A

Project Report

On

ELECTROCARDIOGRAM(ECG) ANALYSIS

(Heart Rate Estimation from ECG Signal)

Submitted in fulfilment of the requirement for the V semester

Bachelor of Technology

By

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DECLARATION

I, **SAKSHI ADHIKARI** student of CST, V SEM, Department of Computer Science and Technology, Graphic Era University, declare that the project work entitled **ELECTROCARDIOGRAM(ECG) ANALYSIS** (Heart Rate Estimation from ECG Signal) has been carried out by us and submitted in fulfilment of the course requirements for the award of degree in BTECH of Graphic Era University, during the academic year 2020-2021. The matter embodied in this synopsis has not been submitted to any other university or institution for the award of any other degree or diploma.

Place: DEHRADUN
Date: 16 DECEMBER 2021

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ACKNOWLEDGEMENT

Here by we are submitting the project report on ELECTROCARDIOGRAM ANALYSIS, as per the scheme of Graphic Era University.

In this connection, I would like to express our deep sense of gratitude to our beloved institution Graphic Era University and, I would like to express my sincere gratitude and indebtedness to Prof. DR. KAMAL GHANSHALA, Dean, GEU.

I consider it my cardinal duty to express the deepest sense of gratitude to MS. Parul Madan, Asst. Professor, Department of Computer Science and Engineering for the invaluable guidance extended at every stage and in every possible way.

Finally, I am very thankful to all the faculty members of the Department of Computer Science and Engineering, friends and my parents for their constant encouragement, support and help throughout the period of project conduction.

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INTRODUCTION

The electrocardiogram (ECG) is one of the simplest and oldest cardiac investigations available, yet it can provide a wealth of useful information and remains an essential part of the assessment of cardiac patients.

With modern machines, surface ECGs are quick and easy to obtain at the bedside and are based on relatively simple electrophysiological concepts. However junior doctors often find them difficult to interpret.

In this project we are going to perform ECG analysis that is finding the heart rate using the ecg signal collected from the physionet atm, performing some modifications to the dataset, detecting the r peaks of the waves, and thus estimating the heart rate using MATLAB.

THEORY

What is an ECG?

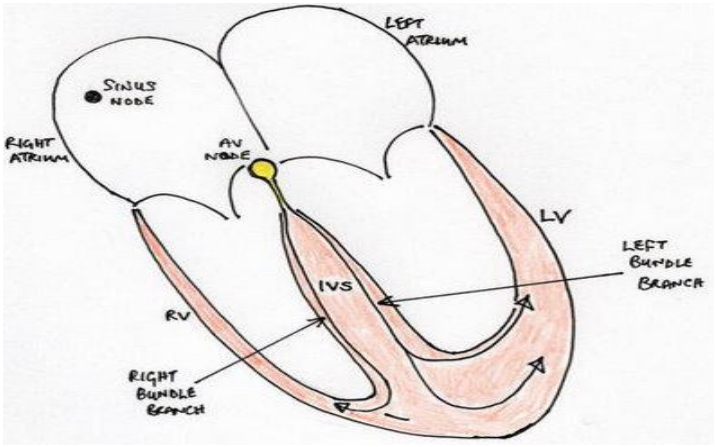
An ECG is simply a representation of the electrical activity of the heart muscle as it changes with time, usually printed on paper for easier analysis. Like other muscles, cardiac muscle contracts in response to electrical depolarization of the muscle cells. It is the sum of this electrical activity, when amplified and recorded for just a few seconds that we know as an ECG.

Basic Electrophysiology of heart

The normal cardiac cycle begins with the depolarization of the sinus nodes. This process then spreads through the high right atrium and into the left atrium.

The atria are separated by an electrically inert ring, which prevents them from being subjected to the electrical depolarization that occurs in the normal heart. The atrioventricular node is the only pathway for depolarization to reach the ventricles. This process spreads the depolarization wave down the interventricular septum and into the two ventricles.

After the heart has been depolarized, its myocardium must repolarize. This process can only be performed once the heart is ready to depolarize again.

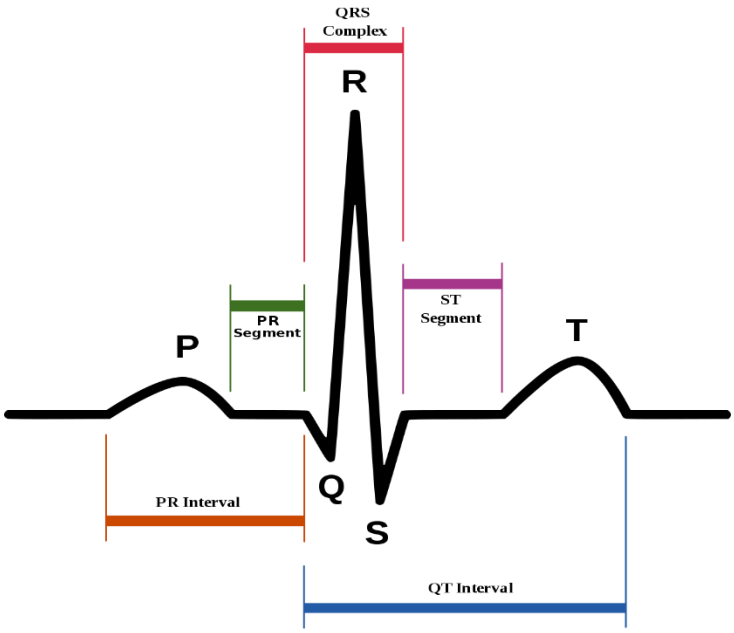


The Normal ECG

Depolarization of the ventricles results in usually the largest part of the ECG signal (because of the greater muscle mass in the ventricles) and this is known as the **QRS complex**.

- The Q wave is the first initial downward or 'negative' deflection
- The R wave is then the next upward deflection (provided it crosses the isoelectric line and becomes 'positive')
- The S wave is then the next deflection downwards, provided it crosses the isoelectric line to become briefly negative before returning to the isoelectric baseline.

In ECG signal, the interval between two consecutive R peaks i.e., R-R interval tell us about the heart rate (HR). The heart rate for a normal person is in between **60-100 BPM** (beats per minutes). If the heart rate is greater than this normal heart rate, then it indicates the tachycardia while heart rate below the normal heart rate gives the possibility of bradycardia disease.



Heart rate estimation from the ECG

Standard ECG paper allows an approximate estimation of the heart rate (HR) from an ECG recording. Each second of time is represented by 250 mm (5 large squares) along the horizontal axis. So, if the number of large squares between each QRS complex is:

- 5 - the HR is 60 beats per minute.
- 3 - the HR is 100 per minute.
- 2 - the HR is 150 per minute.

Wavelet Transform

The wavelet transform is a tool that cuts up data, functions, or operators into different frequency components, and then studies each component with a resolution matched to its scale.

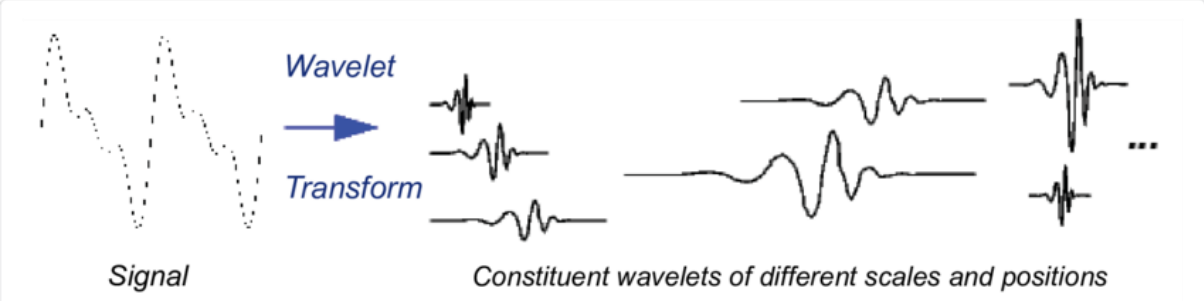
Why Wavelet Transform

1. In ECG each region has different frequency components -QRS has high frequency oscillation, T region has lower frequencies, P and U regions have very low frequencies.

2. Signals of ECG contains noise components due to various sources that are suppressed during processing of ECG signal.

3. Wavelet transform provides good time resolution and poor frequency resolution at high frequencies and good frequency resolution and poor time resolution at low frequencies.

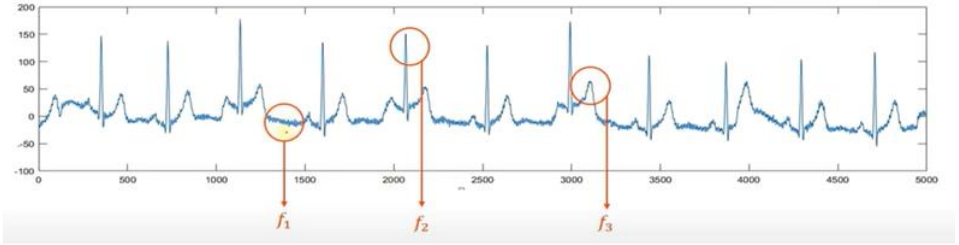
4. It's a useful approach when signal at hand has high frequency components for short duration and low frequency components for long distance as in ECG.



DWT BASED QRS DETECTION

What is DWT

A discrete wavelet transform (dwt) is a transform that decomposes a signal into several sets, where each set is a time series of coefficients describing the time evolution of the signal in the corresponding frequency band.

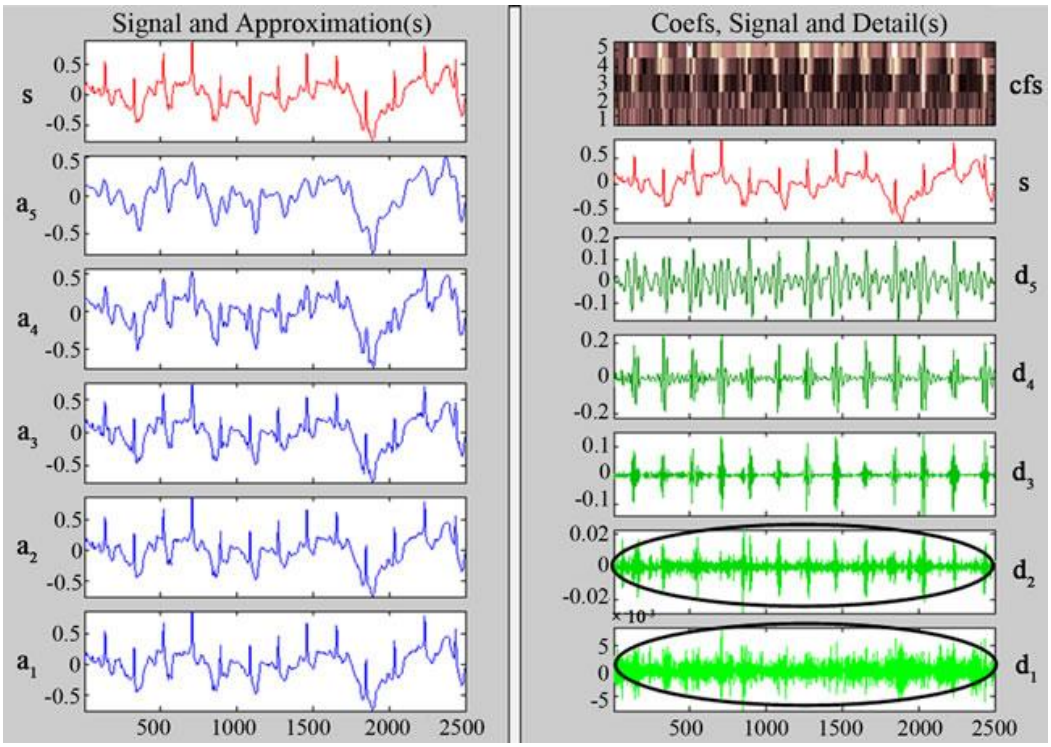


f1 > f2 > f3

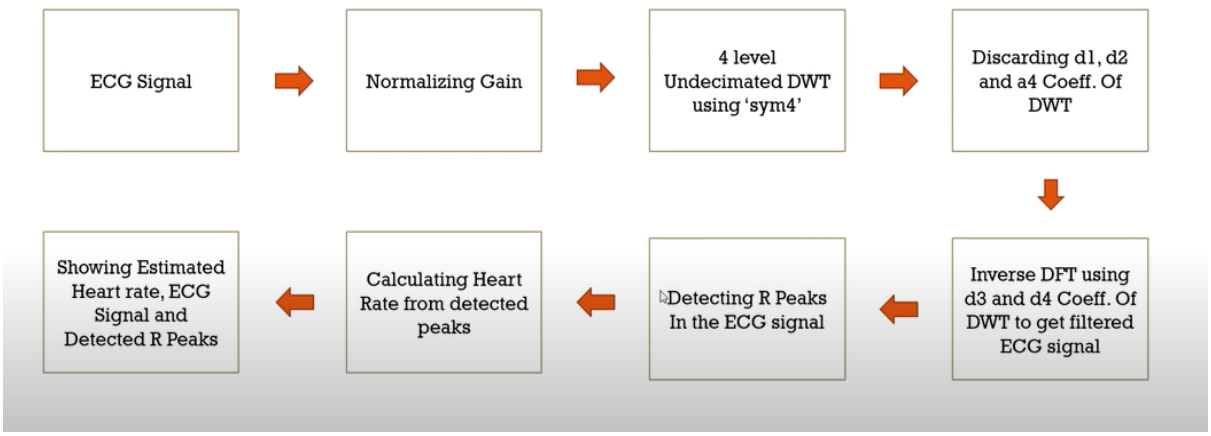
- F1-High frequency noise
- F2-QRS peak frequency
- F3-Lower frequency noise

4-Level Undecimated DWT using sym4

- Frequencies related to R peaks(f2) must be preserved while others must be suppressed. Therefore, bandpass filter is needed
- The wavelet transform separates signal components into different frequency bands. The band pass filtering can be implemented by eliminating some frequency bands.
- The band pass filtering can be achieved by eliminating wavelet coefficients of some lower scales and higher scales of ECG signal.
- For this purpose, undecimated wavelet transform is used to get wavelet coefficients.
- A 4-level decomposition of an ECG signal is shown below-

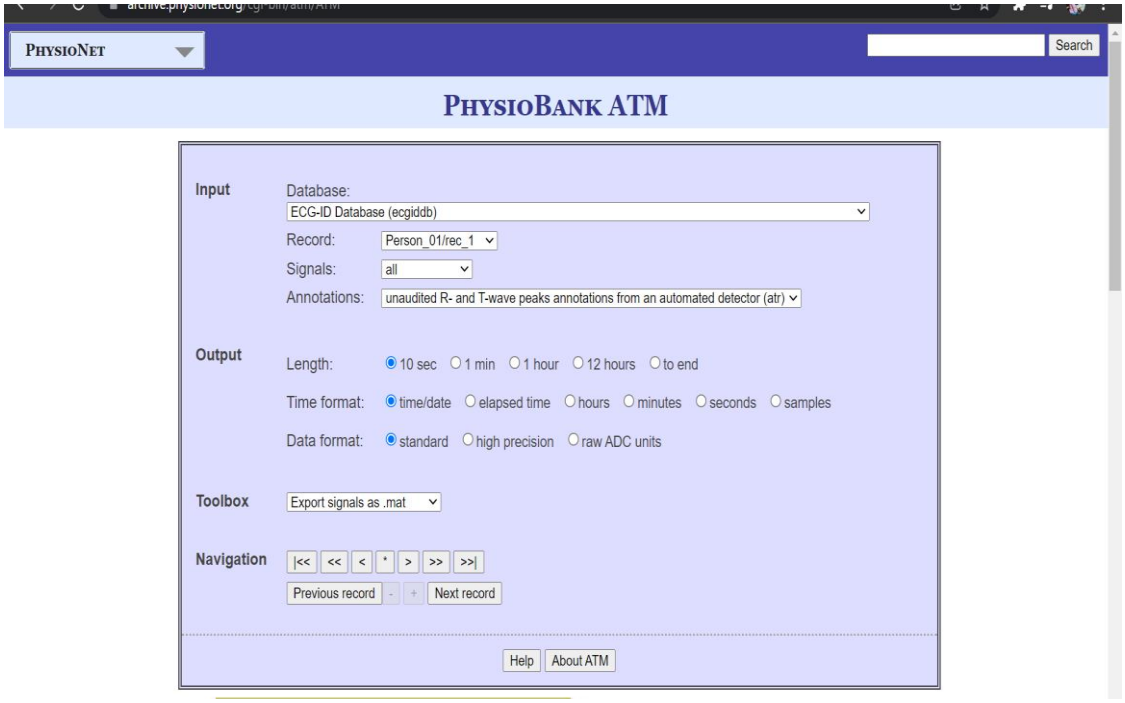


BLOCK DIAGRAM

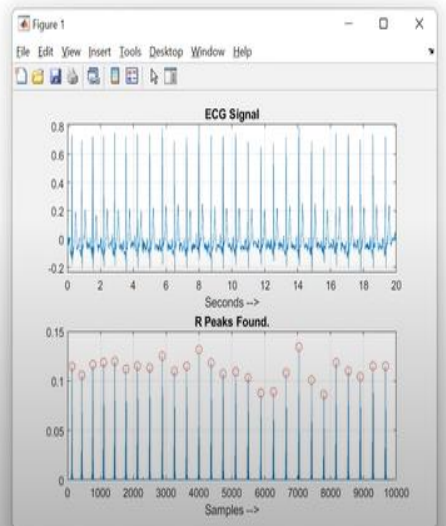


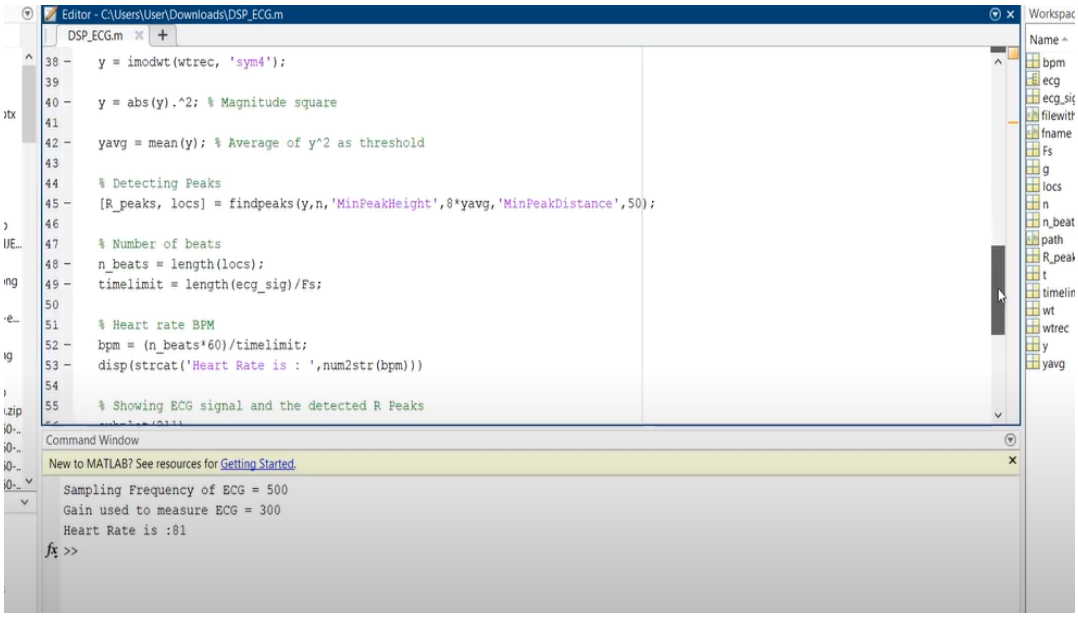
MATLAB CODE

Getting the datasets from physio bank ATM-



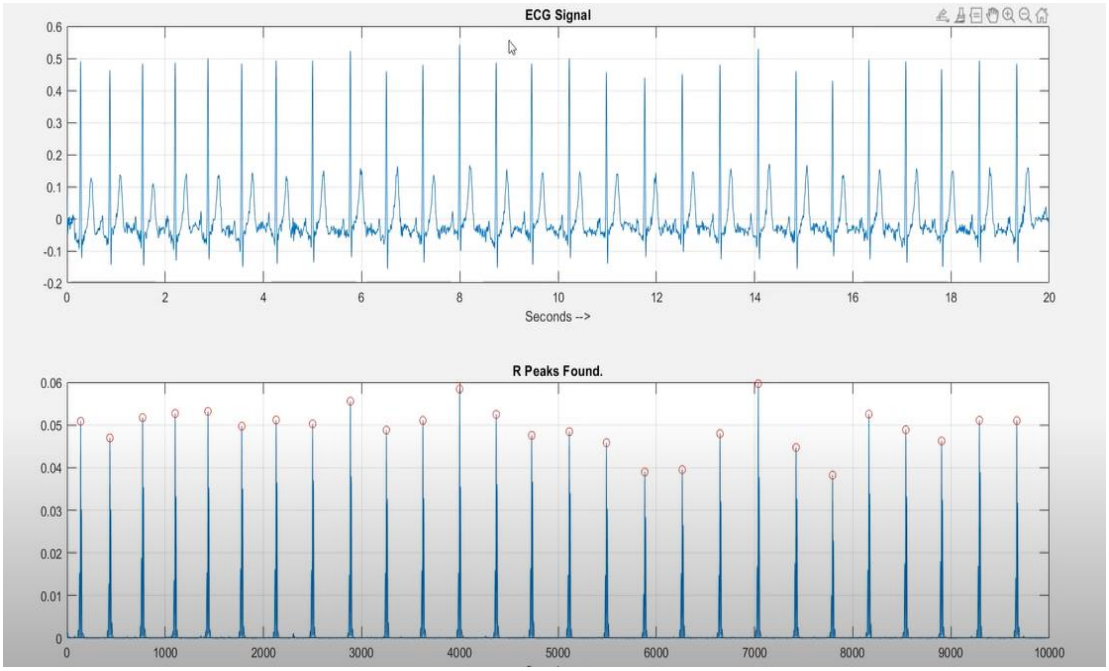

```
% ECG Signal samples taken from Physionet.org ecgid database


clc;
clear all;
close all;

% Loading ECG signal
[fname, path] = uigetfile('*.*', 'Choose the ECG Signal file (.mat)');
filewithpath = strcat(path, fname);
ecg = load(fname);

Fs = input('Sampling Frequency of ECG = '); % Sampling Frequency for ECG
g = input('Gain used to measure ECG = ');

ecg_sig = (ecg.val)./g; % Normalizing gain

n = 1:length(ecg_sig); % Number of samples

t = n./Fs; % Time vector

% 4 level undecimated DWT using sym4
wt = modwt(ecg_sig,4,'sym4');

% Extracting d3 and d4 coeff.
wtrec = zeros(size(wt));
wtrec(3:4,:) = wt(3:4,:);

% Inverse DWT with d3 and d4 coeff.
y = imodwt(wtrec, 'sym4');
```





RESULT

We are able to detect the R peak and hence estimated the heart rate using MATLAB code.
Using [R_peaks, locs] = findpeaks(y, n,”minpeakheight”,8*yavg,”mindistance”,50) for R peak detection.
Using [bpm=(n_beats*60)/timelimit] for finding heart rate as beat per minute.



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