Report on ECG & Heart Rate monitoring System using MATLAB

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Acknowledgements

We would like to express our sincere gratitude to our respected mentor as well as our faculty guide Mr. Kalyan Chatterjee for guiding us throughout and giving his valuable feedback at all times in order to improve the project and make it better. We would specially thank him for his assistance in the project period. Also, we would like to thank the whole faculty members of the department of ECE for motivating us. This project work will not be finished without their guidance. Thank you to them for providing and supporting us throughout the entire project work.

Yours Sincerely,

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Contents

Introduction

●Heart diseases are becoming a big issue for the last few decades.

●In order to prevent such big issues we are analyzing or monitoring the ECG signal at the initial stage of such diseases.

●In order to diagnose various heart conditions electrocardiography is used.

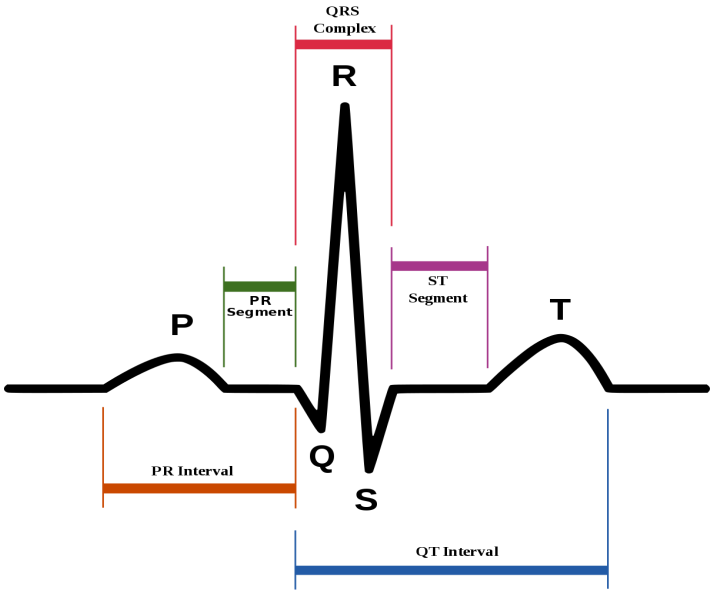
●We have taken Arduino and AD8232 as ecg sensor for implementing the Heart rate monitoring system.

●We are using MATLAB to process the data and to get the respective heart rate and the condition of the heart.

What is ECG ?

An ECG is a paper or digital recording of the electrical signals in the heart. It is also called an electrocardiogram or an EKG. The heart rate, heart rhythm and other information regarding the heart's condition can be determined using ECG. ECGs can help diagnose heart arrhythmias, heart attacks, pacemaker function and heart failure.

ECG can be analysed by studying components of the waveform. These waveform components indicate cardiac electrical activity. The first upward of the ECG tracing is the P wave. It indicates atrial contraction.
The QRS complex begins with Q, a small downward deflection, followed by a larger upwards deflection, a peak (R); and then a downwards S wave. This QRS complex indicates ventricular depolarization and contraction.
Finally, the T wave, which is normally a smaller upwards waveform, represents ventricular repolarization.



How ECG Works?

It works on the principle that a contracting muscle generates a small electric current that can be detected and measured through electrodes suitably placed on the body.

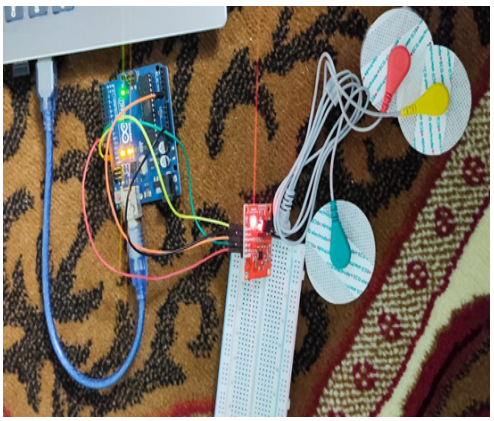
❖The electrodes are attached to the person's skin with the help of a special jelly.

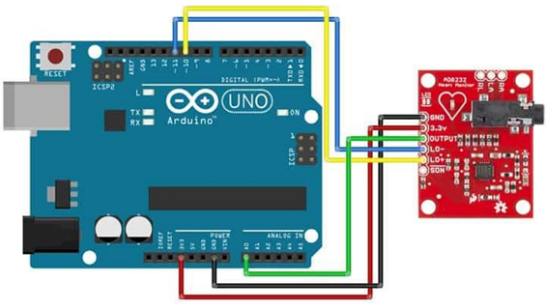
❖The electrode picks up the current and transmit them to an amplifier inside the electrocardiograph. Then electrocardiograph amplifies the current and records them.

Components and Software Used

COMPONENTS	DESCRIPTION
ARDUINO BOARD	ARDUINO UNO
ECG SENSOR	AD8232 ECG SENSOR KIT
DATA CABLE	5V MICRO USB DATA CABLE
SOFTWARE USED	ARDUINO AND MATLAB
CONNECTING WIRES	JUMPER WIRES

Circuit Diagrams and Connections

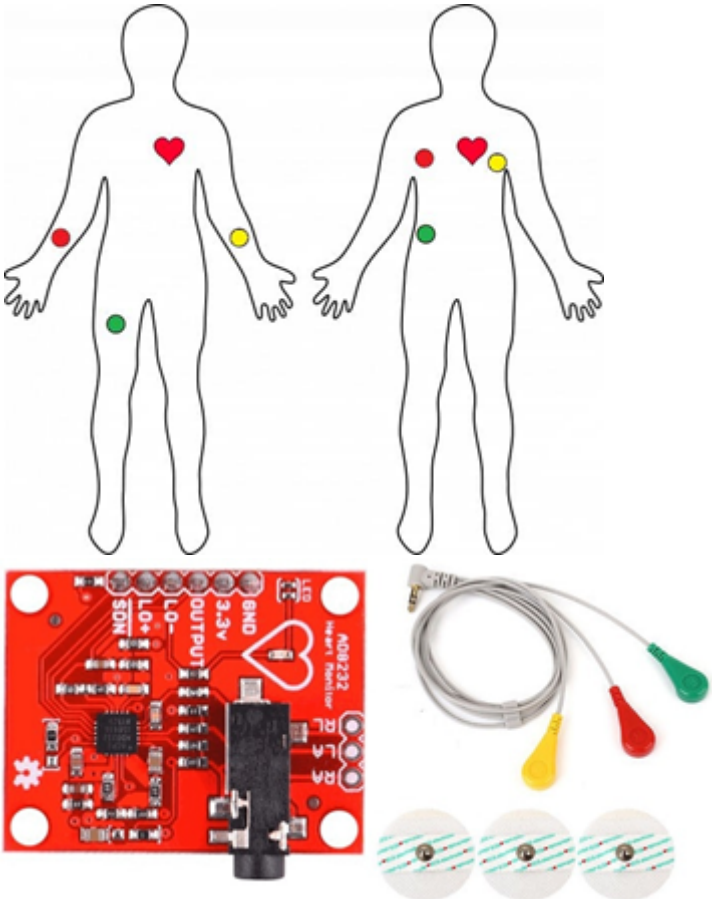




Board Label	Pin Function	Arduino Connection
GND	Ground	**GND**
3.3v	3.3v Power Supply	**3.3v**
OUTPUT	Output Signal	**A0**
LO-	Leads-off Detect -	**11**
LO+	Leads-off Detect +	**10**
SDN	Shutdown	**Not used**

ECG Sensor placement on the body

The electrical activity can be measured by placing electrodes at specific points on the skin.It is recommended to snap the sensor pads on the leads before application to the body.We are placing the electrodes according to 3 lead systems.



Procedure

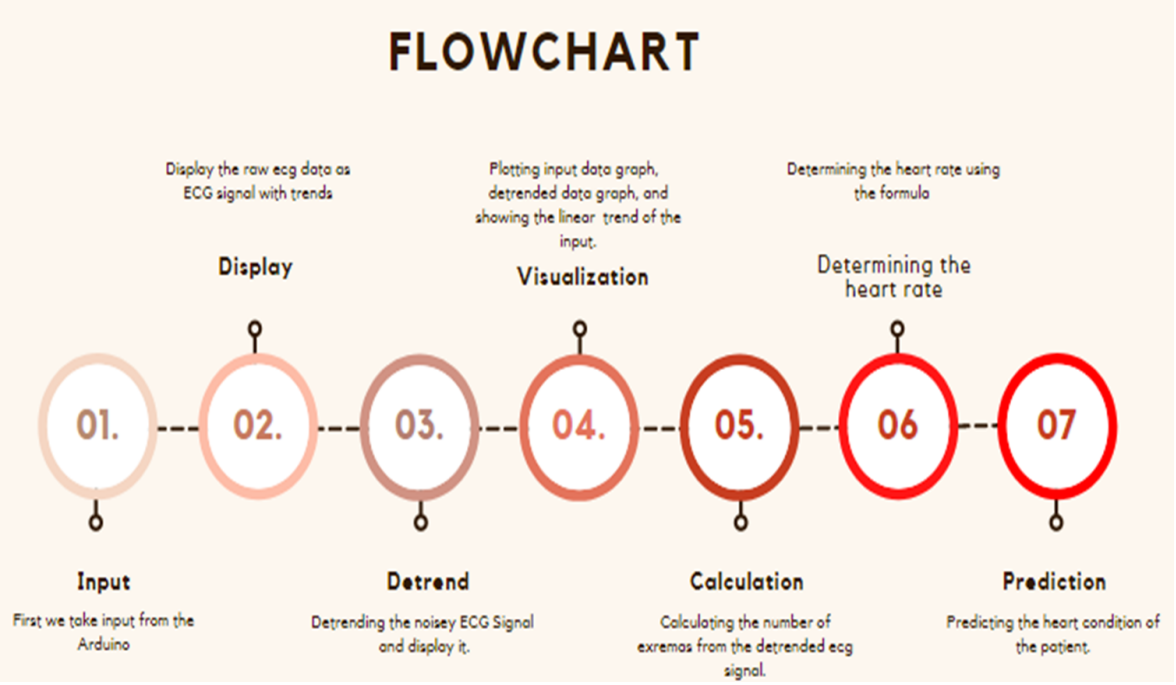
1.Take readings from AD8232 sensor using arduino UNO in MATLAB and store the readings.

2.Remove Trends in the Data

3.Find the R Wave Maximums

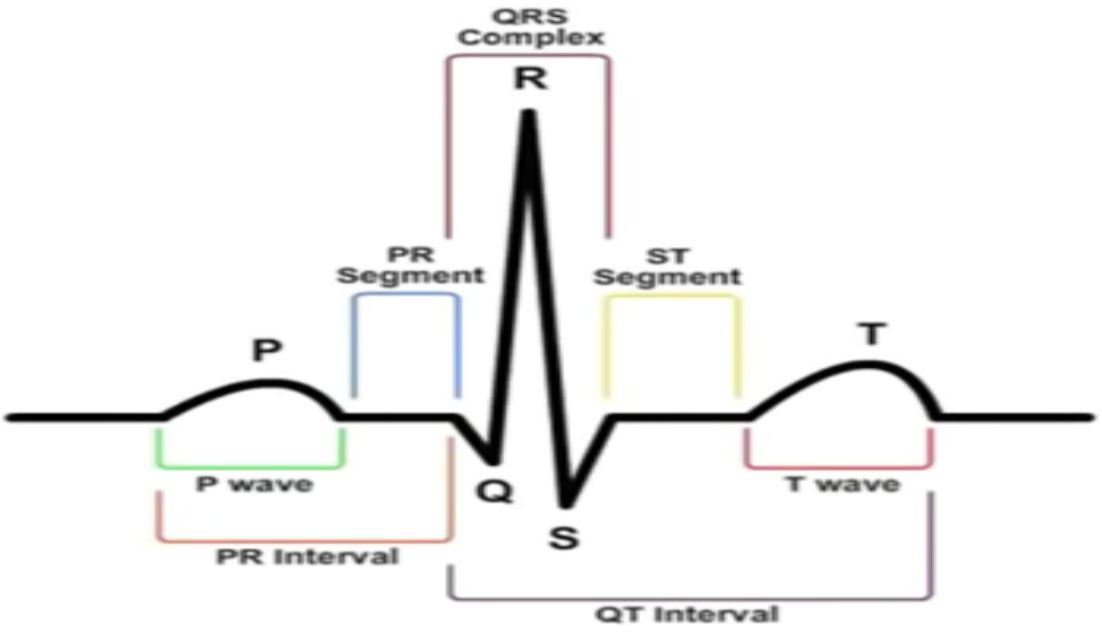
4.Calculate the Heart Rate

5.Analyze heart conditions.



Detection of Peak points

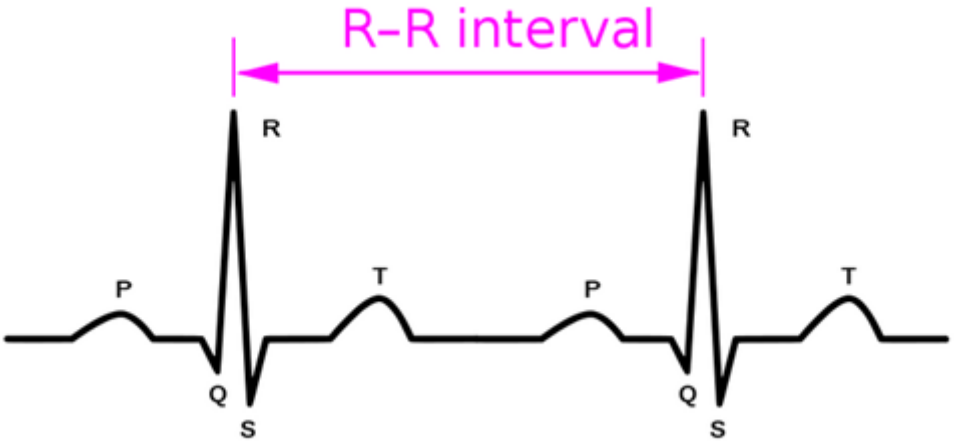
An Ideal ECG looks like this and it keeps repeating itself. We will try to detect the R-peaks in this presentation



Calculation of Heart Beat

Heart Beat Rate in (beats/second) can be calculated by the formula:

*Rate= 60*sampling rate/(R-R interval)*



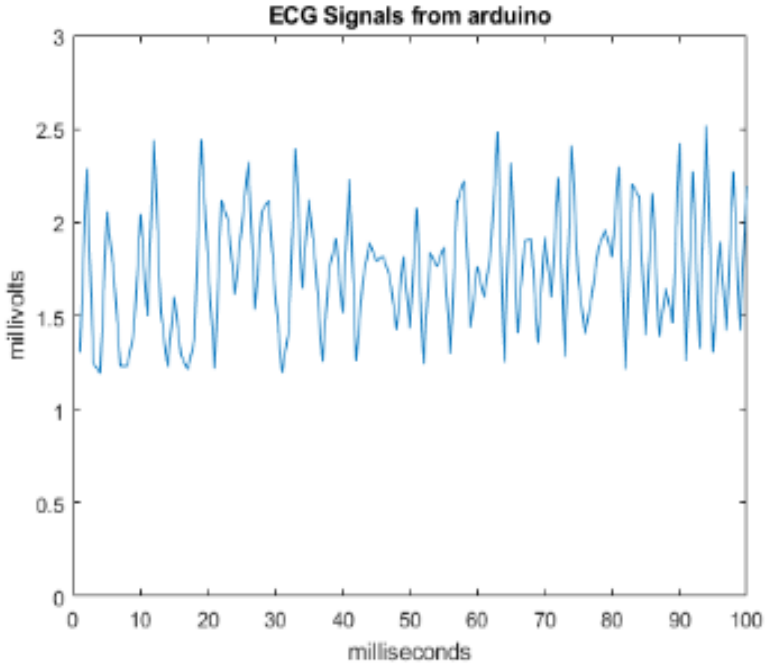
SOURCE CODE

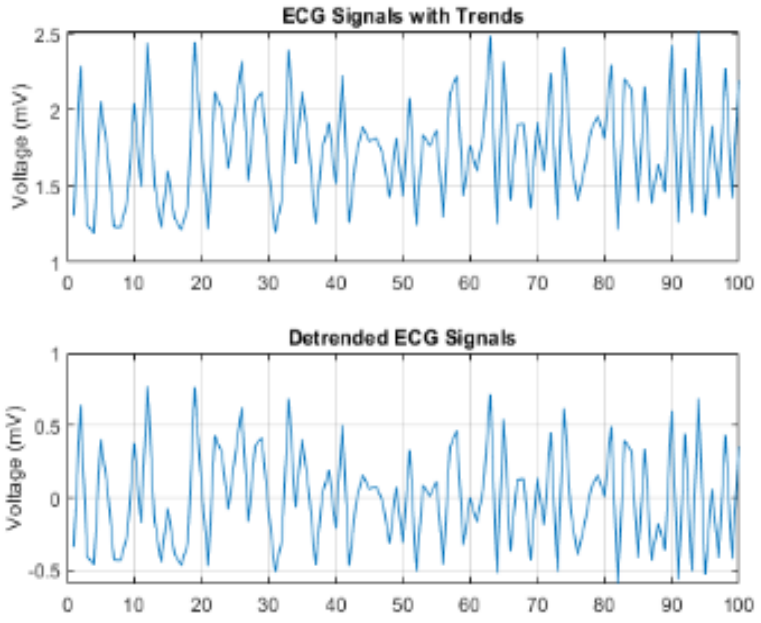
```
clear noisyec;
clear a;
a=arduino('COM4','Uno');
configurePin(a,'D10');
configurePin(a,'D11');
c=0;
data=[];
while(c<100)
    v=readVoltage(a,"A0");
    x= v;
    c=c+1;
    noisyec(c,1) = v;
    plot(noisyec)

xlim([0.0 100.0])
ylim([0.00 3.00])
    title 'ECG Signals from arduino'
xlabel('milliseconds')
ylabel('millivolts')
end



t = (1:length(noisyec))';
```

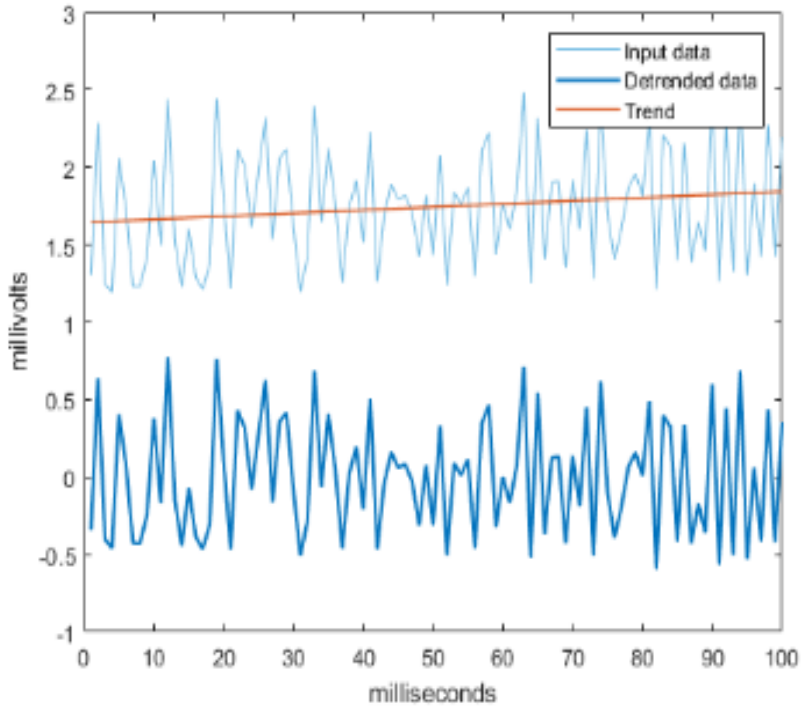
```
subplot(2,1,1)
plot(t,noisyec), grid
title 'ECG Signals with Trends', ylabel 'Voltage (mV)'
dt_noisyec = detrend(noisyec);
subplot(2,1,2)
plot(t,dt_noisyec), grid
title 'Detrended ECG Signals', ylabel 'Voltage (mV)'
% Visualize results
clf
plot(noisyec,'Color',[109 185 226]/255,'DisplayName','Input data')
hold on
plot(dt_noisyec,'Color',[0 114 189]/255,'LineWidth',1.5,...
    'DisplayName','Detrended data')
plot(noisyec-dt_noisyec,'Color',[217 83 25]/255,'LineWidth',1,...
    'DisplayName','Trend')
hold off
legend
xlabel('milliseconds')
ylabel('millivolts')
ismax = islocalmax(dt_noisyec,'MinProminence',0.9);
clf
plot(dt_noisyec,'Color',[109 185 226]/255,'DisplayName','Input data')
hold on
plot(find(ismax),dt_noisyec(ismax),'^','Color',[217 83 25]/255,...
    'MarkerFaceColor',[217 83 25]/255,'DisplayName','Local maxima')
```

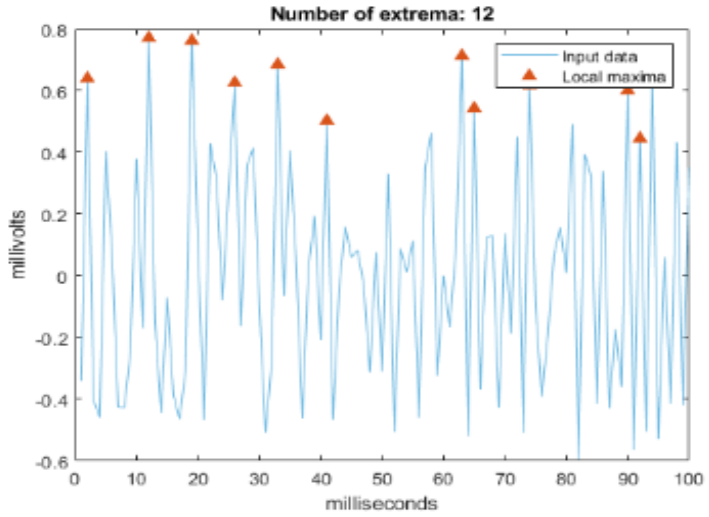
```
title(['Number of extrema: ' num2str(nnz(ismax))])
hold off
legend
xlabel('milliseconds')
ylabel('millivolts')
%heart rate calculations
maxIndices = find(ismax);
msPerBeat = mean(diff(maxIndices));
heartRate = 60*(100/msPerBeat);
heartRate = heartRate/10;
disp("HEART RATE: "+ heartRate);
if heartRate <= 60
    disp('Bradycardia ,it is  slower than normal heart rate')
elseif heartRate>=60 && heartRate<=100
    disp(heartRate);
    disp('A normal heart rate')
elseif heartRate>=100 && heartRate<=150
    disp('Tachycardia, it is faster than normal heart rate')
elseif heartRate>=150 && heartRate<=180
    disp('Supraventricular Tachycardia')
elseif heartRate>=180 && heartRate<=200
    disp('Fetal tachyarrhythmia')
elseif heartRate>200
    disp('Paroxysmal supraventricular tachycardia')
end
```

OUTPUT


ECG Signals from arduino
millivolts
milliseconds
0
0.5
1
1.5
2
2.5
3
0
10
20
30
40
50
60
70
80
90
100


ECG Signals with Trends
Voltage (mV)
1
1.5
2
2.5
Detrended ECG Signals
Voltage (mV)
-0.5
0
0.5
1
0
10
20
30
40
50
60
70
80
90
100






```
HEART RATE: 71.7391
   71.7391
A normal heart rate
```

CONCLUSION

So using an electrocardiogram can be a useful way to find out whether your high blood pressure has caused any damage to your heart or blood vessels. In any type of emergency situation this becomes an absolute necessity for detection of the heart condition and an immediate action has to be taken to restore the normal heart conditions. So using this ecg sensor at home will be of real help rather than going to the diagnostic centre which will be a time consuming process. The data which will be recorded by the sensor can be sent to the professional for analysis. Also if the ecg obtained differs from that of a normal ecg the exact cause for the distortion can be inferred.