SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF BIOMEDICAL ENGINEERING

19BMB302 - BIOMEDICAL SIGNAL PROCESSING

III YEAR/ V SEMESTER

Unit IV : BIOSIGNALS AND THEIR CHARACTERISTICS

- Source of Bioelectric potential
- Resting and action potential
- Propagation of action potentials in nerves
- Characteristics of biomedical signals
- The ECG-Cardiac electrophysiology
- Relation of ECG components to cardiac events
- Clinical applications

Clinical applications

Detection of ECE abnormalities and ECG Analysis

Detection of ECE abnormalities and ECG Analysis

- ECG Signal
  - ECG-ElectroCardioGram is one of the famous diagnosing tools which measure the electrical activities of the heart and record the details.
  - The ECG works mostly by detecting and amplifying tiny electrical changes on the skin that are caused when the heart muscle depolarizes each heart beat.

Normal ECG Signal

- **Frequency :** 0.05 Hz to 100 Hz
- **Duty range :** 1 mV to 10mV
- The number of peaks and valleys in the ECG is represented by the alphabets as P, Q, R, S and T.

Amplitude	P-Wave	.25 mV
	R-Wave	1.60 mV
	Q-Wave	25% of R wave
	T-Wave	.1 to .5 mV
Duration	P-R interval	.12 to .20 sec
	Q-R interval	.35 to .44 sec
	S-T interval	.05 to .015 sec
	P-Wave interval	.11 sec
	QRS interval	.09 sec

Table : Values of the normal heart rate.

Abnormal ECG Signal

- The normal value of the heart beat : 60 to 100 beats/ minutes.
- Bradycardia = heart beat < 60 beats/min (slow heart beat)
- Tachycardia = heart beat > 100 beats/min (high heart beat)
- If the cycle space is not even then it indicates an arrhythmia. Arrhythmia is indicated by verifying the cycles.

Abnormalities Detection Algorithms

Generally two detection algorithms were built. These are :

i) heart rate related abnormalities algorithm and

ii) General heart diseases detection algorithm

Heart rate - related abnormalities detection algorithm:

The algorithm tests three consecutive ECG samples and compares a given sample to its adjacent counterparts and to a threshold value of 0.25 volts. The fixed threshold of 0.25 volts was chosen based on the following:

1. The selected ECG waveforms have a common range of amplitudes (0 to 3 volts) of the samples making the idea of a fixed threshold practical as shown in Fig.

2. The detection mechanism does not rely on the amplitude; however it depends on the number of the "R" peaks of the QRS complexes in the whole waveforms.

General heart diseases detection algorithm

For the detection general heart diseases , a mechanism was developed to identify any unusual drop in the voltage between the P wave and the QRS complex in addition to the peak detection.

i) AV block detection
ii) Ventricular Fibrillation detection
iii) Sudden Cardiac Death Detection

AV Block Detection

The AV block is mainly characterized by a drop in the voltage between the P wave and the QRS complex due to the latency in the signal propagation between the atria and the ventricles through the AV bundle. The algorithm tests three consecutive ECG samples and compares a given sample to its adjacent counterparts and to a threshold value of -2.5 volts. The threshold of -2.5 volts was chosen to detect the third degree AV block, because the drop in voltage is the main characteristic of such conditions as clearly shown in Fig. A voltage–drop count that exceeds 60 is an indication of a third degree AV Block.

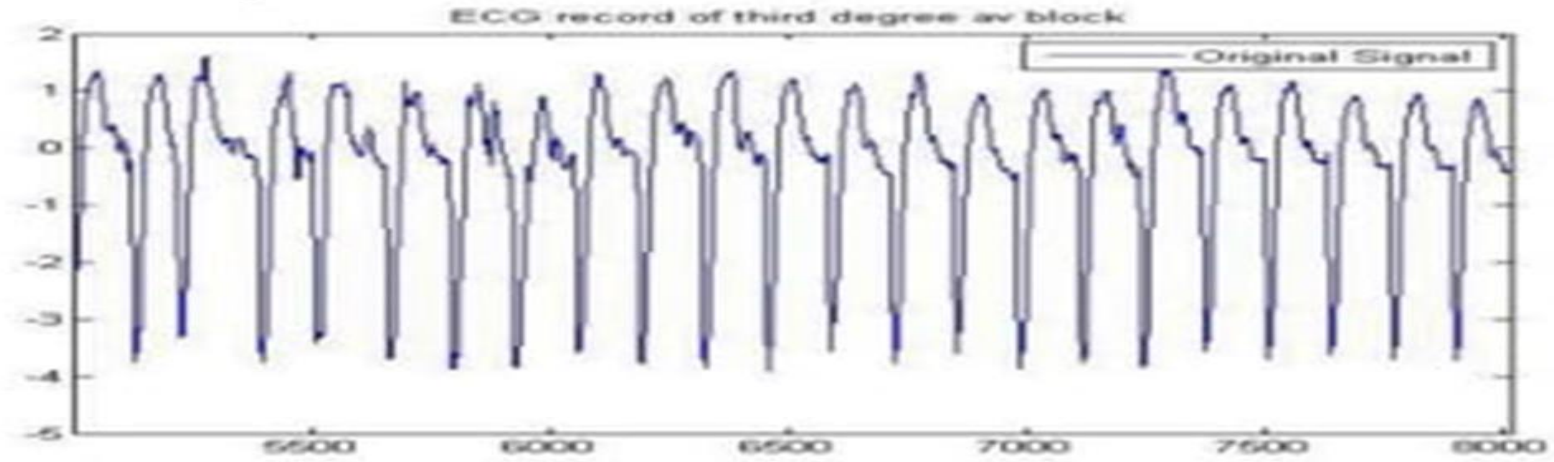

Fig. voltage drop in third degree AV block ECG waveform

Ventricular Fibrillation Condition

The VF is mainly characterized by the absence of peaks and drops with large magnitudes, the samples magnitude ranges from .3 volts to -.15 volts only. The algorithm tests if any given sample lies outside the interval [-0.5, 0.5]. The samples of the VF ECG waveform have narrow range of magnitudes as shown in Fig., therefore the threshold of ± .5 volts was chosen. If the number of peaks counted is equal to 0, it is concluded that the patient suffers from Ventricular Fibrillation.

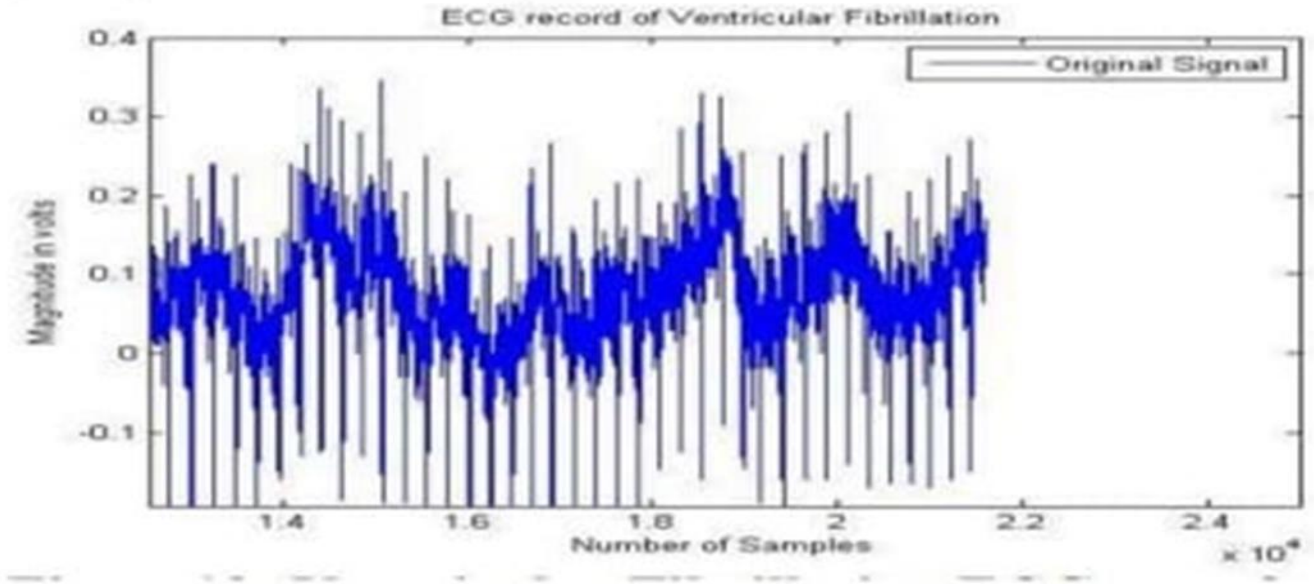

Fig. VF Ventricular Fibrillation ECG waveform with a narrow range of amplitudes

Sudden Cardiac Death Detection

The SCD is mainly characterized by the absence of peaks and drops along with a semi-linear behavior of the signal. The algorithm tests if any given sample lies outside the range [- 0.15,0.15]. The threshold of ± .15 is very adequate to the SCD condition, as the absence of the electrical activity of the heart on the second half of the ECG waveform has dramatically narrowed the range of the amplitudes of the samples as shown in Fig.

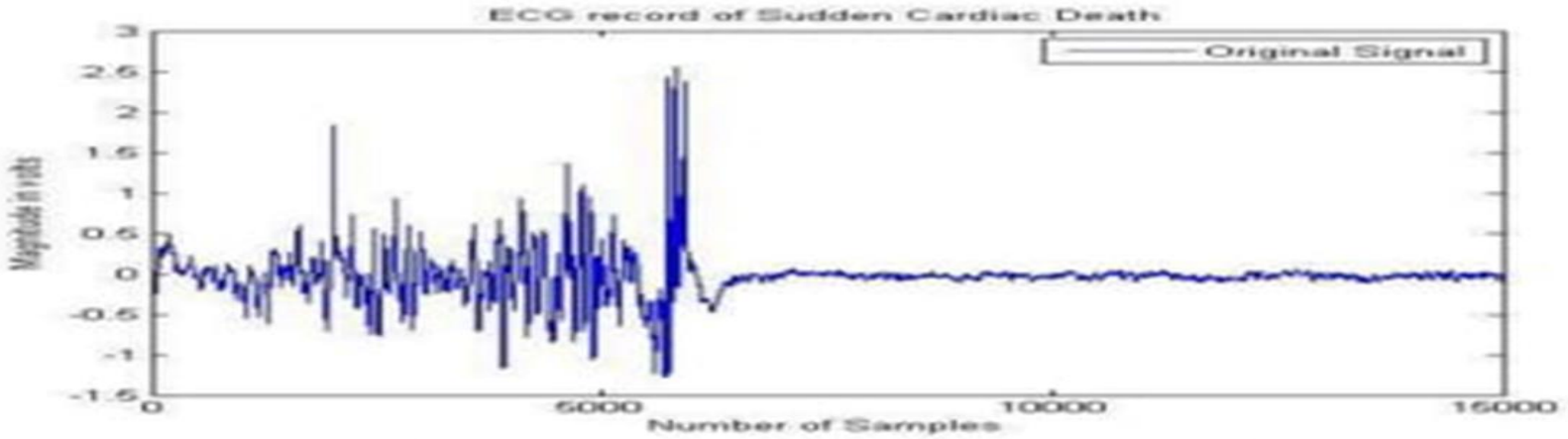

Fig. Absence of the electrical activity of the heart on the second half of the ECG waveform in the SCD Condition

Thank You!