Rajshahi University of Engineering and Technology

Dept. of Electrical & Computer Engineering

Course Title:
Bio-medical Engineering Sessional
Course No:
ECE 4144

Experiment No: 03

Experiment Name: Experimental Observation of Various Features of an ECG Signal Collected from PhysioNet Public Dataset

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Department of EEE, RUET	Session: 2020-21

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Objectives:

1. To observe and measure key ECG waveform features — specifically the RR interval, PP interval, and PR interval — using a public ECG dataset from PhysioNet.
2. To understand the temporal characteristics of cardiac electrical activity and relate them to physiological parameters such as heart rate.

Theory:

The Electrocardiogram (ECG) is a biomedical signal that represents the electrical activity of the heart. The ECG waveform consists of several characteristic points, including the P wave, QRS complex, and T wave. These features are essential for analyzing cardiac health and detecting arrhythmias.

Key intervals measured in this experiment:

- RR Interval – Time between successive R-wave peaks; used to determine heart rate and detect arrhythmia.
- PP Interval – Time between successive P-wave peaks; used in atrial rhythm analysis.
- PR Interval – Time from the onset of the P-wave to the start of the QRS complex; indicates conduction time from atria to ventricles.

The heart rate (HR) can be computed from the RR interval using:

$$HR = \frac{\text{Number of R-peaks in a given time}}{\text{Time (s)}} \times 60$$

Dataset-Description:

The experiment uses the 'MIT-BIH Arrhythmia Database' from PhysioNet. The dataset contains 48 half-hour two-channel ambulatory ECG recordings from 47 subjects, collected between 1975 and 1979 by the BIH Arrhythmia Laboratory. [1]

Details of the Dataset:

- Sampling Frequency (Fs): 360 Hz
- Total annotations: ~110,000
- Subjects: ~60% inpatients, ~40% outpatients

For this experiment, we used record 100, which consists of four files:

- `100.atr` – Annotation file
- `100.dat` – ECG waveform data file
- `100.hea` – Header file containing recording details
- `100.xws` – Additional waveform storage file

Tools Used:

- MATLAB
- WFDB Toolbox for MATLAB – Library for reading PhysioNet data formats

Code:

```
[sig, Fs, tm] = rdsamp('mit bih/100', 1);

plot(sig(1:3600, 1))
time = 10; %in seconds
no_of_r_peak = 13;
HR = (no_of_r_peak/time)*60;
fprintf('Heart Rate (bpm): %.2f\n', HR);
R_Peak_positions = [78 371 664 948 1232];
rri = diff(R_Peak_positions);
RR_mean = mean(rri);
fprintf('Mean R-R Interval (samples): %.2f\n', RR_mean);
rr_mean_second = RR_mean/360;
fprintf('Mean R-R Interval (seconds): %.4f\n', rr_mean_second);
P_Peak_positions = [311 605 885 1164 1467];
ppi= diff(P_Peak_positions);
PP_mean = mean(ppi);
fprintf('Mean P-P Interval (samples): %.2f\n', PP_mean);
pp_mean_second = PP_mean/360;
fprintf('Mean P-P Interval (seconds): %.4f\n', pp_mean_second);
```
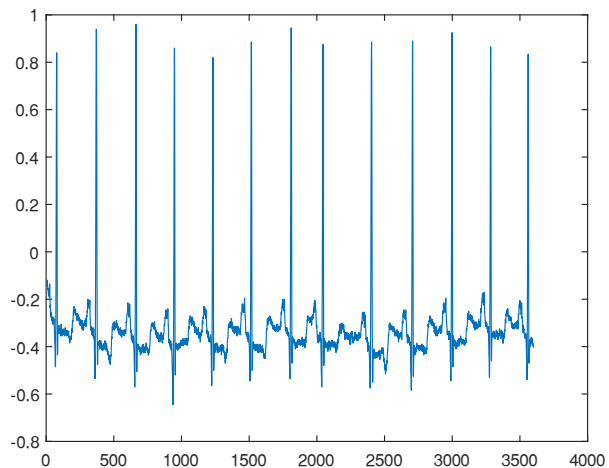
Output:

Heart Rate (bpm): 78.00

Mean R-R Interval (samples): 288.50

Mean R-R Interval (seconds): 0.8014

Mean P-P Interval (samples): 289.00

Mean P-P Interval (seconds): 0.8028

Result & Discussion:

The experiment successfully demonstrated ECG feature extraction using publicly available clinical ECG data.

- The heart rate calculated was approximately 78 bpm, indicating a normal resting heart rate.
- The RR interval averaged 0.8014 seconds, consistent with the heart rate observed.
- The PP interval averaged 0.8028 seconds, showing stable atrial activity.

These results confirm that ECG signal analysis from PhysioNet datasets is a reliable way to study cardiac activity and can be applied to arrhythmia detection in further experiments.

References

[1] PhysioNet, "MIT-BIH Arrhythmia Database," 2020. [Online]. Available: https://physionet.org/content/mitdb/1.0.0/.