www.ijecs.in
International Journal Of Engineering And Computer Science ISSN: 2319-7242
Volume 5 Issue 6 June 2016, Page No. 16746-16748

Preprocessing Techniques of Electrocardiogram

Sai S. Kulkarni[1], Supriya O. Rajankar[2]

[1]Dept. of Electronics and Telecommunication,
SCOE, Pune, India.
saisadanandkulkarni@gmail.com

[2]Dept. of Electronics and Telecommunication,
SCOE, Pune, India.
Sorajankar.scoe@sinhgad.edu

Abstract: ***Nowadays for the analysis of ECG signals and its interpretation, Signal processing plays an important role. ECG signal processing has an important objective to give society a filtered result with maximum accuracy and the information which is not readily extracted from visual assessment of ECG signal. ECG signals are obtained by placing electrodes on the body surface of a human being. It leads to contamination of noise to ECG signals. These noises are baseline wander, power-line interference, electromyographic (EMG) noise, electrode motion artifacts and much more. These noises act as hurdles during processing of ECG signal and thus for removal and rejection of such noise, pre-processing of ECG signal is an important task. Therefore on a primary basis, filtering techniques are used for preprocessing of any signals and similarly for ECG signals. The only care for ECG signal should be taken that the real information should not be distorted. In this paper, the main concentration will be on filtering of the baseline wander and the power-line interference***.

Keywords: baseline wander, electrocardiogram, power-line interference.

For removal of power-line interference and removal of baseline drift, filtering techniques are taken into consideration. Usually, usage of narrow band filter is done for both types of the disturbances. The only care should be taken that the original data is not distorted during the preprocessing techniques, i.e., filtering. Such filtering is said suitable for analyzing the heart rate variability and not suitable for analyzing the micro-potentials

1. ECG Signal

The etymology of electrocardiography is derived from Greek. 'Electro' means electrical activity, 'cardio' is related to heart whereas the word 'graphs' literal meaning is to write. Thus, monitoring of the heart activity is called electrocardiography which demonstrates the electrical activity of the heart. For electrocardiography, a machine called electrocardiograph is used which results out in the electrocardiogram. According to the medical requirement, some leads are varied. There may be eight leads, ten leads or 12 leads. An instrumentation amplifier is a key and critical component of electrocardiography. Fig. 1 represents the electrode's placement. The 'electrodes' and the 'leads' can be differentiated distinctly. In the process of electrocardiography, to complete the electrical circuit with the body, the conductive pads which make contact with the human body are known as electrodes. Whereas to more extent and abstract, lead is the root for measurement of the vector. Sometimes the leads are referred as electrodes in medical settings. In medical settings, the 12 leads of 12-leads EKG are

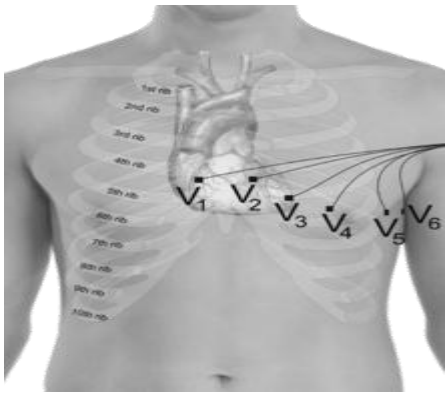

Fig. 1 Precordial electrode's placement

named as V1, V2, V3, V4, V5, V6, RA, LA., RL, and LL noted according to the positions of leads placed.

The instrumentation amplifier is used to measure the voltage differences between the two electrodes placed on the skin of a human body and amplifying the resultant signal.

ECG signals are continuous signals. It consists of three waveforms, P-wave, QRS-complex, and T-wave. All the three waveforms, i.e., P-wave, QRS-complex, and T-wave has its significances. The QRS detection and the PQRST complex helps to find the basics.

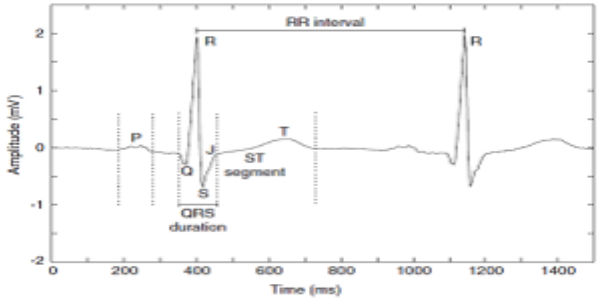

Fig. 2 Wave definition of ECG signal. The dotted lines indicate the onset and the end of the P-wave, QRS complex, and T-wave.

Fig. 2 implies the wave definition of the ECG signal. The dotted lines here indicates the onset and the end of the P-wave, QRS complex, and the T-wave. This Wave of the cardiac cycle can be said to be ideal.

Table 1. give the detail description of each wave described in ECG signal. The description is provided according to the theoretical analysis of the concept. According to the doctors, pathological description and analysis vary explaining the cause of the particular malfunction and improper functioning of the heart.

We can make a proper list of the diagnoses which can be made through the analysis of ECG signal. The patient can be thus examined and treated accordingly. Describing the primary cause, the list can be classified in the main groups as follows:

- Rate disturbances
- Electrolytes disturbances & intoxication
- Ischemia and infarction
- Structural
- Artifacts

Table 1. Description of ECG waves.

Feature	Duration	Description
P wave	<80ms	Depolarization of atria.
PR interval	120-200ms	Reflects the time the electrical impulse takes.
QRS complex	80-100ms	Rapid Depolarization of the right and left ventricles.
J point	--	The point at which the QRS complex finishes and the ST segment starts.
ST segment	--	Represents the period when the ventricles are depolarized.
T wave	160ms	Repolarization of the ventricles. It is upright in all leads except aVR and leads V1.
U wave	--	Hypothesized to be caused by the repolarization of the interventricular septum.

2. Preprocessing of ECG Signal

In every electronic device, noise immunity is major characteristic and asset. Whenever signal processing is carried out, the input signals are not ever ready to go under the actual processing unit. It is mandatory to carry out few processing steps before going for the actual process. It is known as "preprocessing." There may be only one or many numbers of preprocessing unit cells depending on requirement. Because of preprocessing, signals are polished and made ready for actual processing. Removal of unwanted noise is one of the preprocessing units

3.1 Power-line interference

The Power-line causes electromagnetic fields which are said to be common noise source for an ECG Signal. These are characterized by the sinusoidal interference of 50-60 Hz accompanied with a number of harmonics. The narrow band signal makes it difficult for analysis and interpretation of the ECG signal. Various measures can be taken to reduce the effect of power-line interference. We can have the recording location with grounding and shielding effects in a view to reduce power-line interference which is caused during the recording of the signals. Usage of advanced techniques as band-stop filtering, straightforward linear filtering are used to handle the interference also it helps in suppressing the transient manifest caused because of QRS complex.

The output of the filter is dependent on the degree of influence of QRS complex. Thus, it is considered as a prime parameter for filtering out power-line interference. Instead of linear, non-linear structure of the filter is preferred. The assessment of the performance of filter should be done using simulated signals so that the distortion can be quantified precisely and thus can conclude with assurance that filter has not added any unwanted distortion to its input signal.

3.2 Baseline Wander

For minimizing the changes of beat morphology which has no cardiac origin, removal of baseline wander is vital. It is vital when it is termed for "low frequency". Removal of baseline drift can be done by designing a linear, time-invariant and high-pass filter. The critical parameters to take into consideration during designing filter are a selection of cut-off frequency and phase response characteristics.

Cut off frequency should be chosen wisely because the clinical and medical information should remain unchanged and undistorted and accordingly much of baseline wander should be removed. Thus finding lowest frequency component of ECG is an important task to be achieved. The second important parameter under consideration is phase response. Linear filtering structure is very much desirable as because it prevents phase distortion and also prevents the loss of various wave properties such as duration, onset and end points etc.

Therefore FIR filter design is preferable. The filter structure with impulse response being symmetric or asymmetric can give correct required phase response.

3. Conclusion

This is paper gives a detail description of a ECG signal. It tells how the ECG signals are captured. With it, this also informs us various noises added during recording of ECG signals. We also look for the various techniques to reduce the noise i.e the pre-processing techniques used for ECG signal.

References

[1] A Hyvarienen, J. Karhumen, and E Oja, 'Independent Component Analysis', John Wiley & Sons, Inc.,New York,2001.
[2] http://www.electrocardiogram.com
[3] Y. Der Lin andY. Hen Hu, "Power-line interference detection and suppression in ECG signal

processing,"IEEE Trans. Biomed. Eng., vol. 55,pp. 354-357, Jan.2008.

[4] R. Lyons, "Interpolatednarrowband lowpass FIR filters",IEEE Signal Processing Magzine, vol. 20, , pp. 50-57 Issue 1, Jan 2003

Author Profile

Sai S. Kulkarni received the Bachelor of Technology degree from Maharashtra Institute of Technology, Aurangabad in year 2014. Pursuing Master of Engineering from University of Pune. Area of interest is Signal & Image Processing for Biomedical applications.