

# Performance Evaluation of the ECG Signal Filtering using Averaged Signal Approach

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**Abstract** ---*Electro Cardio Gram*(ECG)-is a heart signal that is used to monitor the health status of heart disease. There adding of such a signal requires an expert that extracts information about the patient omit. The expert taken to write a report about the case under investigation which require sometime ,a very valuable factor for some patients, this paper showing how raw ECG signal used to extract an average , then illustrate the which features of ECG can be extracted from signal average.

**Index Terms**—*Electrocardiogram; ECG signal; Signal Filtering Evaluation of the ECG .*

## I. INTRODUCTION

In this work , the heart signal is studied, and a method of finding the average signal for each patient is developed . This average ECG signal carry the information about the condition of the patient . An algorithm is also developed to extract features from the average signal .

This ECGs data records included in the MIT-BIH Arrhythmia Database is a set of over 4000 long-term Holter recordings that were obtained by Harvard-MIT Division of Health Sciences and Technology in Biomedical Engineering Centre[1].

The database contains 48 records (numbered from 100 to 234 inclusive with some numbers missing). Each of the 48 records is slightly over 30 minutes long, The recordings were digitized at 360 samples per second per channel ,this records are the records of ECG taken directly from patient [1].

The heart signal is a periodical signal that repeated based on affixed period . MIT-BIH is a recorded of this repeated signal as series , it is supposing that the received heart signal has the form of MIT-BIH .It is needed to get the average signal from this series of signal . this averaged signal is the characteristics of the patient case and contains the information about him , these information can be extracted in different forms.

In this work to prepare data and extract average signal it was used designed algorithm , but Kania, Fereniec, and Maniewski[8] used cross\_corelation method to get average signal.

## II. LITERATURE REVIEW

There are many research works, which deal with the subject of this paper, the first one, is done by von Wagner et al [9] where they present a complete simulation environment for testing ECG classification algorithms under Matlab with Simulink. There are other studies using Fast Wavelet Transform (FWT) for ECG signal processing such as Provazník, and et al [10],which apply the theory of wavelet transform on ECG signals and give promising results, similar to that done by Kania, Fereniec, and Maniewski[8], their aim of this study was to investigate the application of wavelet denoising in noise reduction of multichannel high resolution ECG signals.

## III. AVERAGE SIGNAL APPROACH

In order to get this work done the following steps need to be done in this order :

- Taking and preparing a sample signal.
- Determination of signal period length and average signal.
- Generalization the idea for different patients.
- Feature extraction from the averaged signal

### A. Taking And Preparing A Sample Signal

This process is required to cut the first 24000pointsofthepatient signal record and then process it to get the average signal, this process can be summarized in the following steps as shown in Fig. 1.

- Read the whole raw signal of the patient
- Determine length of the sample.
- Cut the required sample from raw signal.

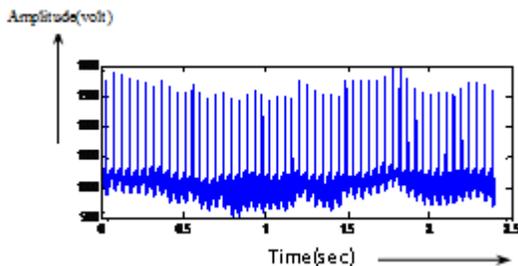


Fig .1 . graphical representation of sample of signal

**B. Determination Of Signal Periodic Length And Average Signal**

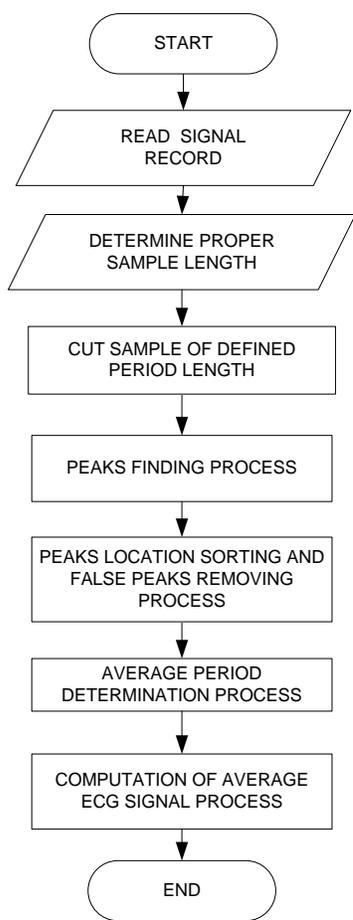


Fig.2. average signal algorithm

This step is collected as complete algorithm to process the sample signal which is shown in Fig .2.This algorithm is named as average signal, Which contain sub process which are:

- 1.Peaks finding process.
- 2.Peaks location sorting and false.  
Peaks removing process.
- 3.Average period determination process.
- 4.Computation of average ECG signal process.

**C. Generalizing the idea for different patient**

The approach shown in previous section concerning with using only one recorded of the data collected from the considered source.

The program can be generalized to give the average signal of all recorded signal of different patient by putting the written algorithm program that find the average signal inside a loop as show sin Fig.3. This generalized algorithm works on all signals that represent different patient.

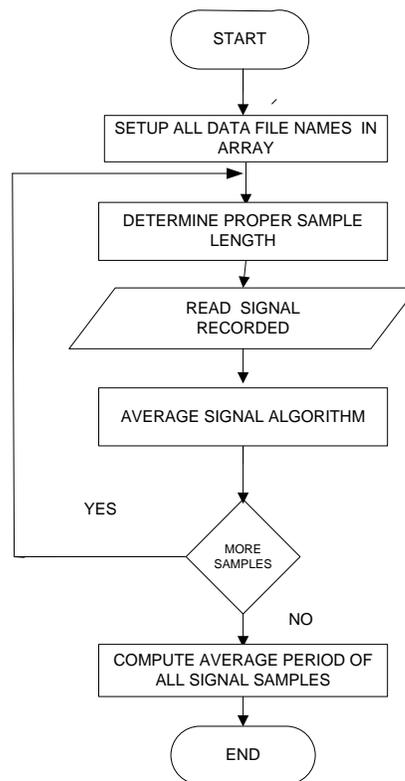


Fig.3. Generalizing the idea for Different patient

**D. Feature extraction from the averaged signal**

After getting average of signal from raw data, these features must be extracted from it, these features are represent the parameters of ECG such as :QRS duration ,PR interval ,QT interval, T interval, P interval and others .

- *ECG structure and its components*

As explained before, the normal shape of ECG signal has the following waves and segments[2][3] ,which are shown inFig.4.

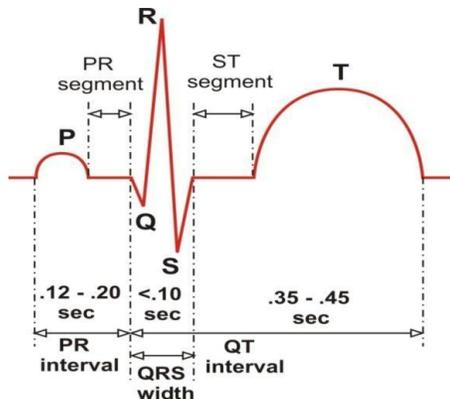


Fig.4.normal shape of ECG signal

- *ECG feature set*

One the average ECG is determined ,features needs to be extracted from it , these features are classified into[4][5].

Interval features:

ECG signal contain same of features related to heart beats intervals, which used in second data type ,it can be getting from average ECG signal, these interval are(see Fig.5):

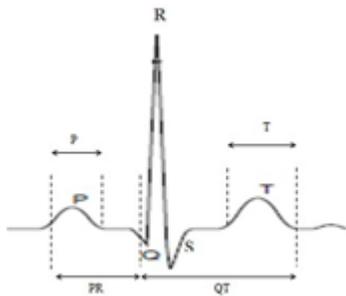


Fig.5.intervalfeatures

PR interval: average duration between onset of p and Q wave.

QT interval: average duration between on set off Q and T wave.

T interval :average duration of T wave.

P interval :average duration of p wave.

Amplitude features

This features relative to amplitude of R peak in QRS complex, which are computed by determine amplitude (height)of R peak and compared the difference between it and other waves, this appears same feature srelated to heart rate, similarly to interval feature it can be getting from average ECG signal as following(see Fig .6):

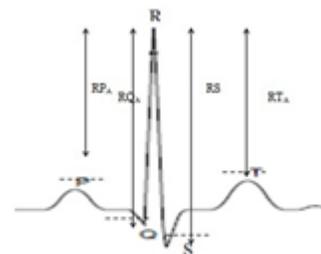


Fig.6.Amplitude features

RQ amplitude: difference amplitude between R wave and Q wave.  
 RS amplitude: difference amplitude between R wave and S wave.  
 RT amplitude: difference amplitude between R wave and T wave.  
 RP amplitude: difference amplitude between R wave and P wave.

feature extraction can be performed as a preprocessing step of the average of signal prior to work on [6].Where several methods can be used in the process of extracting appropriate feature by compute importance, for each feature , which provided as input to any supervised learning techniques such as data classification and Pattern Recognition [7] ,

#### IV. EXPERIMENTS RESULTS

This paper shows the results obtained in this work. MATLAB was used to program the principles of this work. Based on proposed method for computing the average signal from the raw data, this raw data is a train of heart signals that is taken from a single patient and is needed to compute characteristic features of heart signal.

A designed algorithm named average signal algorithm does this procedure, the obtained averaged signal has general features of ECG signal of the patient.

Figure 7 and 8 are represented one of train pulses of normal case and other of train pulses up normal case respectively with obtained average heart signal for different patient:

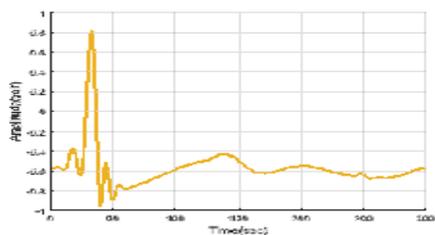


Fig.7 average signals of normal case

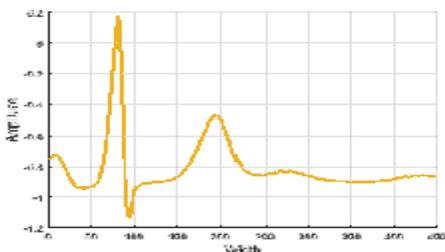
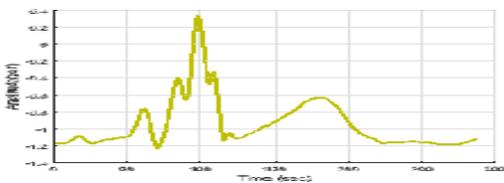
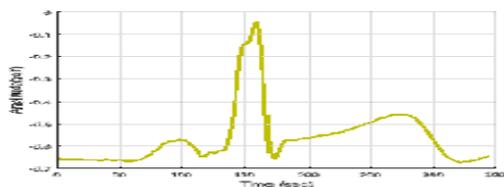


Fig.8 average signals of up normal case



#### V. CONCLUSION

In this work, the ECG signal data were collected from data source, which gives a ECG signal that represent the ECG recorded of patient healthy people and Non- healthy people of different heart disease.

In this work, a method was developed to get the average pulse ECG signal of the patient which represent his/ her status and condition. A method were developed to process the signal to get features from the average ECG signal.

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