INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN: 2278 – 0211 (Online)

ECG Analysis And Detection Of Arrhythmia Using MATLAB

Ms. P. G. Patel
M.E. Student, Department of Biomedical Engineering
MGM's College of Engineering & Technology
Mumbai University, Navi Mumbai, Maharashtra, India
Prof. J. S. Warrier
Department of Biomedical Engineering
MGM's College of Engineering & Technology
Mumbai University, Navi Mumbai, Maharashtra, India
Prof. U. R. Bagal
HOD in Biomedical Engineering Department
MGM's College of Engineering & Technology
Mumbai University, Navi Mumbai, Maharashtra, India

Abstract:

This paper has been inspired by the need to find an efficient method for ECG Signal Analysis which is simple and has good accuracy and less computation time. For analysis the ECG signals from MIT database are used. The initial task for efficient analysis is the removal of noise and detection of QRS peaks. It actually involves the extraction of the QRS component by rejecting the background noise. This task is done using Pen Tompkins algorithm. The second task involve calculation of heart rate, detection of tachycardia ,bradycardia , asystole and second degree AV block from detected QRS peaks using MATLAB. The results show that from detected QRS peaks, arrhythmias which are based on increase or decrease in the number of QRS peak, absence of QRS peak can be diagnosed.

Keywords: *ECG, tachycardia, bradycardia, asystole, second degree AV block, MATLAB*

1.Introduction

Electrocardiography measures the electrical activity of the heart. The activation of the heart starts at the sino-atrial node that produces the heart frequency, at about 70 cycles per minute. This activation propagates to the right and left atria muscle tissues. At the atrioventricular node, there is a delay to allow the ventricles to fill with blood from atrial contraction. The depolarization then propagates to the ventricles through the Bundle of His and spreads along the Purkinje fibers. This activates the ventricles to contract and pumps blood to the aorta and to the rest of the body. Finally, depolarization occurs and this cycle is repeated .As the above cycle occurs, the transmembrane potential, which is the voltage difference between the internal and external spaces of the cell membrane, changes at each stage. These voltage differences can be measured using surface electrodes. The different peaks P, Q, R, S, T, and U are noticeable at these stages, as observed in Fig. 1.1 If ECG is properly analyzed, can provide us information regarding various diseases related to heart. Moreover, visual analysis cannot be relied upon. This calls for computer-based techniques for ECG analysis.

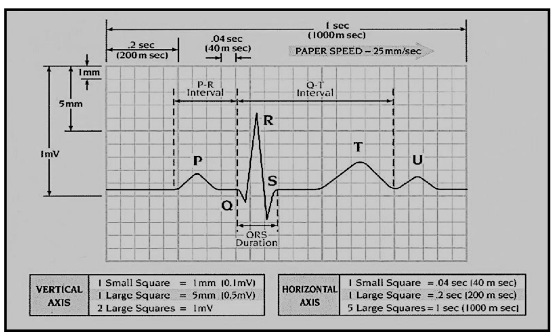

Figure 1.1: General ECG Waveform [6]

Sr. No	**Name of abnormality**	**Characteristic features**
1.	Tachycardia	Heart rate>100 bpm
2.	Bradycardia	Heart rate <60 bpm
3.	First degree heart block	Long PR interval
4.	Second degree AV block	QRS dropped
5.	Sinoatrial block, asystole	Complete drop out of a cardiac cycle

Table 1: Various abnormalities and their characteristic features [2]

2.Algorithm/Structure For ECG Analysis And Detection Of Arrhythmia

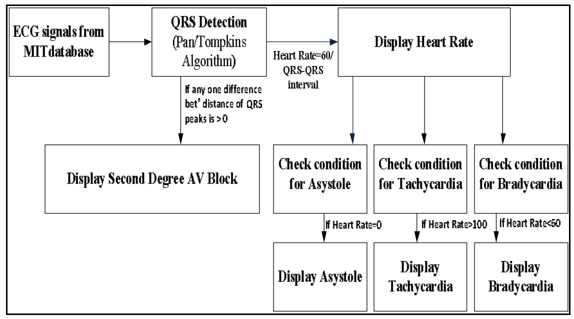

Figure 1.2: Algorithm/structure of ECG analysis and detection of arrhythmia

To implement this algorithm firstly ECG signal from MIT database are loaded in MATLAB software .Then using Pan /Tompkins algorithm QRS peaks of ECG signal are detected and heart rate calculated. From heart rate tachycardia, bradycardia, asystole measurement done. Second degree AV block is detected from QRS peaks.

3.Pen Tompkins Algorithm/Structure For QRS Peak Detection

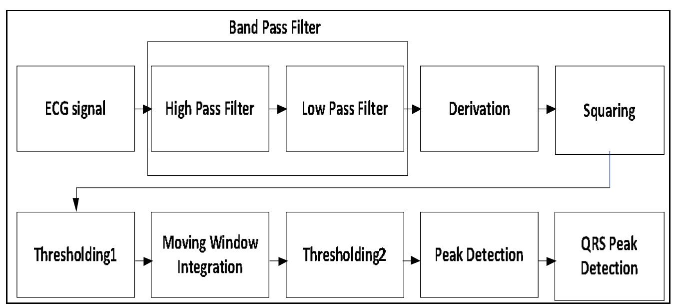

Figure 1.3:Algorithm/Structure of QRS Peak Detection [1]

It's the algorithm for detection of QRS complex of ECG signals. It reliably recognizes QRS complexes based upon digital analyses of slope, amplitude and width. Special digital band pass filter reduces false detection caused by various types of noises such as muscle noise, artifacts due to electrodes motion, power line interference, base line wander, T wave with high frequency characteristic similar to QRS complex. This algorithm is implemented for detection of QRS complex on normal database as shown in Fig.1.4

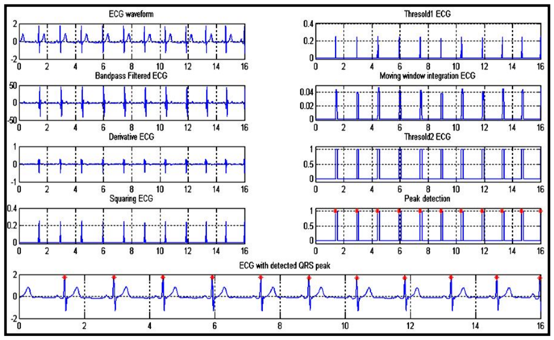

Figure 1.4: QRS Peak Detection Algorithm/Structure processing steps for a Normal ECG

First step is to select signal for ECG analysis.

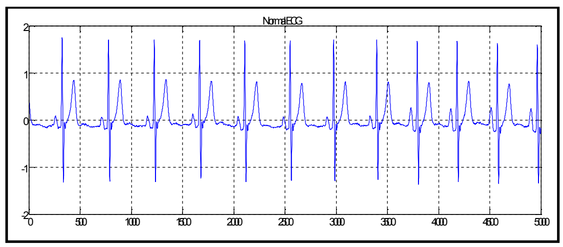

Figure 1.5: Original ECG Waveform from MIT database [5]

In next step ECG signal is passed through a band pass filter which is composed of cascaded low-pass and high-pass filter. Its function is noise rejection. The desired pass band to maximize QRS energy is 5-15 Hz. The band –pass filter reduces the influence of muscle noise, 50 Hz interference, baseline wander and T wave interference [4].

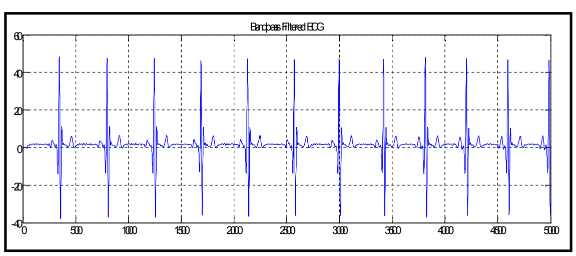

Figure 1.6: Output of band-pass filter

The next step is derivative filter, helps in identifying a change in direction in the slope of the signal which is indicative of a peak in the signal [4].

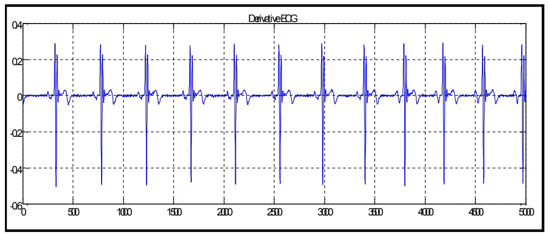

Figure 1.7: Output of Derivative Filter

The next step is simple Squaring function which makes all the signal values positive but also amplifies the output of the previous stage in a nonlinear manner thus emphasizing the R peaks in the signal [4].

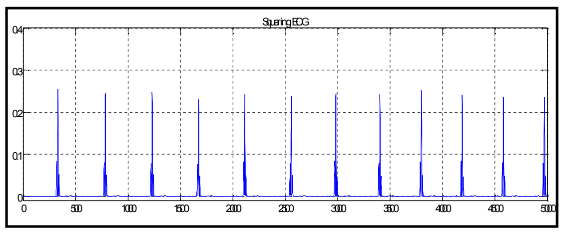

Figure 1.8: Output of Squaring Process

In next step Thresholding of the obtained signal is done which identifies threshold peaks in the ECG signal under the threshold value signal will be zero. If a peak exceeds thresholdi1 during the first step of analysis, it is classified as a QRS peak [4].

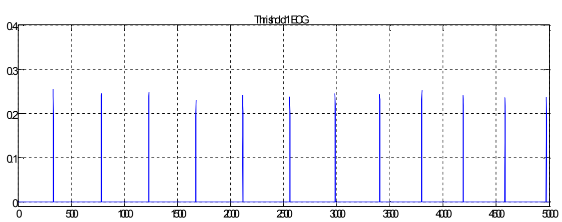

Figure 1.9: Output of Thresholding1 Process

In next step moving window summation of the previous N samples of the output of the previous stage is done. N is decided based on the sampling rate of the signal being analyzed. It performs smoothing of output of the preceding operations through a moving-window integration filter. For a single QRS a window width of N=30 was found to be suitable for f_S = 500Hz. The choice of the window width N is to be made with the following considerations: too large a value will result in the outputs due to the QRS and T waves being merged, whereas too small a value could yield several peaks [4].

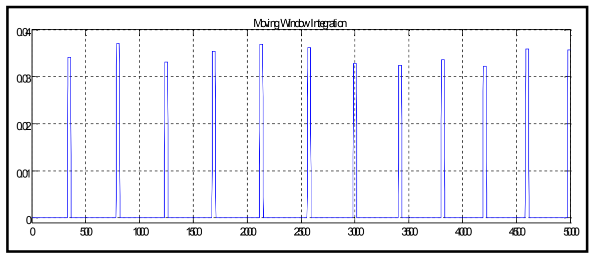

Figure 1.10: Output of Moving Window Integration Process

In next step again thesholding of obtained signal is done. Peak should be above threshold2 to be called a QRS [4].

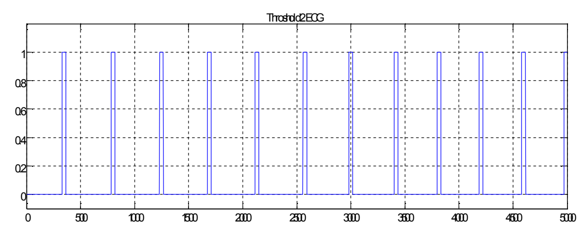

Figure 1.11: Output of Thresholding2 Process

In next step peak detection at rising edge of waveform is done.

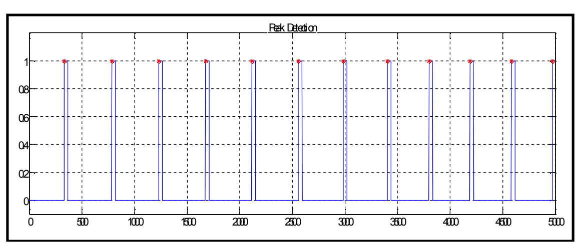

Figure 1.12: Output of Peak Detection Process

Final step is QRS peak detection which is implemented on main ECG signal to be analyzed for arrhythmia. In this step horizontal window of +20 samples from peak of previous step and -20 samples from peak of previous step is selected and for that horizontal window maximum amplitude is find out which indicated as QRS peak.

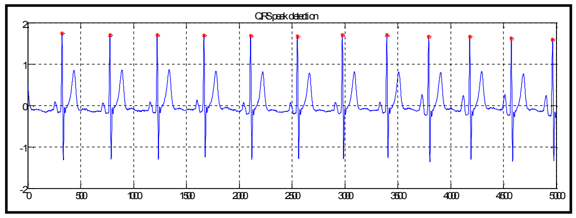

Figure 1.13: ECG with detected QRS peak

4.Arrhythmia Detection After QRS Peak Detection

In first step Heart rate is calculated from detected QRS peak.

Hear rate=60/ (average distance between two QRS peak)

In next step detection of tachycardia, bradycardia, asystole and second degree AV block is done

5.Results

Figure & command window results of various detected arrhythmia is shown in figure.

5.1.Bradycardia

Patient: 1, Male, Age 55

For below figure in peak detection step we get R-R interval is 1.40636.

So Heart rate=60/R-R interval= 60/1.40636=42.6632 bpm

5.1.2.<u>Command Window Result</u>

Bradycardia

Heart Rate = 42.6632 bpm

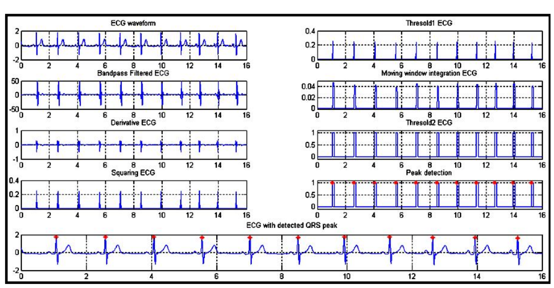

Figure 1.13: QRS Peak Detection Algorithm/structure processing steps for Bradycardia

5.2.Tachycardia

Patient: 2, Female, Age 40

For below figure in peak detection step we get R-R interval is 0.41958.

So Heart rate=60/R-R interval= 60/0.41958= 143 bpm

5.2.1.<u>Command Window Result</u>

Tachycardia

Heart Rate = 143 bpm

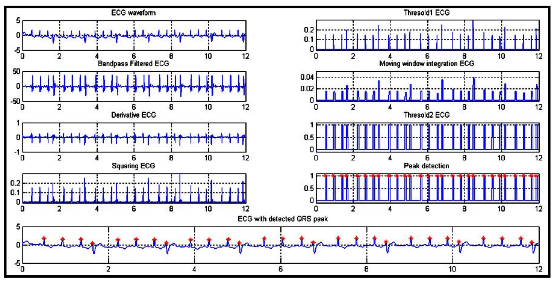

Figure 1.14: QRS peak detection Algorithm/structure processing steps for Tachycardia

5.3.Figures & Command Window Results Of Second Degree Heart Block

Patient: 3 Male, Age: 69

For below figure in peak detection step we get R-R interval is 0.73171.

So Heart rate=60/ R-R interval= 60/0.73171=82 bpm

5.3.1.<u>Command Window Result</u>

Second Degree AV Block

Heart Rate = 82 bpm

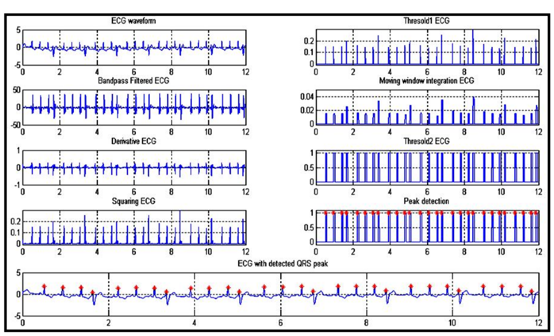

Figure 1.15: QRS peak detection Algorithm/structure processing steps for Second degree AV Block

5.4.Figures & Command Window Results Of Second Degree Heart Block

Patient: 4, Male, Age: 70

For below figure in peak detection step we get R-R interval is infinite.

If R-R interval is infinite than Heart Rate is zero

5.4.1.Command Window Result

Asystole

Heart rate = 0 bpm

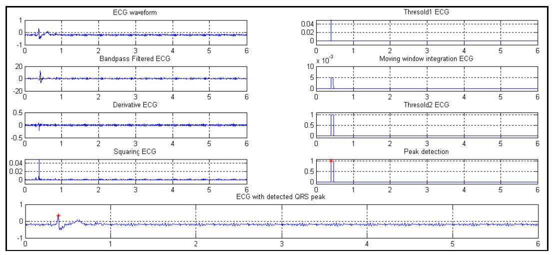

Figure 1.16: QRS peak detection Algorithm/structure processing steps for Asystole

6.Conclusion

The results obtained using MATLAB for ECG analysis and detection of arrhythmia is very fast and useful, as the ECG can be easily read , saved in a file and the filtering, derivation, squaring, thresholding , applying the moving window integration, peak detection can be done accurately .The peak detection is very important in diagnosis arrhythmia which is proved as tachycardia, bradycardia, asystole, second degree AV block is detected using this paper.

7.Reference

1. P. J. Tompkins, "A real-time QRS detection algorithm", IEEE Trans Biomed Eng, vol.31 (3) pp .230-236, 1985.
2. C. Saritha, V. Sukanya, Y. Narasimha Murthy, "ECG Signal Analysis Using Wavelet Transforms" Bulg. J. Phys. pp. 68–77,2008
3. G.B. Moody, "Physio Net A Web-based resource for the study of physiologic signals", IEEE Engineering in Medicine & Biology Magazine, Vol.20 (3) pp. 70-75, 2001.
4. S. R. Sanjee, Merck & Co., Inc., U. Gwynedd, P.A. Sridhar Vijendra, MaxisIT Inc., Metuchen, NJ " ECG Feature Detection Using SAS®", Pharma SUG - Paper AD09, pp .1-5, 2010
5. MIT/BHI arrhythmia database-Tape directory and format specification. Database is available from Bioengineering division KB-26, Beth Israel Hospital, 330 Brookline Avenue, Boston, MA 02215.
6. http://www.google.co.in/images