyer-Baese, O. Lange, A. wismueller, and M. K. Hurdal, "Analysis of Dynamic Susceptibility constrast MRI Time Series Based on Unsupervised Clustering Methods", IEEE Transactions on Information Technology in Biomedicine, VOL. 11, NO. 5, September 2007. https://doi.org/10.1109/titb.2007.897597
4. 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.
5. Fraser, H.S.F., et al., "Differential diagnoses of the heart disease program have better sensitivity than Resident Physicians", Tufts-New England Medical Center, Boston, MA(2001).
6. 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.
7. Frawley and Piatetsky-Shapiro, 1996. Knowledge Discovery in Databases: An Overview. The AAAI/MIT Press, Menlo Park, C.A.

8. 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. https://doi.org/10.35940/ijitee.f1072.0486s419
9. I. Turkoglu, A. Arslan, E. Ilkay, "An expert system for diagnosis of the heart valve diseases", Expert Systems with Applications vol.23, pp. 229–236, 2002. https://doi.org/10.1016/s0957-4174(02)00042-8
10. I. Turkoglu, A. Arslan, E. Ilkay, "An intelligent system for diagnosis of heart valve diseases with wavelet packet neural networks", Computer in Biology and Medicine vol.33 pp.319–331, 2003. https://doi.org/10.1016/s0010-4825(03)00002-7
11. Haque ME, Sudhakar KV. ANN back propagation prediction model for fracture toughness in microalloy steel. Int J Fatique 2002;24:1003–10. https://doi.org/10.1016/s0142-1123(01)00207-9
12. Shaikh Abdul Hannan, A.V. Mane, R. R. Manza and R. J. Ramteke, "Prediction of Heart Disease Medical Prescription Using Radial Basis Function", IEEE International Conference on Computational Intelligence and Computing Research at Tamilnadu College of Engineering, Coimbatore, Tamilnadu, India, ICCIC-2010, December 28-29, 2010. https://doi.org/10.1109/iccic.2010.5705900
13. P.I.J. Keeton, F.S. Schlindwein, Application of Wavelets in Doppler Ultrasound, vol. 17, number 1, MCB University Press, 1997, pp. 38–45. https://doi.org/10.1108/02602289710163355
14. I.A. Wright, N.A.J. Gough, F. Rakebrandt, M. Wahab, J.P. Woodcock, Neural network analysis of Doppler ultrasound blood low signals: a pilot study, Ultrasound in Medicine & Biology 23 (5) (1997) 683–690. https://doi.org/10.1016/s0301-5629(97)00011-2
15. I. Guler, M.K. Kiymik, S. Kara, M.E. Yuksel, Application of autoregressive analysis to 20 MHz pulsed Doppler data in real time, International Journal Biomedical Computing 31 (3–4) (1992) 247–256. https://doi.org/10.1016/0020-7101(92)90008-g
16. 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.
17. Santosh K. Maher, Sumegh Tharewal, Abdul Hannan, "Review on HRV based Prediction and Detection of Heart Disease", International Journal of Computer Applications (0975 – 8887), Pag 7-12, Volume 179 – No.46, June 2018. https://doi.org/10.5120/ijca2018917083
18. https://www.who.int/en/news-room/factsheets/detail/cardiovascular-diseases-(cvds)
https://www.mayoclinic.org/diseases-conditions/stroke/symptoms-causes/syc-20350113.
19. 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.
20. 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 SecApplicatiion (IJCA), New York, USA. https://doi.org/10.5120/ijca2019919714
21. Akram Ablsubari, Shaikh Abdul Hannan, Mohammed Eid Alzaharani, 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. https://doi.org/10.48084/etasr.2500
22. Yogesh Rajput, Shaikh Abdul Hannan, Mohammed Eid Alzaharani, 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. https://doi.org/10.1007/978-981-13-9184-2_44
23. 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, Singapore. https://doi.org/10.1007/978-981-16-0493-5_1
24. Y. M. Rajput, A. H. Hannan, M. E. Alzahrani, R. R. Manza, D. D. Patil, "EEG-Based Emotion Recognition Using Different Neural Network and Pattern Recognition Techniques–A Review", International Journal of Computer Sciences and Engineering, Vol 6, Issue 9, Sep 2018. https://doi.org/10.26438/ijcse/v7i1.615618
25. 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.
26. Eliane Rich and KevinKnight – Artificial Intelligence – Secone Edition Mcgraw Hill , 1983.
27. Long, W., et.al., "Developing a program for Tracking Heart Failure", MIT Lab for Computer Science, Cambridge, MA(2001).
28. Frase, H.S.F., et.al., "Comparing complex diagnoses a formative evalution of the heart disease program", MIT Lab for Computer Science, Cambridge, MA(2001)

29. Shaikh Abdul Hannan, A.V. Mane, R. R. Manza and R. J. Ramteke, "Prediction of Heart Disease Medical Prescription Using Radial Basis Function", IEEE International Conference on Computational Intelligence and Computing Research at Tamilnadu College of Engineering, Coimbatore, Tamilnadu, India, ICCIC-2010, December 28-29, 2010. https://doi.org/10.1109/iccic.2010.5705900
30. J. Galindo, P. Tamayo, Credit risk assessment using statistical and machine learning: basic methodology and risk modeling applications, Computational Economics 15 (1 – 2) (2000) 107–143
31. V. Vapnik, The Nature of Statistical Learning Theory, Springer- Verlag, New York, 1995.
32. M.A. Hearst, S.T. Dumais, E. Osman, J. Platt, B. Scho¨lkopf, Support vector machines, IEEE Intelligent Systems 13 (4) (1998) 18– 28. https://doi.org/10.1109/5254.708428
33. Broomhead D., & Lowe, D., Multivariable functional interpolation and adaptive networks. Complex Systems, vol.2, pp.321-355, 1988.
34. Haralambos Sarimveis, Philip Doganis, Alex Alexandridis, "A classification technique based on radial basis function neural networks", Advances in Engineering Software vol.37, pp.218–221, 2006. https://doi.org/10.1016/j.advengsoft.2005.07.005
35. Shaikh Abdul Hannan, Pravin Yannawar, R.R. Manza and R.J. Ramteke, "Expert System Data Collection Technique for Heart Disease" , in IT & Business Intelligence, on 06-08 Nov 2009, Organised By IMT, Nagpur, India.
36. Haralambos Sarimveis, Philip Doganis, Alex Alexandridis, "A classification technique based on radial basis function neural networks", Advances in Engineering Software vol.37, pp.218–221, 2006. https://doi.org/10.1016/j.advengsoft.2005.07.005
37. Chauvin in, Y and D.E. Ruumehart Backpropagation : Theory, Architechtures and Applications, Erbaum Mahwah, NJ, ISBN : 080581258. PP 561, 1995.
38. Shaikh Abdul Hannan, V. D. Bhagile, R.R. Manza, R. J. Ramteke, "Heart Disease Diagnosis By Using FFBP algorithm of Artificial Neural Network", International Conference on Communication, Computation, Control and Nanotechnology, ICN-2010 Organized by Rural Engineering College Bhalki-585328, during October 29-30, 2010.
39. Cigizoglu HK, Alp M. Generalized regression neural network in modelling river sediment yield. Adv Eng Software 2005;37:63–8. https://doi.org/10.1016/j.advengsoft.2005.05.002
40. Kim B, Lee DW, Parka KY, Choi SR, Choi S. Prediction of plasma etching using a randomized generalized regression neural network. Vacuum 2004;76:37–43 https://doi.org/10.1016/j.vacuum.2004.05.018
41. Jang JSR, Sun CT, Mizutani E. Neuro-fuzzy and soft computing: a computational approach to learning and machine intelligence, Prentice Hall, Upper Saddle River, New Jersey, USA; 1997 [Chapter 9].
42. Shaikh Abdul Hannan, R. R. Manza and R.J. Ramteke, "Association Rules for Filtering The Medicine To Avoid Side Effects Of Heart Patients", on 16 -19 Dec 2009, at Advances in Computer Vision and Information Technology – 09, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad. https://doi.org/10.23953/cloud.ijarsg.130
43. Anupriya Kamble, Abdul Hannan, Yogesh, Dnyaneshwari, "Association detection of Regular Insulin and NPH Insulin Using Statistical Features", Second International Conference on Cognitive Knowledge Engineering, 21-23 December 2016 (ICKE-2016), Aurangabad, Maharashtra, India, pp 59-62, ISBN 978-93-80876-89-4. https://doi.org/10.1109/sysmart.2016.7894490
44. Shaikh Abdul Hannan, Pravin Yannawar, R. R. Manza and R.J. Ramteke, "Data Mining Technique for Detection of Cardiac Problems Using Symptoms Medicine and Its Side effects", in IT & Business Intelligence -09 , in IT & Business Intelligence, on 06-08 Nov 2009, Organized By IMT, Nagpur, India.
45. 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).
46. Ordonez C," Association rule discovery with the train and test approach for heart disease prediction", IEEE Transactions on Information Technology in Biomedicine, P(334 – 343), April 2006 https://doi.org/10.1109/titb.2006.864475
47. 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. https://doi.org/10.35940/ijitee.f1072.0486s419
48. AbuKhousa, E "Predictive data mining to support clinical decisions: An overview of heart disease prediction systems", IEEE Transaction on Innovations in Information Technology (IIT), pp(267 - 272) March 2012. https://doi.org/10.1109/innovations.2012.6207745