ECG Signal Classification Using Hidden Markov Model and Artificial Neural Network

Mr. Ankit Sanghvi
PG Scholar,
Alamuri Ratnamala Institute of Engineering & Technology,
Mumbai, India

Prof. Sachin M. Bojewar
Asst. Professor,
Vidyalankar Institute of Engineering & Technology,
Mumbai, India

Abstract— Heart's abnormal activities are analyzed using electrocardiogram (ECG). The hearts arrhythmia is distinguished using electrical signals from ECG. Supraventricular Tachycardia, Ventricular Tachycardia, Tachycardia and Bradycardia can be analyzed. Here we use neural network to program with analog data and then test to validate the data set. Hyperkalemia and Myocardial Ischemia can be found on examining the T-wave and Hypocalcaemia can be found on calculating QRS interval. Abnormality detection becomes an essential in a Telecardiac system. Data will be extracted from MIT-BIH supraventricular database and ECG machine of expertise doctor. During the last fifteen years the wavelet transform has proven to be a valuable tool in many applications area of non-stationary signals such as biomedical signals and ECG particularly. Advantage of using wavelet transform is that it divides the characteristics of ECG into different scales with various resolutions. This helps anyone to extract the main features in the ECG signal for the analysis purpose by removing the high frequency noise

Keywords— Electrocardiogram, Cardiac Arrhythmia, MATLAB, Neural Network, Telecardiac system,

I. INTRODUCTION

Abnormal activities of heart which are called arrhythmias can be analyzed by an electrocardiogram (ECG). These arrhythmias are classified using details of electrical signals and by analyzing PQRST wave properties. Multiple data samples of normal ECG characteristics were read and analyzed for difference between normal signal and irregular signal. Data will be extracted from MIT-BIH supraventricular database and ECG machine of expertise doctor. Here we will analyze mostly chaotic and stochastic signals, though we know that chaotic and stochastic behaviour have limitation. Here we will try to classify which are directly or indirectly related to heart arrhythmias. Hidden markov model (HMT) and Artificial neural network (ANN) is used for signal analyzing, for pattern recognition tool in MATLAB will be used.

II. MOTIVATION

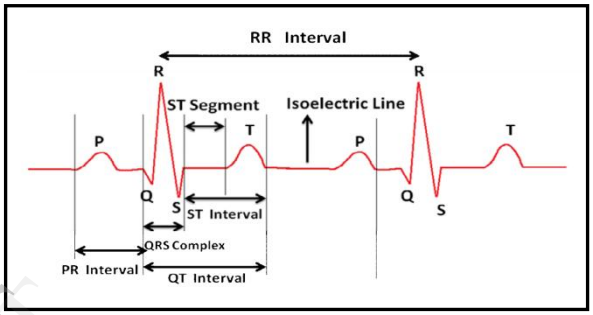


Figure shows the PQRST wave segments of ECG

ECG detection is the first step in guarantying the accuracy of heart-risk alert. For ex. Threshold – based wavelet transform method is used to deal with QRS complex detection. ECG beat recognition can be done by artificial neural network (ANN). If the ECG signals are clean and high fidelity then the health information can be understood properly. T wave and ST segment contain abundant information about cardiac disease like myocardial infraction, high risk CVD's (Cardiovascular diseases) causes changes in ST waveform. Also the diseases like sinus Bradycardia, sinus Tachycardia, Respiratory sinus Arrhythmia, Sinus Node disease, Atrial Tachycardia.

Stress and anxiety during pregnancy can influence the development of the fetus. Stress influences the cardiac system so ECG helps in detecting it.

III. LITERATURE SURVEY

A. Title:

"A novel multi-resolution SVM (MR-SVM) Algorithm to detect ECG signal Anomaly in WE-CARE project"

PQRST wave gives lot of information like

P wave- During atrial depolarization the main electrical vector is directed from the sino –atrial (SA) node towards the atrioventricular (AV) node and spreads from the right atrium to the left atrium the turns in to P-Wave.

QRS-complex- To reflect the rapid depolarization of the right and left ventricles, which have a large muscle mass compared to the atria, their fore the QRS-complex usually has much larger amplitude.

ST-segment- To connect the QRS complex and the T-wave, the ST-segment reflects the period when the ventricles are depolarized. It is isoelectric when its morphology is normal.

T-wave – To represent the repolarization (or recovery) of the ventricles, the interval from the beginning of the QRS-complex to the apex of the T-wave is reflected to as the absolute recovery period. And the last half of T-wave is referred to as the relative refractory period (or vulnerable period).
Technique: MR-SVM Algorithm (Multi Resolution Support Vector Machine), Basic idea is to decompose signals by orthogonal wavelet basis function and get useful information.
Conclusion: The algorithm suffering from much noise effects that is why the performance is downgraded.
Title: "A novel multi-resolution SVM (MR-SVM) Algorithm to detect ECG signal Anomaly in WE-CARE project"
PQRST wave gives lot of information like
P wave- During atrial depolarization the main electrical vector is directed from the sino –atrial (SA) node towards the atrioventricular (AV) node and spreads from the right atrium to the left atrium the turns in to P-Wave.
QRS-complex- To reflect the rapid depolarization of the right and left ventricles, which have a large muscle mass compared to the atria, their fore the QRS-complex usually has much larger amplitude.
ST-segment- To connect the QRS complex and the T-wave, the ST-segment reflects the period when the ventricles are depolarized. It is isoelectric when its morphology is normal.
T-wave – To represent the repolarization (or recovery) of the ventricles, the interval from the beginning of the QRS-complex to the apex of the T-wave is reflected to as the absolute recovery period. And the last half of T-wave is referred to as the relative refractory period (or vulnerable period).
Technique: MR-SVM Algorithm (Multi Resolution Support Vector Machine), Basic idea is to decompose signals by orthogonal wavelet basis function and get useful information.
Conclusion: The algorithm suffering from much noise effects that is why the performance is downgraded.

B. Title:

"A Journal of real peak recognition of electrocardiogram (ECG) signals using Neural network " – When ECG signals has been chosen by using an ANN method via MATLAB software then this approach is useful in real peak recognition since it provides valuable information to doctors regarding heart diagnosis and also indicate condition of heart.
Technique: An ECG signal has been chosen by using neural network method via matlab software.
Conclusion: Neural network pattern recognition is suitable software with high ability to classify input patterns into a corresponding output target with high efficiency. The real peak of ECG signals can be identified by training the network accordingly.

C. Title:

"ECG signal classification using Principal component Analysis with Neural Network in Heart Computer Interface Applications" – The characteristics features of ECG like QRS-complex, QRS-duration, R-peak height, T-peak, T-onset And T-offset points, T-peak height, ST and QT segment duration helps the clinical staff in disease diagnosis.
Technique: Artificial Neural Network (ANN) is a functional pattern classification technique which is trained all the way through the error Back-Propagation algorithm.
Conclusion: Principal classification of input data of neural network has been increased by using Principal Component Analysis with neural network and using other soft computing techniques like Fuzzy logic.

D. Title:

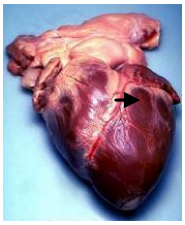
"Help system for medical diagnosis of Electrocardiograph" – Human heart beats ceaselessly about 60 times a minute until the end of his life, the disease can be identifies as Sinus Bradycardia (frequency< 60 beats per minutes), Sinus Tachycardia (frequency80 to 90 beats per minutes), Sinus node disease (ECG signal will be slow and may contain pauses), Atrial Tachycardia (Deformation of P Wave) etc.
Technique: Average filter Matlab code is used, filter consists to remove a linear trend of the vector using Fourier transform.
Conclusion: Algorithm would be improved so that it can run on any type of ECG signal.

E. Title:

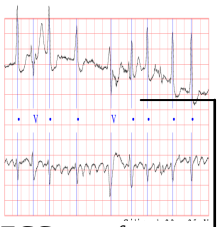
"Investigation and classification of ECG beat using input output additional weighted feed forward neural network"- A single normal cycle of ECG represents successive arterial depolarization and ventricular repolarization that occurs with every heartbeat. These can be approximately associated with the peaks and other ECG waveforms, labelled as P, Q, R, S and T.
Technique: Soft computing techniques are used for ECG classification, Features are extracted using Discrete Cosine Transform (DCT). Radial Basis Function (RBF), Multi-layer Perceptron Neural Network (MLP-NN), Multi-layer Feed Forward Network (FF-NN) which provides additional weights between the input layer and the output layer.
Conclusion: Using proposed method, the classification accuracy is improved up to some extent. Further work needs to be done in the area of optimization to select the best learning rate and momentum.

IV. PLAN OF PROJECT WORK

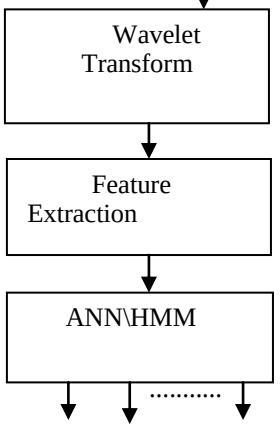
As per the old work done in this area, lots of work has to be done in this area. By my point of view CVD (Cardiovascular Disease) can be evaluated perfectly if we use Wavelet Transform Method with the help of Hidden Markov Model & Artificial Neural Network.
Rough structure of proposed work has to be done in this area are as follows:



Human heart



ECG waveforms



Electrocardiogram i.e. ECG data for the analysis and classification will be obtained from the MIT-BIH arrhythmia database, the MIT-BIH Ventricular Arrhythmia database and the MIT-BIH supraventricular arrhythmia database or necessary signals can be collected from local super-specialty hospitals. Various ECG segments will be selected from the databases for modeling and classification. The data set included around 200 segments each of normal ECG, APC, PVC, SVT, VT and VF. The data from the MIT-BIH arrhythmia and supraventricular arrhythmia databases may be re-sampled so that all the data used in the analysis had a same sampling frequency (say 250 Hz).Prior to modeling, the ECG signals may be preprocessed to remove noise due to power line interference, respiration, muscles tremors, spikes etc. Thus after removing noise, the data will be analyzed and features are extracted with the help of wavelet transform. Then the classifiers like neural networks and HMM system will be used for identification and classification.

V. CONCLUSION

If this planed technique for classification and detection has been implemented perfectly so, it is very useful for the classification of cardiac arrhythmias in critically ill patients and aid in the diagnosis of heart disease effectively. This technique is suitable for real-time implementations and can be used for diagnosis.

REFERENCES

[1]. Qian Zheng, Chao Chen, Zhinan Li "A Novel Multi-Resolution SVM (MR-SVM) Algorithm to detect ECG signals anomaly in WE-CARE project" Center for wireless communication and signal processing.Vol 04, No. 02, Mar-2012.

[2]. Izzah Amani Tarmizi, Dr. Syed Sahal Nazli Alhady Syed Hassan "A Journal of Real Peak Recognition of Electrocardiogram (ECG) Signal Using Neural Network" 978-1-4673-0734-5/12/$31.00©2012 IEEE. Page 504-510.

[3]. Kottaimalai R, Pallikonda Rajasekaran M, Selvam V, Kannapiran B (2013) "ECG signal classification using Principal component Analysis with Neural Network in Heart Computer Interface Applications" 978-1-4673-5036-5/13/$31.00©2013IEEE. Page 227-230.

[4]. Sarikal, p., & Wahidabanu, R. (2010) "Help system for medical diagnosis of Electrocardiograph" (IJACSA) International Journal of Advanced Computer Science Applications, 1(6), 48-53.

[5]. R Ganesh Kumar, Y S Kumaraswamy (2013) "Investigation and classification of ECG beat using input output additional weighted feed forward neural network"- 2013 International Conference on Signal Processing and Pattern Recognition [ICSIPR], 978-1-4673-4862-1/13/ $31.00© 2013IEEE.

[6]. Gothwal, H., Kedawat, S., & Kumar, R. (2011). "Cardiac arrhythmias detection in an ECG beat signal using fast fourier transform and artificial neural network". Journal of Biomedical Science & Engineering, 4(4), 289-296.

[7]. Vijaya, V., Rao, K., & Rama, V. (2011). "Arrhythmia detection through ECG feature extraction using wavelet analysis", European Journal of Scientific Research, 66(3), 441-448.7 Page

[8]. Jacqueline Wijsman, et al., "Towards mental stress detection using wearable physiological sensors " , 33rd Annual International Conference of the IEEE EMBS, 2011.

[9]. A website on http:/ biology.about.com/ library/organs/heart/blatrionode.htm, image courtesy of Carolina Biology Supply / Access Excellence.

[10]. Elif Tuba Celik, Bogdan Hurezeanu, A.D., M.M., " Fatal ECG representation using recurrence plot analysis" Polytechnic university of Buchrest, Romania, Military Technical Academy Bucharest, Romania. 978-1-4673-1740-5/12/©2012IEEE.

[11]. Hari Mohan Rai, Anurag Trivedi, " ECG signal classification using Wavelet Transform and Back Prapogation Neural Network" 2012 5th International conference on computers and devices for communication (CODER).

[12]. S. Behbahani and N. J. Dabanloo, "Detection of QRS complexes in the ECG signal using Multiresolution wavelet and thresholding method" IEEE Computing in Cardiology, pp. 805-808, 2011.

Mr. Ankit S. Sanghavi
Received the B.E. Degree from the Department of Computer Science and Engineering affiliated to Sant Gadge Baba Amravati University, Maharashtra in 2009. He is currently pursuing M.E. in Computer Engineering degree under the guidance of Prof. Sachin M. Bojewar.