ECG Signal Fibrillation Classification on Android Platform: A Survey Approach

Kritika Bawa, Pooja Sabharwal

Abstract*— Electrocardiography deals with the electrical activity of the heart. The condition of cardiac health is given by ECG and heart rate. Automatic analysis of cardiac diseases is the vast area of research,. In literature there are number of techniques for classification of ECG signal on Android platform. ECG signal is the most commonly used for diagnosing various heart related disease like ventricular fibrillation, artial fibrillation, arrhythmia detection, premature ventricular contraction, Tachycardia, Bradycardia etc,. This paper presents a comparative study of the techniques used in the literature.

***Index Terms*— ventricular fibrillation, arterial fibrillation, fuzzy, neural networks, ECG**

I. INTRODUCTION

Heart disease has become major problem for both the developed and developing countries. But nowadays, it has become easier to detect the disease at earlier stage by electrocardiograph (ECG). ECG has become a golden tool and an effective medium to detect the various abnormalities of heart. ECG is a non-invasive device for the detection of the disease related to the heart .It records the data and further this data is used for analyzation of any abnormalities. Abnormalities can be enlargement of heart, abnormal heartbeats, and thickened heart. ECG classification can be done using android phones which has solved the problem for the doctors. With the help of different technology it is possible to monitor the ECG signals continuously and there are devices which sends the alarm, messages directly to the doctors.ECG signal waveform consists of three different wave shapes, these are P wave, QRS complex, and the T wave. The ECG result is in the form of waves or spikes. The P wave represents the electrical excitation of the two artria or arterial depolarization. The QRS wave represents the electrical excitation of the two ventricles or ventricular depolarization. The T wave represents the repolarization of the ventricles. The P wave has amplitude of 0.2 mv, QRS wave has a amplitude of approximately 1mv and T wave has a variable amplitude ranging from 0.1 to 0.3 mv. ST segment is the region between the ORS complex and T wave which is the period between ventricular depolarization and repolarization.QRS complex is used in various algorithms for detecting ECG beats due to its high amplitude and its short duration which helps it in making an important feature. ECG signal can be analyzed by data compression, feature detection, feature extraction, heart rate variability (HRV) and R-wave detection.ECG R wave detection plays a vital role in ECG analysis algorithms. Once the position of R-wave peak is found other components location can be found. By knowing the relative position of R wave peak we can locate the Q, S waves. T wave position is relative to the S wave and P wave position is relative to the Q wave. R wave peak detection plays a very important role in ECG signal analysis.

II. COMPARITIVE STUDY OF THE WORK DONE TILL NOW

Uvais Qidwai, Mohamed Shakir, in their paper there is a monitoring system in which there is incorporation of the ECG measured values corresponding to different types of cardiac health conditions are there. Then there is an analyzation of the ECG signals and then the decisions are issued to the Android gateway [1] cellphones for further broadcasting the information and waveforms to the doctors for further quick response by them. In this a unique identification algorithm is used for classification of Second degree Atrio-Ventricular block type, Premature Ventricular Contraction, Ventricular Fibrillation. Android SDK had been used for the third generation smart phones. This method can be used as classifiers as well as predictor .for arrhythmia problem. In this change of waveform is 100% detected correctly by the algorithm but there is a limitation of processing delay which requires 13 seconds to take the decision which is available for transmission.

Noureddine Belgacem, Said Assous, in their paper a MATLAB based Graphical User Interface(GUI) has been used for storage and processing of ECG signal which is a low cost method. In this smartphones using IEEE 802.15.1 is wirelessly connected with the ECG devices. This consist of analog system[2] and a Bluetooth transceiver, flexible and stretchable for monitoring purposes.QRS detection algorithm is used for ventricular fibrillation and MATLAB is used for designing of the software. The ECG systems in this was able to transmit and detect the basic elements w ith high quality and efficiency of the ECG waveform.

Fabian Meija Martinez, Efrain Bernal Alzate, in their paper clinical and non-clinical environment have been proposed for ECG monitoring systems. Detection and alarm monitoring is performed by the prototype. Base Algorithm, QRS detection algorithm, Cardiac event detection algorithm are used in this. Linus operating systems is used for implementation. Detection of various diseases like Tachycardia, bradycardia, acute myocardial infarction and ventricular fibrillation had been done. The best overall capacity is given by bz2 CR compression algorithm which is better than rar CR algorithm. The bz2 algorithm [3] has compression rates which has the advantage of no information loss and is compatible with embedded OS.

Joseph J.Oresko, Zhanpeng jin, in their paper they have united the portability and real time processing capability of holter monitors and ECG

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machines which are used to provide an effective diagnosis solution along with the use of smart phones. In this two smart phones based wearable CVD detection have been developed which helps in the performance of real time ECG acquisition. It also helps to extract the features from the signals, data acquisition [4] and beat classification. Disease like Arrhythmia, Cardiovascular disease has been detected .MATLAB is used in this along with QRS detection algorithm. In this verification of algorithm has been done offline and online by using MIT-BIH database. They have provided ECG signal that is recorded offline as well as a platform is provided for real-time CVD monitoring.

Shijie Zhou,Zichen Zhang, they had presented and implemented a time domain algorithm architecture on a smart phone for ECG signal analysis. In this QRS detection algorithm is used by which heart beats are detected and classified as premature ventricular contractions [6] and normal beats which had been suggested by Pan-Tompkins and the beat classification Method. They have presented a method which is very efficient to separate ventricular tachycardia (VT) and ventricular fibrillation (VF).For coarse-graining process Lempel and Ziv complexity analysis along with K-means algorithm has been utilized and a classification of new rule is presented to recognize VT and VF .In this implementation of algorithm has been done in Carbide C++ emulator and a Nokia S60 smart phones. They achieved a good performance while using MIT-BIH database.

K.W.Goh,E.Kim, J.Lavanya, Y.Kim, C.B.Soh, they have designed a health monitoring system in order to detect the problem which people are suffering i.e. cardiac arrhythmia .For appropriate performance of ECG analysis techniques they have developed computer simulation models which can be implemented on personal mobile devices. There is an ECG analyser which performs episode [7] and ECG beat classification. In this QRS detection algorithm has been used along with Microsoft .net platform with c#. Disease like normal sinus rhythm (NSR), premature ventricular contraction (PVC),ventricular bigeminy (VBG),ventricular trigeminy (VTG), ventricular couplet (VC),ventricular tachycardia (VT), ventricular fibrillation (VF), 2nd degree heart block (BII) had been detected. The algorithm which they had used has shown good performance to detect PVC, NSR, VF arrhythmia.

Fernando Arena Varella, Guilherme Lazzarotto de Lima, Cirano Iochpe, Valter Roesler they have proposed a method which performs the classification of ECG beats on mobile phones. They had used Discrete Wavelet Transform and Higher Order Statistics in order to extract features from each ECG beat and then a Multilayer Perceptron [8] to classify it between six types of beats. Disease like Left Bundle Branch Block (LBBB), Right Bundle Branch Block (RBBB), Premature Ventricular Contraction (PVC), Atrial Premature Beat (APB) and Paced Beat (PB) are detected. In this, 99.83% overall accuracy and greater than 99.48% sensitivity rates for all beat has been achieved. To classify each heart beat only 27ms is required, which in giving better performance with computer-aided diagnosis on remote and critical situation.

Peter Leijdekkers, Valerie Gay, in their paper ubiquitous computing is combined with mobile health technology in order to monitor the wellbeing of cardiac patients who have a greater risk .In this they used personalized heart monitoring system along with smart phones and bio sensors. Smart phones [9] help in analyzing real time ECG data and help in determining whether someone needs any external help. They detected ventricular fibrillation (VF) and ventricular tachycardia (VT).Smart phones further forward the information through alarm alert for the ambulance and medical care is given to a person whosoever is suffering from the disease. In this three warning levels have been defined i.e. Red warning level depicts immediate intervention, Yellow warning level depicts that a level is reached where the user need to be carefull and green warning level depicts everything to be normal.

Kristoforus Hermanwan ,Aulia Arif Iskandar and Reggio N.Hartono, they had developed ECG signal interpretation Software on Android2.2 platform. It consist of Ecg data preparation, QRS detector, heart rate [10] and QRS time extraction and classification. Disease like Premature Ventricular Contraction (PVC) and Supra Ventricular Tachycardia (SVT).They used Android Java which was written in Eclipse software. They gathered all the data from the MIT-BIH Arrhythmia for evaluation of the performance of the software. The software accuracy had given a very good overall performance. In this they have approached to 99.15% average N-accuracy, 84.22% average V-accuracy, 97.78% average SVT accuracy and the overall accuracy was 93.71%.

Fahim Sufi and Ibrahim Khalil ,they had performed real-time classification of CVD which is an innovative technique, hospital or the doctors are automatically informed about the user suffering from cardiac abnormality of the CVD[11] through SMS/MMS/e-mail. First of all they used data mining i.e. they selects some features from the compressed form of ECG and expectation maximization (EM) based clustering .These techniques produces a set of constraints which helps in representing the abnormalities. Mobile phone of the patient then receives the set of constraints and it can identify each of abnormal beats in real time with the help of rule based system which had been employed in the phone. Expectation maximization algorithm had been used along with the java in Net Beans interface. Disease like ventricular flutter, ventricular fibrillation, premature ventricular contraction, atrial fibrillation had been detected. It had a good approach of 97% accuracy which help a lot in successfully detecting cardiac abnormalities .Compressed ECG packets had helped a lot to them in providing faster identification of cardiac abnormalities to develop a best telecardiology diagnosis system.

N Jannah, S.Hadjiloucas, F.Hwang and R K H Galvao , they had parameterized the ECG waveform in wavelet domain in order to classify ECG. With the help of Smart phones i.e. mobile phones they had developed an accurate classification algorithm that can be used to diagnose cardiac beat abnormalities. European ST-T database had been decomposed by using discrete wavelet transform filter banks in the wavelet domain and then these coefficient are filtered and used as an input for the neural network classifier. They had worked on improvement area of reduction of memory [12] for the signals which is important for mobile application In this neural network and wavelet domain using discrete wavelet transform has been used. Disease like heart beat rates, arrhythmias, myocardial infarctions, atrial enlargements, ventricular hypertrophies, bundle branch blocks, abnormal cardiac rhythm, abnormal cardiac conduction, ischemia of

myocardium, and cardiac hypertrophy had been detected.
Hristo Mateev, Iana Simova, Tzvetana Katova, Nikolay Dimitrov, Ivaylo Christov, they had evaluated 60 patients and had applied simultaneously heart rhythm telemonitoring system TEMEO and standard Holter ECG. Then they compared the data from both types of monitoring systems. There was also comparison between the TEMEO derived and standard ECG. The evaluation of level of agreement [13] between Holter ECG derived and TEMEO derived parameters and they founded high and statistically significant correlation coefficients for maximal and minimal heart rate, % of time in single supraventricular ectopic and tachycardia beats. 99.3% of accuracy was got then they compared TEMEO derived ECGs with standard ECGs. Disease like heart rate, rhythm, ventricular ectopic beats, atrial fibrillation, supraventricular ectopic beats. QRS algorithm is used in this. In this analyzation of the ECG recordings were done by considering different parameters. There was the coincidence of the percentage between the TEMEO and standard ECG that is 99.3%.Recording which was taken for TEMEO had helped to achieve proper determination of all the parameters. The system is very much efficient in recording of the events of artrial fibrillation
Henian Xia1, Gabriel A Garcia1, Joseph C McBride, Adam Sullivan, Thibaut De Bock,Jujhar Bains, Dale C Wortham, Xiaopeng Zhao, In this different time series techniques had been explored to evaluate ECG quality which also includes time domain analyses, frequency domain analyses, cross correlation, joint correlation, joint time-frequency analysis and entropy analysis. They had proposed two algorithms which were based on these techniques. In the first algorithm there are multi-stage tests. In this acceptable quality [14] is that when all the tests are passed by records. In the second algorithm, the regularity of ECG is measured and different results are essembled in to a matrix. Multistage algorithm is used along with MATLAB. They had worked to detect cardiovascular diseases. In this ,85% of accuracy is achieved by the multistage algorithm.90% of accuracy is achieved by the regularity matrix and this method produces scores ranging between 0 and 1 but in multistage algorithm output is in the form of yes or no.
Chin-Teng Lin, Kuan-Cheng Chang, Chun-Ling Lin, Chia-Cheng Chiang, Shao-Wei Lu, Shih-Sheng Chang, Bor-Shyh Lin, Hsin-Yueh Liang, Ray-Jade Chen, Yuan-Teh Lee, and Li-Wei Ko, In this a novel wireless, real time, telecardiology system is presented in this for improvement of the healthcare[15] for cardiovascular disease. In this system lightweight and power saving wireless ECG device which is equipped with automatic warning expert system. In this with the help of Bluetooth acquired ECG signal are transmitted instantaneously to the mobile phones and at last processed by the expert system. On detection of the abnormal ECG an alert signal is transmitted to the remote database server where all the data is maintained. Alarm is also generated if there is a need of emergency required, alert alarms will be generated to the hospital and some means of emergency is provided i.e. ambulance. QRS-Wave-Detection Algorithm, algorithm1 and algorithm2 had been used along with Java. Disease like sinus tachycardia, sinus bradycardia, wide QRS complex, atrial fibrillation (AF), and cardiac asystol was 94% of accuracy is provided by this system with high sensitivity, prediction rates and specificity. Results from algorithm 2 is better than from algorithm1i.e having 94% of average accuracy, 94.56% of sensitivity and 99.39% of positive predictive performance detected.
Cheng Wen , Ming-Feng Yeh , Kuang-Chiung Chang , Ren-Guey Lee, They have proposed ECG telemonitoring system which is based on platform i.e. of mobile phones. In this Holter performs [16] the function of identifying the abnormal heartbeats and if identified it transfer all the data to the database of hospitals through MMS or SMS on GPRS and in this way GPRS information helps in providing emergency to the user who needs help. In this they had used MIT-BIH arrhythmia database. ECG classification algorithm along with java language using CLDC and MIDP on Linux OS. 98.98% of accuracy is achieved in this system. For clean records it has achieved 99.24% of accuracy and for noisy records it has achieved 98.81% of accuracy. This shows that proposed algorithm is robust in nature among noise and movement artifacts.

III. RESULTS

TABLE I.

Author	Results
Joseph n etal	Prediction accuracy-90%, Prediction accuracy for fusion of Paced and normal beat 81%.
Zichen,Jason n etal	Sensitivity on SR Signal –100%, Sensitivity on VT and Sensitivity on VF 94.74%.
E.Kim,J.Lavanya n etal	Sensitivity for NSC-100%, PVC-80%, VF-94%.
Varella, , Lima n etal	99.83% Overall accuracy, sensitivity rate is greater than 99.48% for all beat.
Zhou , Zhang n etal	Sensitivity on SR signal is 100%,sensitivity on VT is 96.94% and sensitivity on VF is 94.74%
Iskandar,Hartono n etal	Overall frequency for heartbeat is 97.10%,average N-accuracy-99.15%,average V-accuracy-84.22%,average SVT accuracy of 97.78%,overall classification accuracy-93.71%
Sufi ,Khalil n etal	97% of overall accuracy
Xia, Garcia, J Sullivan n etal	Accuracy for the training set is 93.5%.
Cheng Chang,Lin, n etal	94% accuracy
Cheng Wen , Yeh , Lee n etal	98.98% accuracy

IV. CONCLUSION

Although a lot of studies dealing with classification are present in the literature, a strict comparison of the results is difficult to perform, since different heartbeat categories were used and different ECG datasets were considered. From the above comparison wavelet

transform is best for feature extraction and different classifiers are presented. The feature extraction technique or algorithm developed for ECG must be highly accurate and fast

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