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Developing Detection Technique of Arrhythmia using Basic ECG Parameters

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Abstract

Arrhythmia is simply known as the irregular or abnormal beating of heart. This paper presents a procedure to extract information from Electrocardiogram (ECG) data and determine types of Arrhythmias. The decisions were achieved by determining different intervals such as PR Interval, RR Interval, Heart Rate (HR) etc. and those intervals were compared with the ideal intervals. During the whole process ECG signals were taken from PhysioBank ATM and Savitzky–Golay filter was used to reduce the noise of the signal. Tachycardias, Bradycardia, Heart Block, Junctional Arrhythmia, Premature Articular Contraction were detected during this analysis and the results show simplified detection of arrhythmia.

Keywords: Electrocardiogram; Arrhythmia; PR Interval; RR Interval; Heart Rate.

1. Introduction

An arrhythmia is the abnormal rhythm of heart. It is also known as dysrhythmia. It causes the heart to pump less effectively. There are a lot of changes in the shape of the heart wave because of arrhythmia. ECG is a common term in the diagnosis of cardiac diseases. It provides information about the electrical activity of the heart. We can detect different kinds of heart diseases by analyzing the ECG signal. Higher efficiency in classifying ECG signal is very important nowadays. There are different sorts of arrhythmias. Different kinds of arrhythmias can be detected in different parts of the heart. Heart pumps blood in a regular way. But when it is affected by arrhythmia, it can’t pump blood normally.

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Right bundle branch block (RBBB), left bundle branch block (LBBB), premature ventricular contractions (PVC), ventricular fibrillation (VF) are some serious arrhythmias. However ECG being a non-stationary signal, the irregularities may not be periodic and may not show up all the time, but would manifest at certain irregular intervals during the day. So, continuous ECG monitoring permits observation of cardiac variations over an extended period of time, either at the bad side or when patients are ambulatory, providing more information to physician. The heart rate and the morphology reflect the cardiac health of human heart beat [1]. It is a noninvasive method which means this signal is measured on the surface of human body, which is used in identification of the heart diseases [2].

1.1 Electrocardiography

Electrocardiography is the recording of the electrical activity of the heart. A typical ECG tracing of the cardiac cycle (heartbeat) consists of a P wave, a QRS complex, a T wave, and a U wave.

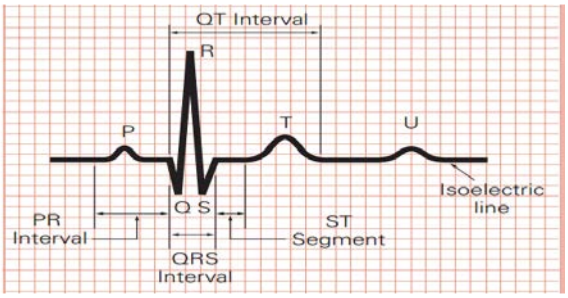

Figure 1.1: Typical ECG Signal

For Arrhythmia detection we went through the Time Domain based technique. The technique is followed by ECG signal processing, determination of PR Interval, QRS Interval, QT Interval, ST segment, RR Interval (To determine Heart Rate) followed by Arrhythmia detection via decision making rules.

Table 1.1: Normal ECG Signal Characteristics

Component	Characteristics
Heart Rate	60-100 BPM
PR Interval	0.12-0.2 sec
QRS Interval	0.06-0.10 sec
QT Interval	Less than half of the R-R interval
ST segment	0.08 sec

2. Proposed ECG based Arrhythmia detection:

The signals used in this process were taken from MIT-BIH database. The signals are sampled at 360Hz. From

Figure 1, we can see a typical ECG signal showing P, Q, R, S, T & U points including PR Interval, QRS Interval, QT Interval, ST Segment, Isoelectric line. The ECG parameters shown in Table 1 are important in finding the arrhythmia. Our proposed method is described using the flow diagram shown in Figure 2.1.

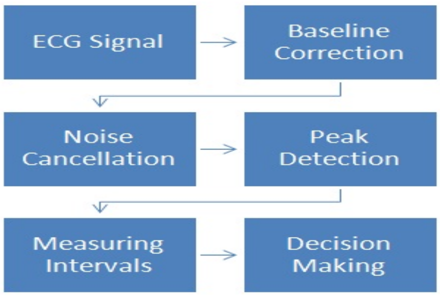

Figure 2.1: Flow diagram for proposed method

Firstly, here is the ECG signal shown in Figure 2.2. This is a noisy signal with variable baseline. Also the peaks cannot be detected easily.

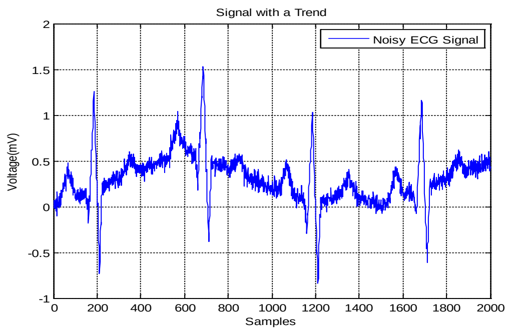

Figure 2.2: Actual ECG Signal

2.1Baseline Correction and Signal Smoothing

The original ECG Signal is fed through smoothing filters. At the output of the smoothing filter, baseline of the signals was corrected and is shown in Figure 2.3.

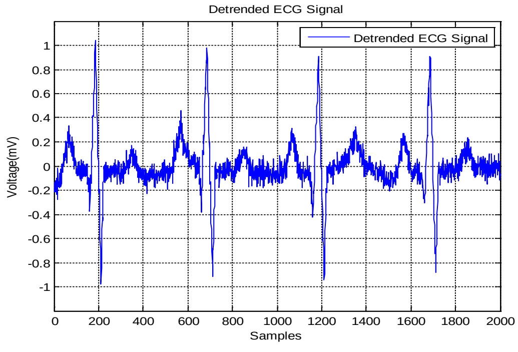

Figure 2.3: Baseline Corrected ECG Signal

2.2 Noise cancellation using Savitzky–Golay Filter

Savitzkey-Golay filter is used to cancel the noise in the ECG signal. Savitzkey-Golay filter is widely known for its signal noise cancellation. The ECG signal after using Savitzkey-Golay filter is shown in Figure 2.4.

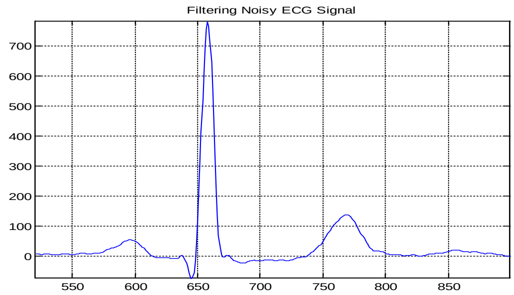

Figure 2.4: Noise cancellation using Savitzky–Golay Filter

2.3 Locating Peaks

P, Q, R, S, T peak detection is a tough task. Especially, when the ECG signal is not normal, more than two peaks are found. We used a algorithm to eliminate the unnecessary peaks. After using the algorithm, the program was able find the peaks in all conditions. Figure 6 shows the detection of peaks.

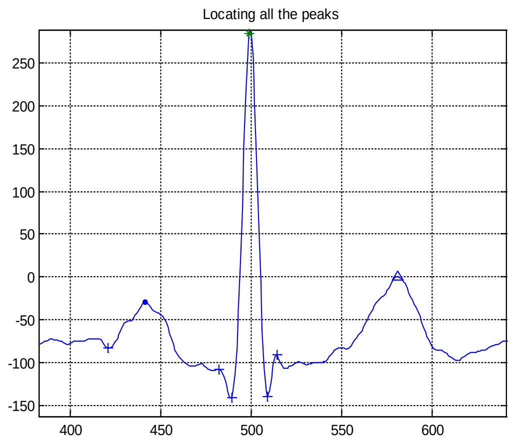

Figure 2.5: Peak Detection

2.4 Measuring Intervals

After locating peak points, different intervals, such as: PR Interval, QRS Interval, QT Interval, ST segment, RR Interval were measured.Heart Rate (HR) can be measured.

2.5 Decision Making

We have consulted with different cardiologists for decision making process and finally came up with six decision making rules.

Sample MATLAB Code used in our program is given below:

```
if f1>0 && f2==0 && f3==0; disp ('Heart Rate Normal')

else if f2>0 && f3==0; disp ('Tachycardia')

else if f3>0 && f2==0; disp ('Bradycardia')

% else if f3>0 && f2>0; disp ('PACs detected')

else if f5>0; disp ('Heart Block Detected')
```

3. Simulation & Result

For this evaluation, confusion matrix criteria was taken into account. The popular MIT-BIH database is used for extracting ECG beats of different arrhythmia for simulation.

3.1 Simulation Database

In our proposed method, we have used MIT-BIH arrhythmia database [17]. The ECG recordings are sampled at 360 samples per second per channel with eleven beat resolution over a 10 mV range. The signal 103 is used from MIT-BIH database [17] to calculate different intervals. Heart rate is also calculated from different sample of that signal. These intervals for 11 samples from 103 number dataset is shown in Table 3.1.

Table 3.1: Extracted data from ECG Signal

PR Interval	QRS Interval	Heart Rate (HR)
0.1778	0.0944	69.6774
0.1778	0.0917	71.7608
0.1722	0.0917	71.0526
0.1722	0.0889	71.5232
0.1806	0.0889	69.0096
0.1861	0.0972	65.0602
0.1750	0.0944	68.1388
0.1694	0.0889	72.0000
0.1750	0.0917	72.0000
0.1722	0.0917	71.2871
0.1778	0.0944	70.2580

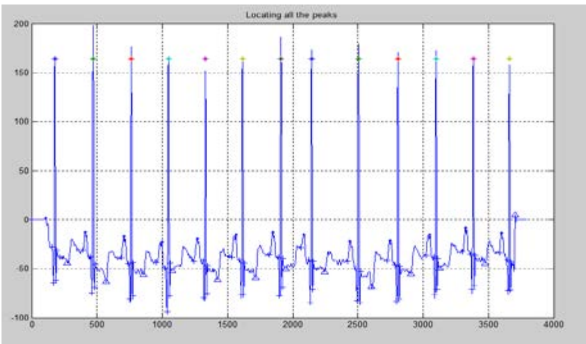

Figure 3.1: Testing Signal #100(Normal signal)

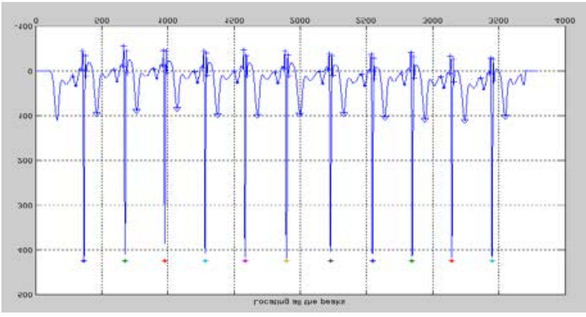

Figure 3.2: Testing Signal #103(Normal signal)

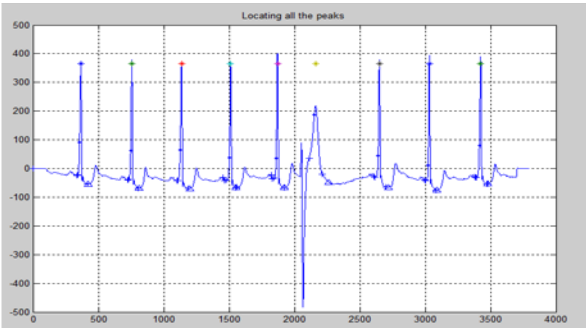

Figure 3.3: Testing Signal #114-1(PVC)

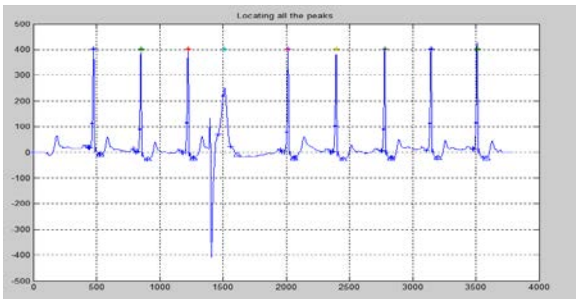

Figure 3.4: Testing Signal #114-2(PVC)

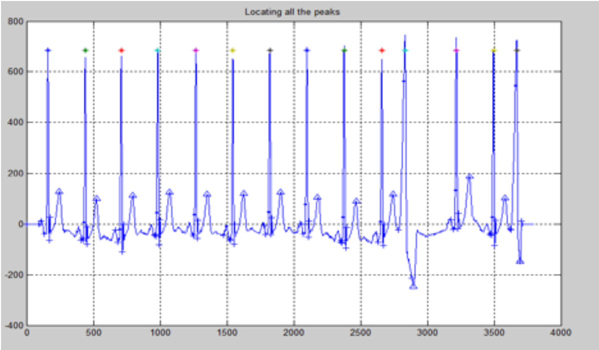

Figure 3.5: Testing Signal #116(PVC)

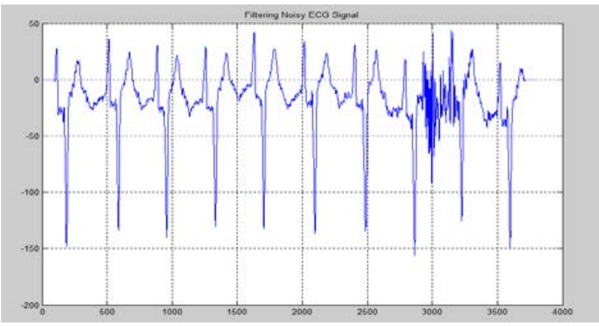

Figure 3.6: Testing Signal #108(Heart Block)

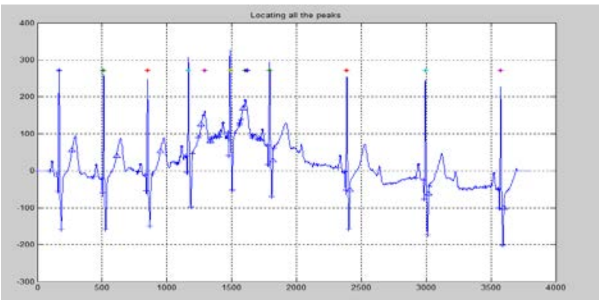

Figure 3.7: Testing Signal #231-1(Heart Block)

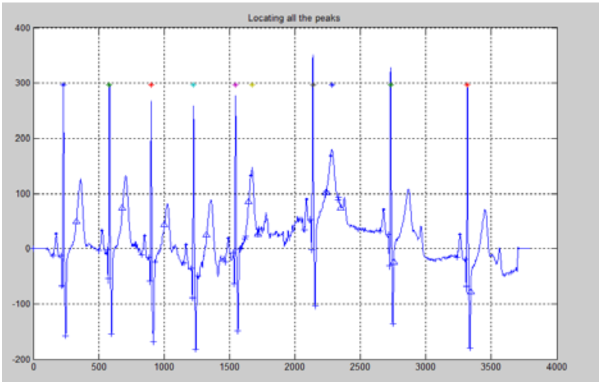

Figure 6.6: Testing Signal #231-2(Heart Block)

After using our program and simulation, the arrhythmias are detected and compared with the database results and are listed below at Table 3.2

Table 3.2: Arrhythmia Detection from different sample

S.N.	Classification
01	Heart Block
02	Normal
03	Normal
04	Junctional Arrhythmia
05	Junctional Arrhythmia
06	Bradycardia, Junctional Arrhythmia
07	Tachycardia
08	Bradycardia, Junctional Arrhythmia
09	Premature Ventricular Contraction (PVC)
10	Premature Ventricular Contraction (PVC)

4. Calculated data & Comparison

Table 4.1: Confusion matrix table

Type	Normal	Heart Block	PVC
Normal	627	7	10
Heart Block	3	319	0
PVC	4	18	237

Table 4.2: Sensitivity calculation

Type	Sensitivity	Overall sensitivity
Normal	97.36%	96.08%
Heart Block	99.37%	
PVC	91.51%	

Table 4.3: Specificity calculation

Type	Specificity	Overall Specificity
Normal	96.95%	95.66%
Heart Block	97.36%	
PVC	92.67%	

So, our overall efficiency is 89%

Sensitivity is 96.08% and

Specificity is 95.66% .

5. Conclusion

In this paper, we've shown a program to identify features from an ECG signal and detect different sorts of Arrhythmia. To test our program we've used data files (in .mat format) taken from Physio Bank ATM of MIT-BIH database. At first the efficiency was quite low because we tested very few data from the database. After that, we increased the number of samples and data and have found more efficient result. Randomly we have selected ECG beats. Decision making rules were made taking help from several cardiologists. Five-step procedure was taken to find the arrhythmia. The results shown here gives an easy way to detect different arrhythmias. To improve the accuracy further, we had to increase the number of parameters in the decision making process. That helped us to improve the calculated sensitivity, specificity and accuracy which were good.

5. Future Work

There are a lot of other methods which can be combined with our proposed method. By this combination, we hope our result will be more efficient and also by using more data, the result will be more efficient We have classified only normal, Bradycardia, Tachycardia, heart block and PVC ECG signals. In future, we will try to classify other types of abnormal ECG signals. We have used MIT-BIH database [17]. We can use other databases in the future and we will try to create our own database.

References

[1]. Wen Wei and Jerry M. Mendel, "A Fuzzy Logic Method for Modulation Classification in Nonideal Environments", IEEE Transactions on Fuzzy Systems, Vol. 7, No. 3, June 1999, pp. 333-344.

[2]. Tomoharu Nakashima, Gerald Schaefer, Yasuyuki Yokota, HisaoIshibuchi, "A weighted fuzzy classifier and its application to image processing tasks", Fuzzy Sets and Systems 158, 2007, pp. 284 – 294.

[3]. Reza Boostani, MojtabaRismanchib, Abbas Khosravani, LidaRashidi, SamanehKouchaki, PayamPeymani, SeyedTaghiHeydari, B. Sabayan, K. B. Lankarani, "Presenting a hybrid method in order to predict the 2009 pandemic influenza A (H1N1)", Advanced Computing: An International Journal (ACIJ), Vol.3, No.1, January 2012, pp. 31-43.

[4]. Ken Nozaki, HisaoIshibuchi and Hideo Tanaka, "Adaptive Fuzzy Rule-Based Classification Systems", IEEE Transactions on Fuzzy Systems, Vol. 4, No. 3, 1996, pp. 238-250.

[5]. Jia Zeng and Zhi-Qiang Liu, "Type-2 Fuzzy Sets for Pattern Recognition: The State-of-the-Art", Journal of Uncertain Systems, Vol.1, No.3, 2007, pp. 163-177.

[6]. F. Hoffmann, B. Baesens, J. Martens, F. Put and J. Vanthienen, "Comparing a genetic fuzzy and a Neuro-fuzzy classifier for credit scoring", presented at Int. J. Intell. Syst., 2002, pp. 1067-1083.

[7]. F.M. Schleif, T. Villmann, B. Hammer, “Prototype based Fuzzy Classification in Clinical Proteomics”, International Journal of Approximate Reasoning, 2008, 47(1), pp. 4-16.

[8]. Aaron K. Shackelfordand Curt H. Davis, “A Hierarchical Fuzzy Classification Approach for High-Resolution Multispectral Data Over Urban Areas”, IEEE Transactions on Geo-science And Remote Sensing, Vol. 41, No. 9, September 2003, pp. 1920-1932.

[9]. Benoit Mandelbrot, “How long is the coast of Britain?” Science, New Series, Vol. 156, No. 3775, May 5, 1967, pp. 636-638.

[10]. B. Mandelbrot, “The fractal geometry of nature”, Wh. Freeman, 1983.

[11]. S. Raghav and K. Misra, “Fractal Feature Based ECG Arrhythmia Classification”, IEEE, 2008, pp. 1-5.

[12]. L. Y. Shyu, Y. H. Wu, and W. C. Hu, “Using wavelet transform and fuzzy neural network for VPC detection from the holter ECG,” IEEETrans. Biomed. Eng., vol. 51, no. 7, pp. 1269–1273, Jul. 2004

[13]. Z. Benyd L. Czinege, Computer Analysis of Dynamic Systems with Application in Physiology, Proc IS" Worldcongress of MACS on Scient$c Computation, Modelling and Applied Mathematics.Berlin, 1997. Vol. El. pp. 663-668.

[14]. V. Kecman, Learning and Soft Computing Support vector machines Neural Networks-Fuzzy Logic, MIT, 2001

[15]. HA Guvenir, B Acar, Feature Selection using a Genetic Algorithm forthe detection of abnormal ECG recordings, International Conference onMachineLearning,Florida, 2001.

[16]. ECG Notes Interpretation & Management Guide, Shirley A. Jones

[17]. Online resource for physiologicalSignals. http://www.physionet.org