METHODS OF IMPORTING AND PLOTTING VARIOUS ECG SIGNAL FORMAT IN MATLAB AND CALCULATION OF ECG HEART BEAT RATE BASED ON ECG SIGNAL

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Abstract: In this paper discussed various methods of ECG Signal importing techniques and also how to plot ECG signal in matlab. As we know that Matlab is a tool of numerical computation and in this computation tool analysis of various signal is possible. ECG Signal records electrical activity of heart. There are some available online databases or we can import ECG Signal from External inputs. Here, In this paper we are going to see in detail what are the various methods are available for importing and plotting of ECG Signal in Matlab and Also Calculation of ECG Heart beat rate.

Index Terms - **ECG Signal, Matlab, Import, Plot** etc.

I. INTRODUCTION

ECG means electrocardiogram which records electrical activity of heart. ECG is also known as EKG Electrocardiogram. It is graphically representation of electrical activity of heart.

Generally human being takes ECG in the condition of chest pain or shortness of breath. In this condition generally people meet to cardiologist and takes ECG Signal to check whether the chest pain or breathing problem is happening due to abnormal heart beat or anything else. ECG plays vital role in the life our life because by observing ECG Signal doctor can interpret cause of chest pain or shortness of breathing.

There are various ECG Databases are available like PhysioNet Database, PTB Diagnostic ECG Database etc. These ECG Database consist of various ECG Waveforms in the form of .mat file format, .csv file format, EDF file format, .DAT file format, .bin file format etc. Physio Bank ATM consist of Various ECG file formats with different output length like 10 sec , 1 min , 1 hour , 12 hours to end. We can select ant one of the output length file as per requirement. PhysioBank ATM has ECG Signal available in various time formats like time /date, elapsed time, hours, minutes, seconds and samples. PhysioBank ATM also consist of Toolbox about plot waveform and export signal as .csv, .mat , EDF file formats etc. A simple file reader for European Data Formatted (EDF) file.

Read European Data Format file into MATLAB

[hdr, record] = edfread(fname)
Reads data from all redcords of file fname ('*.edf'). Header information is returned in structure hdr, and the signals (waveforms) are returned in structure record, with waveforms associated with the records returned as fields titled 'data' of structure record.

>> pwd

ans =

C:\Program Files\MATLAB\MATLAB Production Server\R2015a\bin

>>ls

```
.               lcdata_utf8.xml
..              m3iregistry
100m.mat        mappolezero.m
A.fig           mask.wtc
A.m             matlab.exe
```

```
ECG1.m             mbuild.bat
MemShieldStarter.bat   mcc.bat
PID.slx            mex.bat
POPUP.fig          mex.pl
POPUP.m            mexext.bat
a.jpg              mexsetup.pm
a.mat              mexutils.pm
classlist.xls      mtf.asv
convolutionsignal.slx  mtf.m
data.csv           mw_mpiexec.bat


>>a=load('100m.mat')
a =
val: [1x3600 double]
```
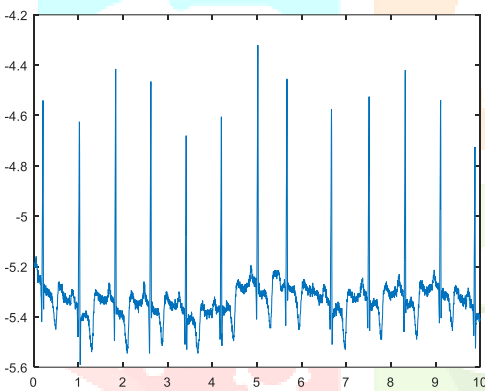
1. Matlab code to plot ECG Signal and Result :

```
clc;
load('100m.mat');
ECGsignal=(val-1024)/200;
Fs=360;
t=(0:length(ECGsignal)-1)/Fs;
plot(t,ECGsignal)
```
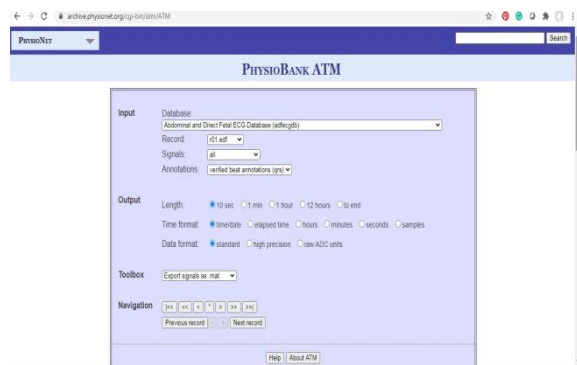
Result in figure window:

Fig. 1 Result in figure window

Fig.1 shows result of plotting of ECG Signal in matlab.
ECG Signal database are available in
PhysioBank ATM Database. It consist of Input database signals

Fig 2.   Window of ECG Signal Database

How to load ecg signal in matlab from physiobank ATM
Step 1.Goto Physiobank ATM
Step 2.select input signal
Step 3.select output signal parameters
Length, time format and data format etc.
Step 4: Go to Toolbox and select ecg signal format .mat , .csv etc as per requirement

How to load and save .mat file in matlab

step 1: goto command window
a=[1 2 3 4]
step 2: save a.mat
step 3:ecg1=load ('a.mat')
step 4:plot(ecg1)

Importing signal from Physiobank ATM
ECG Signal in Physiobank ATM is in the form of CSV, EDF and .mat file formats.
CSV Stands for Comma Separated value
EDF European data format
.mat stands for matlab file format

After importing ECG signal in matlab contains Time and Date , Direct_1, Abdomen_1, Abdomen_2 , Abdomen_3 , Abdomen_4 , EDF Notations etc.
Each Abdomen ECG Signal consist of 4 types of signals.We can plot signal by plot('Abdomen_4) in matlab.

4. How to load file in matlab

we can load file in matlab any text file , .csv file or .mat file.
Steps
>>pwd
If we enter pwd in matlab command window it will desplay matlab all documents path.

>>ls
If we enter ls in matlab command window then it will display list of all files of matlab.
we can save matlab file in text file .txt format and later we can load and display in figure window.
>>sig = load('ecgs1.txt');
where ecgs1 is file name and format of file is text file.
>>plot(sig)
How select particular ecg signal samples length
>>sig=sig(1:600);
1:600 means 600 ecg signal samples will select
>>plot(sig) ; this plot matlab command will plot 600 ecg signal samples.

5. How to load csv file format

Step 1.Goto Physiobank ATM
Step 2.Select Input (Database , Record and signal) , Output (Length , Time format and Data format) Proper Format
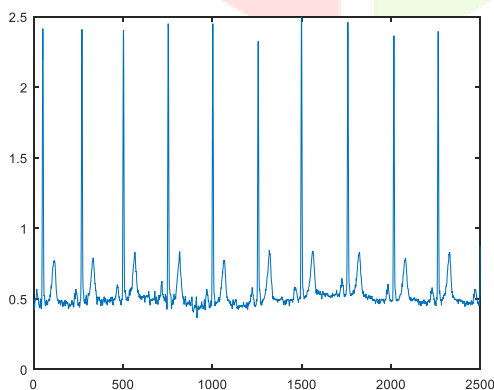Step 3. Select Format in Toolbox
Step 4. Download ECG Signal of .csv file format
Step 5.Drag and Drop ECG Signal in MATLAB Command window OR
>> uiopen('F:\ \ecg signals\samples.csv',1)
>> plot(V4)

Fig. 3 Result in figure window
Fig.3 shows result of plotting of ECG Signal in matlab.
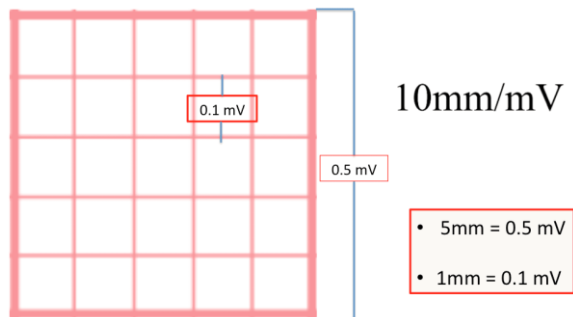
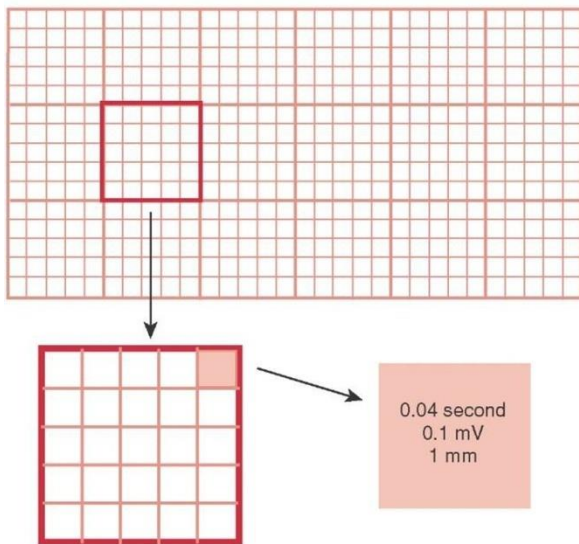**Scale of ECG Graph Paper**

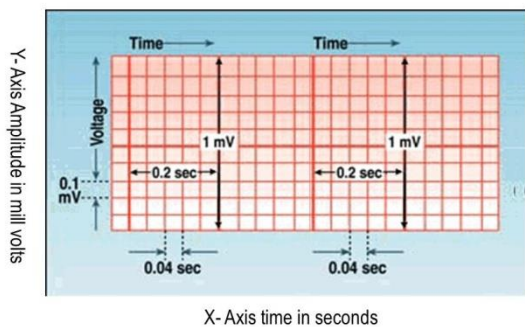Fig 4. Y Axis ECG Scale

Fig 5. Y Axis ECG Scale

Fig 6. ECG Graph Paper Scale

Scale of X and Y axis 1 line is 1mm = 0.1cm
X axis is representing time
X axis 1 line = 40msec = 0.04 Sec
X axis 5 line = 1 Horizontal Block = 200msec = 0.2 Sec
X axis 5 Block = 5 Horizontal Blocks = 1000msec = 1 Sec

Y axis is representing amplitude or Voltage in milli volt
Y axis 1 line = 0.1mvolt
Y axis 5 line = 1 Vertical Block = 0.5 mvolt
Y axis 10 line = 2 Vertical Blocks = 1 mvolt
Normal ECG Machine is recording 12 second ECG Signal .
1 Second = 5 Horizontal Blocks
12 Second = 60 Horizontal Blocks
1 Block = 5 mm =0.5 cm
60 Horizontal Blocks / 2 = 30 cm = 1 feet of ECG Graph Paper
To record 1 minutes of ECG Signal of patients
1 minutes = 60 Seconds
1 Second = 5 Horizontal Blocks
60 Seconds = 60 x 5 = 300 Horizontal Blocks
1 Horizontal Block = 5 lines = 5 mm = 0.5 cm
300 Horizontal Block / 2 = 150 cm

150 cm = 5 feet of ECG Graph Paper is required

To calculate Heart Beat rate = Calculate Interval between RR

Heart Beat rate =
Horizontal Blocks in 1 minutes/RR Interval Blocks
Heart Beat rate =
300 / RR Interval Blocks

Case 1. RR Interval is 4 Blocks
Heart Beat rate = 300 / 4 = 75 Heart Beat per minutes

Case 2. RR Interval is 5 Blocks
Heart Beat rate = 300 / 5 = 60 Heart Beat per minutes

Case 3. RR Interval is 6 Blocks
Heart Beat rate = 300 / 6 = 50 Heart Beat per minutes

Case 4. RR Interval is 3 Blocks
Heart Beat rate = 300 / 3 = 100 Heart Beat per minutes

Case 5. RR Interval is 2.5 Blocks
Heart Beat rate = 300 / 2.5 = 120 Heart Beat per minutes

Case 6. RR Interval is 4.5 Blocks
Heart Beat rate = 300 / 4.5 = 66 Heart Beat per minutes

Case 7. RR Interval is 3.5 Blocks
Heart Beat rate = 300 / 3.5 = 86 Heart Beat per minutes

Table 1: **Relationship between RR Interval and Heart Beat Rate**

No. of RR Interval Blocks	Heart Beat Rate (Beats Per Minute)
2.5	120
3.0	100
3.5	86
4.0	75
4.5	66
5	60

As RR Interval is increasing Heart Beat rate is decreasing and RR Interval is decreasing Hear Beat rate is increasing.
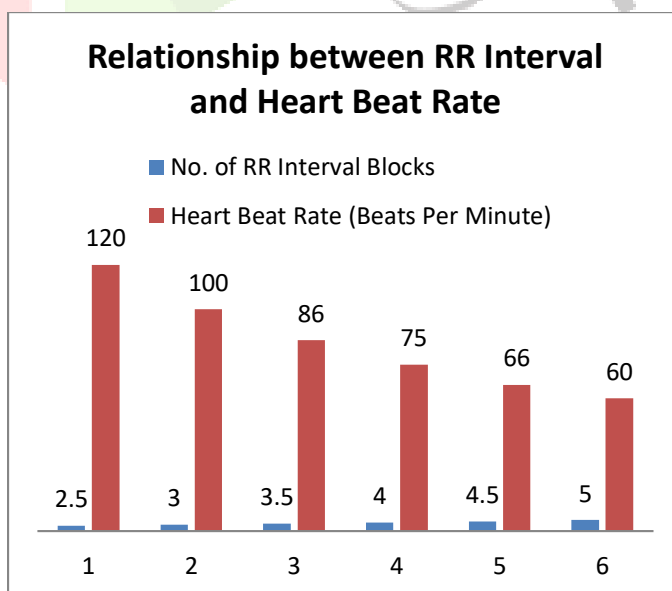

Fig 7. Relationship between RR Interval and Heart Beat Rate
Fig 7. Indicates Relationship between RR Interval and Heart Beat Rate. In this As RR Interval increases Heart Beat rate will decrease and As RR Interval decreases Heart Beat rate will increase.
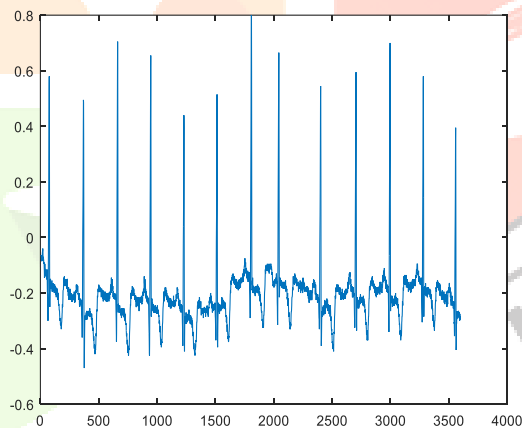Heart Beat Calculation:-
close all

```
clear all
clc
disp('Program to calculate ECG beats')
sample_freq=input('Enter the sampling frequency of the signal:');
% Load file
data=load('ecgh.csv');
plot(data);
% Perform CWT with scale 3 and wavelet Coiflet-1
cof=cwt(data,3,'coif1');
% R -Peak Identification
cofsq=cof.^2;
threshold=mean(cofsq);
peak=0;
%datapoints=6*sample_freq*10;
% Remove edge effects
cofsq(1)=0;
cofsq(end)=0;
ntime=6*sample_freq;
for i=1:ntime
if cofsq(i) >=threshold
peak=peak+1;
end
end
% Beats per minute
beats= peak;    % (peak/sample_freq)*36;
% Show output
disp(sprintf('Beat interval is %g beats per minute',beats))
```

Result:-
Program to calculate ECG beats
Enter the sampling frequency of the signal:280
Beat interval is 79 beats per minute

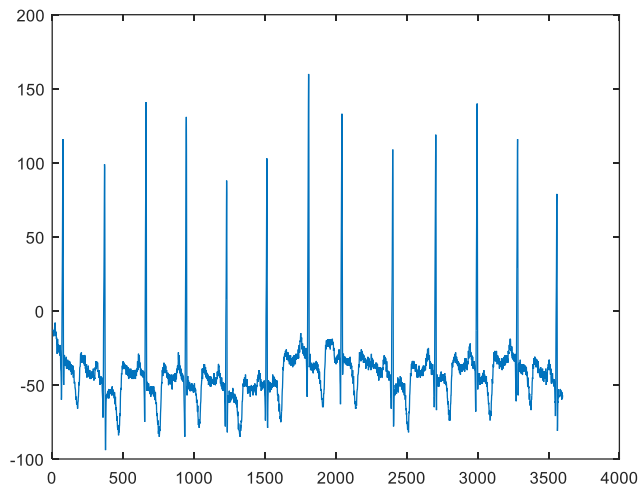Heart beat calculation is possible using above matlab code.
Load .mat file
>> sig=load('100m.mat')

sig =

val: [1x3600 double]
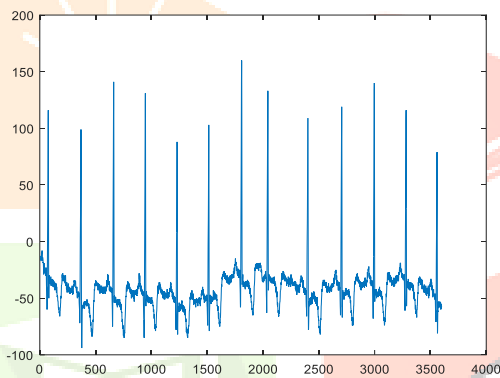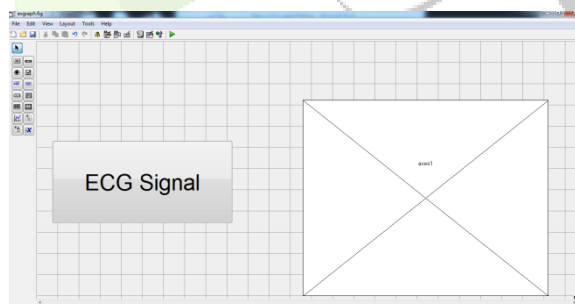
>> plot(sig.val)
>> sig=load('100m.mat')

Matlab Program:-
clc;
val=load('100m.mat');
ECGsignal = (val - 1024)/200;
Fs = 360;
t=(0:length(ECGsignal)-1)/Fs;
plot(t,ECGsignal)
>> plot(val.val)
>>

ECG Signal Plotting using GUI :-
GUI Stands for Graphical User Interface. GUI is using to user interface So any user can easily use it.

Fig.8 Front Panel ECG Signal GUI

Fig.9 Result ECG Signal GUI

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REFERENCES

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[2] Pandelis Perakakis et al. KARDIA: A Matlab software for the analysis of cardiac interbeat intervals, Computer Methods and Programs in Biomedicine Volume 98, Issue 1, April 2010, Pages 83-89

BIOGRAPHIES

	Mr. Sachin Sambhaji Patil is a Research Scholar, He is **Pursuing PhD at Shivaji University Kolhapur.** Currently, He working as an **Assistant professor** at **Zeal college of Engineering and Research Pune.** He stood 5th rank at the time of BE in SUK Exam. He has more than 13 years of teaching experience. He has attended 22 STTP, 11 Workshops, 5 national conferences, 15 international conferences. He has published near about 30 papers in international journals. He got young instigator award at an international conference at Nagpur. His area of specialization is signal and systems, digital signal processing, Image processing.
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