Electro-cardiogram (ECG)

Project : Analyisis of E.C.G Signals using Fourier Transform .

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ABSTRACT

- In this project, we developed a method for finding Normal and Abnormal cases using Fourier Transforms.
- The procured ECG signal is subjected to feature extraction.
- The extracted features detect abnormal peaks present in Waveform
- Abnormal ECG signal could be differentiated based on the features extracted.
- The project was implemented in the MATLAB platform and tested.

FOURIER TRANSFORM

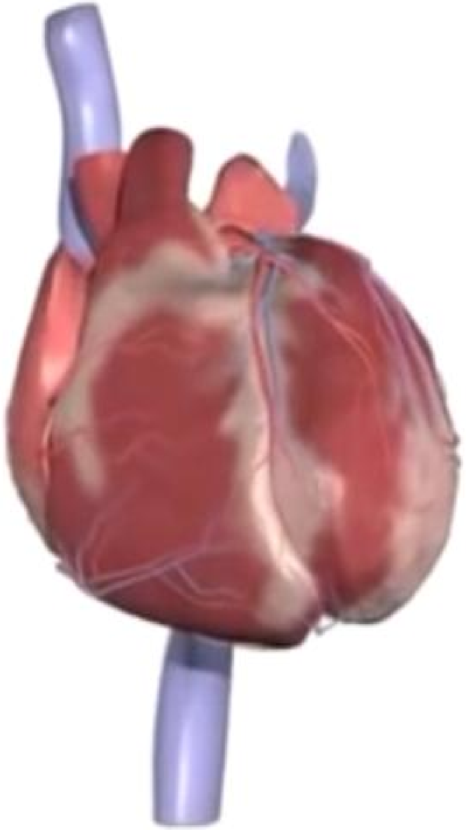
The Fourier transform (FT) decomposes a function of time (a signal) into the frequencies that make it up. The Fourier transform of a function of time itself is a complex -valued function of frequency, whose absolute value represents the amount of that frequency present in the original function. The Fourier transform is called the frequency domain representation of the original signal.

The Fourier transform of a function f(x) is formulated in matlab as follows: fft(f(x)) .

Content

- How ECG is recorded?
- Why the ECG occurs?
- Finding Normal and Abnormal cases using Fourier Transforms .

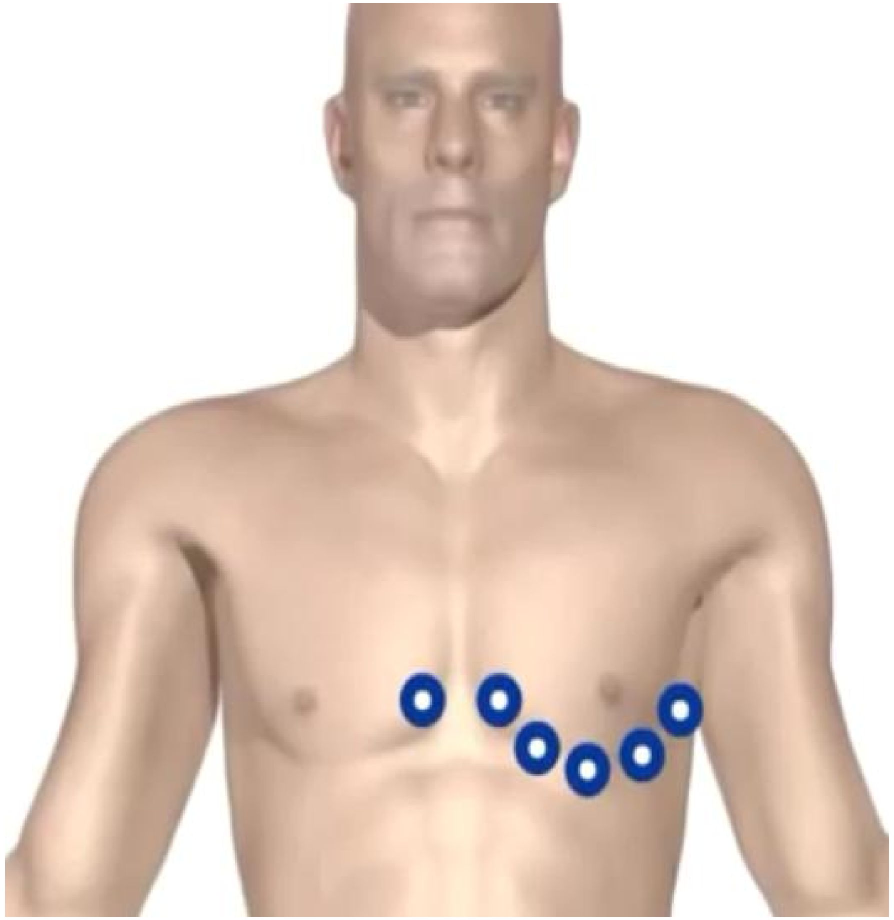
ECG Introduction



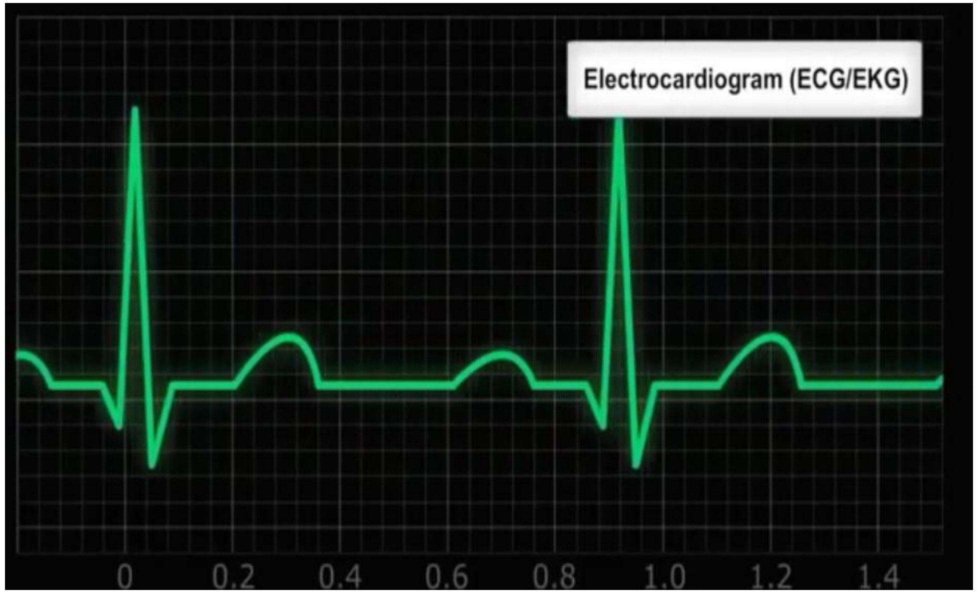
Propagation
=
continuation
or
movement

- The heart muscles contract and expand to generate signals that is recorded as ECG.
- ECG is the measured electrical activity of the heart.

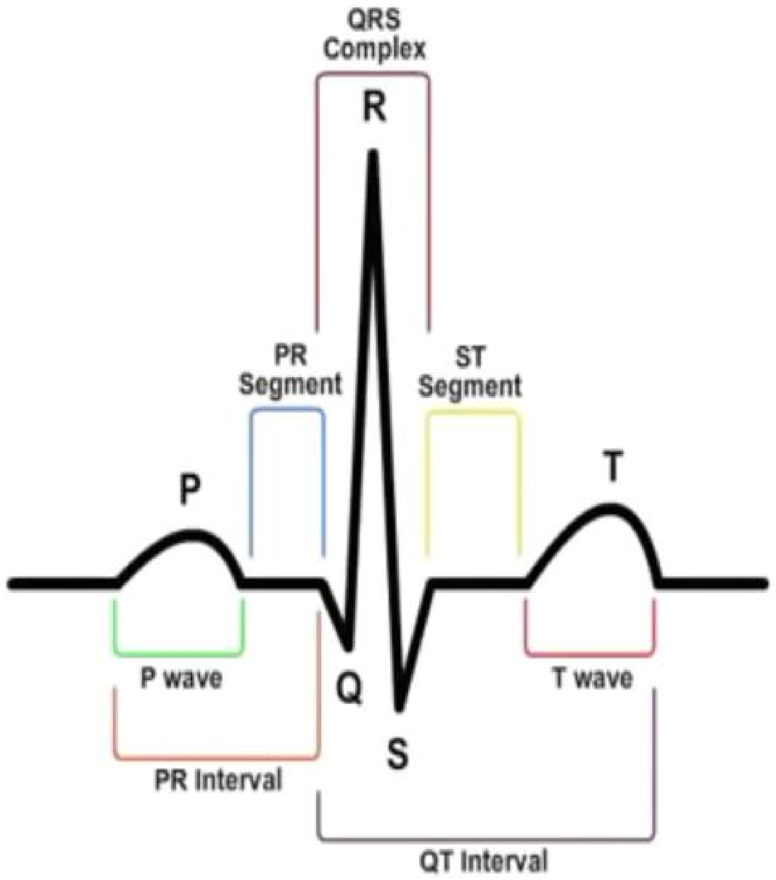
ECG Introduction



- This electrical activity and be measured by placing electrodes at specific points on the skin.



ECG Introduction



- An Ideal ECG looks like this and it keeps repeating itself.
- We will try to dstinguish Normal and Abnormal cases.

THEORY :

- In the present analysis we are about to distinguish the difference between Normal ECG Signal and a Abnormal ECG Signal.

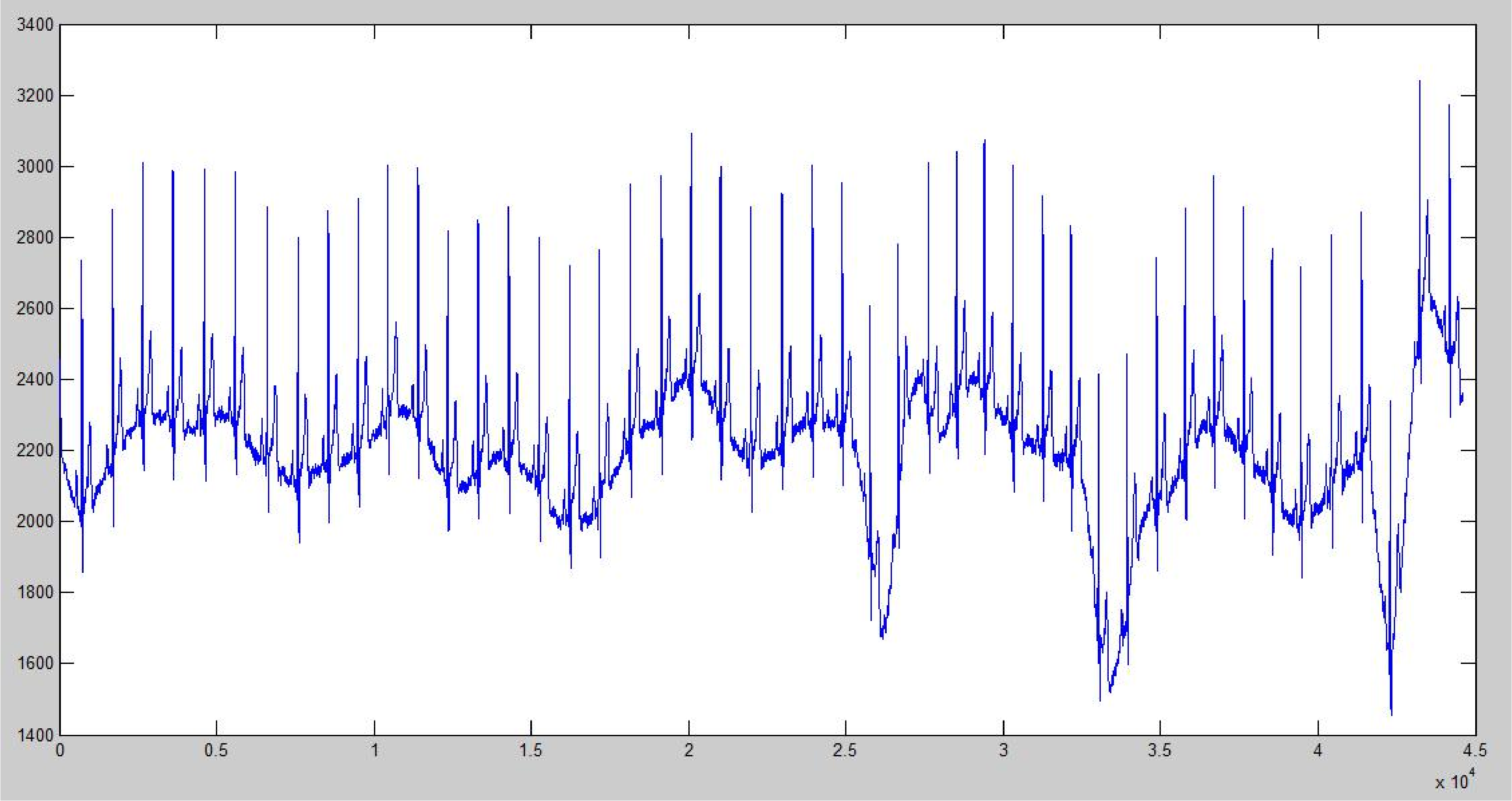
- A typical scalar cardiogram lead is shown in th previous fig, the significant features of waveform are the P, Q, R, S waves, the duration of each wave and time intervals such as P-R, S-T and Q-T intervals.

- ECG signal is periodic with fundamental frequency determined by the heartbeat. It also satisfies the Dirichlet's condition.

- Hence, Fourier series can be used to represent an ECG signal. If we observe Fig. 1 carefully, we may notice that a single period of an ECG signal is a mixture of triangular and sinusoidal waveforms.

- The significant feature of ECG signal can be represented by shifted and scaled versions.

Initial ECG Input Signal.

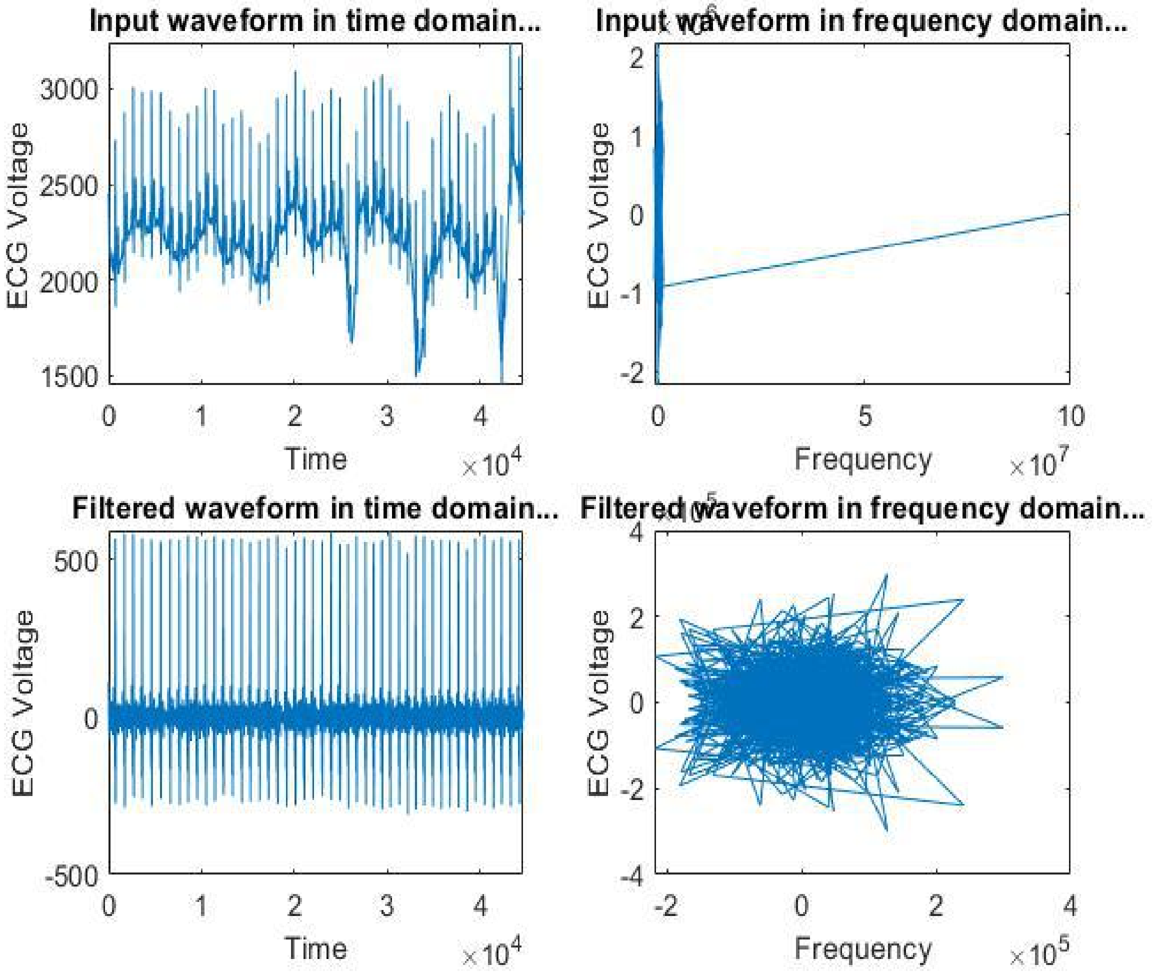


- The ECG signal we are going to work with looks like this.

Steps to plot Filtered ECG Waveform

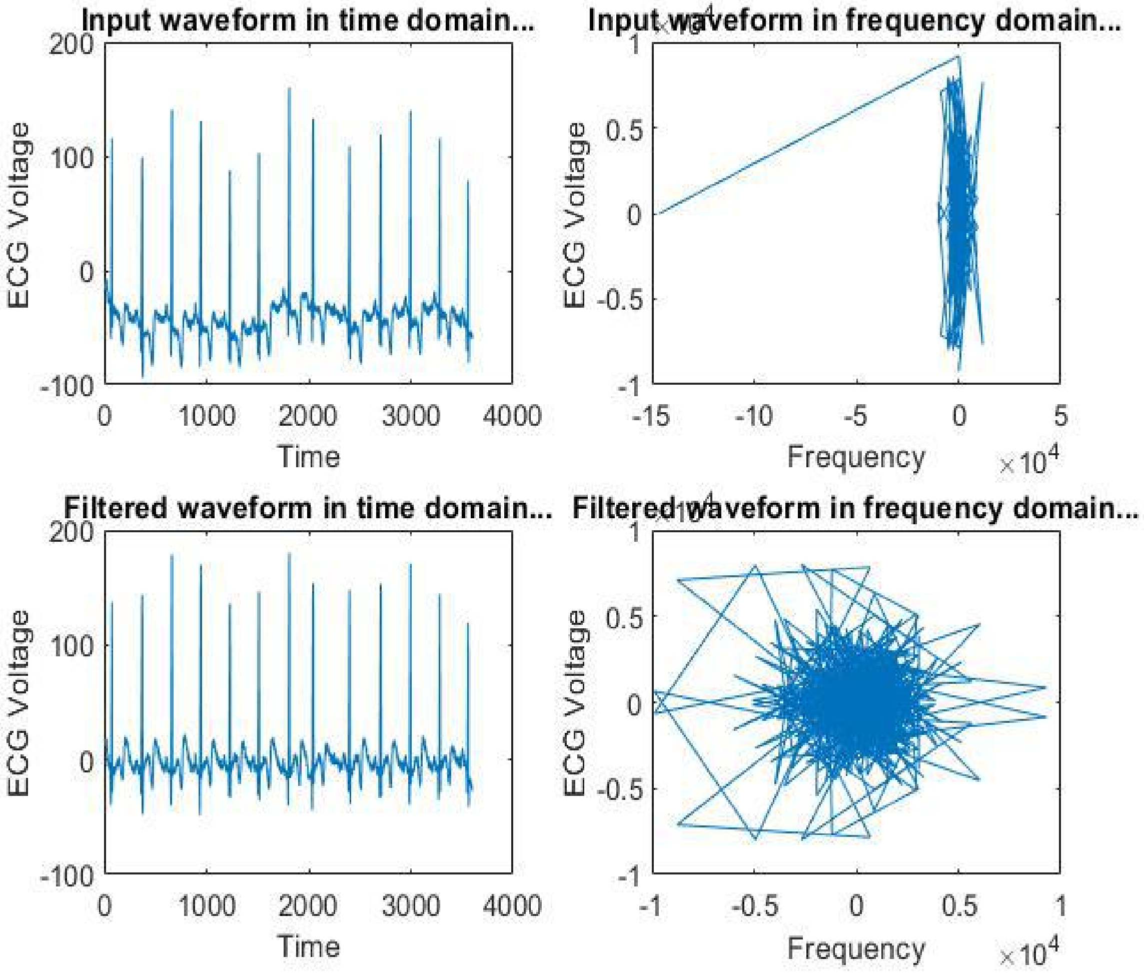
1. Change input signal to frequency domain using fft .
2. Remove low frequency components by 0.5% in order to make isoelectic line horizontal.
3. Remove high frequency noise by 0.5%.
4. Back to time domain using ifft.

Normal ECG Signal



1. Input
2. Fourier Transform of Input Signal.
3. Output filtered waveform.
4. Fourier Transform after removing low frequency and high frequency components.

Abnormal ECG Signal



1. Input
2. Fourier Transform of Input Signal.
3. Output filtered waveform.
4. Fourier Transform after removing low frequency and high frequency components.

Matlab Code

```
% for clearing the workspace
clear;
% loading sample 1
  plotname = 'Sample 1';
  load 100m;
  % taking fourier transform of sample
  fresult=fft(val);
  % plotting input waveform in time domain
  figure('Name','Abnormal waveform results.');
  subplot(2,2,1)
  plot(val), xlabel('Time'), ylabel('ECG Voltage’), m
  title('Input waveform in time domain...')
  % plotting input waveform in frequency domain
  subplot(2,2,2)
  plot(fresult), xlabel('Frequency'), ylabel('ECG Voltage’),
  title('Input waveform in frequency domain...')
```

```
% filtering the low and high frequency part
  fresult(  1 : round (  length (fresult) *5/1000  )  ) = 0;
  fresult(end - round(length(fresult)*5/1000) : end)=0;
  corrected=real(ifft(fresult));
  % plotting filtered waveform in time domain
  subplot(2,2,3)
  plot(corrected), xlabel('Time'), ylabel('ECG Voltage’),
  title('Filtered waveform in time domain...')
  % plotting filtered waveform in frequency domain
  subplot(2,2,4)
  plot(fresult), xlabel('Frequency'), ylabel('ECG Volage’),
  title('Filtered waveform in frequency domain...')
```

```
% loading sample 2
  plotname = 'Sample 2';
  load ecgdemodata1;
  % taking fourier transform of sample
  fresult=fft(ecg);
  % plotting input waveform in time domain
  figure('Name','Normal waveform results.');
  subplot(2,2,1)
  plot(ecg), xlabel('Time'), ylabel('ECG Voltage’),
  title('Input waveform in time domain...')
  % plotting input waveform in frequency domain
  subplot(2,2,2)
  plot(fresult), xlabel('Frequency'), ylabel('ECG Voltage’),
  title('Input waveform in frequency domain...')
```

```
% filtering the low and high frequency part
  fresult(  1 : round (  length (fresult) *5/1000  )  ) = 0;
  fresult(end - round(length(fresult)*5/1000) : end)=0;
  corrected=real(ifft(fresult));
  % plotting filtered waveform in time domain
  subplot(2,2,3)
  plot(corrected), xlabel('Time'), ylabel('ECG Voltage’),
  title('Filtered waveform in time domain...')
  % plotting input waveform in frequency domain
  subplot(2,2,4)
  plot(fresult), xlabel('Frequency'), ylabel('ECG Voltage’),
  title('Filtered waveform in frequency domain...')
  hold all
```

CONCLUSION

After successfully completing the above steps to distinguish between a Normal ECG Signal and an Abnormal ECG Signal.

From the analysis starting from taking the Fourier transform to plotting the Filtered waveform we conclude with result that due to abnormal conditions, the ECG voltage graph in frequency domain alters from normal condition graph.

This work could be continued to further improve the algorithm to detect abnormalities and implement this system to find deposits of arrhythmia in the heart by using calculations of intervals between impulses of two different signals in real time.

THE END

Thanking you .