ECG Signal Processing: Detection of Arrhythmia - PVC

Kavita L. Awade
S.N.D.T Women’s University Mumbai, India

Abstract — The objective of this paper is to develop an algorithm for detection and classification of different cardiac arrhythmias from the recorded ECGs, the algorithm can efficiently handle noise like power line interference and baseline shift caused by unstable amplifiers during the ECG measurement. The characteristic shape of QRS and its frequency of occurrence are commonly used to classify arrhythmias with the records of the subjects database refer to [9]

Keywords — ECG, QRS, Arrhythmia and PVC, Sinus Bradycardia, Sinus Tachycardia, Paroxysmal atrial tachycardia, Atrial flutter, Atrial fibrillation, Ventricular fibrillation

I. INTRODUCTION

The ST-shift can be visually found by observing the ECG records. ST-shift normally occurs in ischemia and coronary infarction. It can either be an elevation or a depression of the ST segment ref. to [1]. To detect arrhythmias, the key point is to detect the QRS complexes in the heart rhythm. The reason is that the QRS complex is the most prominent waveform within the ECG, which reflects the electrical activity during the ventricular contraction of the heart. The characteristic shape of QRS and its frequency of occurrence are commonly used to classify arrhythmias. With the detected QRS peaks, we can calculate the R-R interval width. (for the complete review) refer to [4]

Mainly, the algorithm is expected to detect the following types of arrhythmias:

- Sinus Bradycardia,
- Sinus Tachycardia,
- Paroxysmal atrial tachycardia,
- Atrial flutter,
- Atrial fibrillation,
- Ventricular fibrillation (a lack of QRS complex for a period of time),
- Premature ventricular contraction (PVC)

II. METHODOLOGY

The block diagram of the signal processing of ECG data is presented in Figure 1. Firstly, the ECG signal is normalized. Then we use a Butterworth band pass filter with cut-off frequencies of 0.5 Hz and 45 Hz, where the high pass filter removes the baseline drift [1].

The differentiation used afterwards is to find the high slope that distinguishes the QRS complex from the other parts of the ECG waves.

In the next, step the differentiated signal is squared, so that all the points of the signal become positive and the higher frequencies which represent QRS waves are highlighted.

![Figure 1: Blocks diagram of ECG signal processing](image)
With the index of the peaks of QRS complex obtained and the intervals between the peaks calculated, we are able to detect the arrhythmias, and especially to distinguish PVC, which is characterized by the distorted and enlarged QRS complex.

The criteria chosen for arrhythmias detection is: if the difference between a certain R-R Interval and the average R-R width is greater than 20% of the average, then the arrhythmia is reported.

In addition, the rate of heartbeats can be calculated with the R-R intervals to check if there is bradycardia or tachycardia, or other arrhythmias that lead to rapid discharges of heart impulses.

Furthermore, the areas of the QRS complex are calculated. If the standard deviation of the areas is greater than 5, the PVC is reported [5].

2.1 Detection of normal sinus rhythm:

Figure 3 show the histogram of the R-R intervals, which gives us a clear view on how the frequencies of heart impulses are distributed, thus indicates the regularity of the heart rate for the record 16420 normal sinus rhythm (nsr2db) ref to [9].

The frequency appears highly clustered between 2.2 to 2.6 Hz. Using the same method, arrhythmias can be detected in the records.

2.2 Detection of arrhythmia

The record 100 from the arrhythmia database [9] is processed and the histogram is shown in figure 4. The frequency of occurrences of RR interval is spread between the 1.75 – 2.5 Hz.

2.3 Detection of PVC

The histogram of the record 800m from super ventricular arrhythmia database from the ref [9]. The area of standard deviation is more the 5. the PVC is detected shown in figure 5.
III. CONCLUSION

This algorithm performs well in this task to detect the specific kinds of arrhythmias, which usually show irregular heart rates and distorted QRS complex. However, as the changes of ECG in the numerous heart diseases behave very differently, this algorithm is not fully developed yet to discover other diseases associated with distorted S or T waves.

REFERENCES

[3] Cromwell “Biomedical Instrumentation and Measurements”
[6] Assessment of Arrhythmias for Heart Failure Management by J. Henriques#1, P. Carvalho#2, M. Harris*1, M. Antunes+1, R. Couceiro#3, M. Brito#4, R. Schmidt*2
[10] Physionet ATM,Physionet Archive from the link www.physionet.org,