Heaven's Light is Our Guide

Rajshahi University of Engineering and Technology

Course Code
ECE 4144

Course Title
Biomedical Engineering Sessional

Experiment Date: August 06, 2025,
Submission Date: August 13, 2025

Lab Report 3:
Experimental Observation of Various Features of an ECG Signal Collected from PhysioNet Public Dataset

Submitted to	**Submitted by**
Md Mayenul Islam	Md. Tajim An Noor
Assistant Professor	Roll: 2010025
Dept of EEE, Ruet	

Experiment 3

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

Objectives

- Measure key ECG features (RR, PP, PR intervals) using a PhysioNet dataset.
- Relate these intervals to heart rate and cardiac function.

Theory

An electrocardiogram (ECG) records the heart's electrical activity [1]. Key features include the P wave, QRS complex, and T wave.

Important intervals:

- **RR Interval**: Time between R-wave peaks; used to calculate heart rate.
- **PP Interval**: Time between P-wave peaks; reflects atrial rhythm.
- **PR Interval**: From P-wave onset to QRS start; indicates atrioventricular conduction.

Heart rate (HR) is calculated from the RR interval [1]:

$$\text{Heart Rate (bpm)} = \frac{\text{Number of R-peaks}}{\text{Time (s)}} \times 60$$

Dataset Description

This experiment uses the MIT-BIH Arrhythmia Database from PhysioNet, which contains 48 half-hour, two-channel ECG recordings from 47 subjects [2].

Key details:

- **Sampling Frequency:** 360 Hz
- **Annotations:** ∼110,000
- **Subjects:** 60% inpatients, 40% outpatients

Record 100 was analyzed, including files: `100.atr` (annotations), `100.dat` (ECG data), `100.hea` (metadata), and `100.xws` (extra waveform data).

Tools Used

- **MATLAB**: For ECG signal processing and analysis.
- **WFDB Toolbox**: To access and handle PhysioNet data in MATLAB.

ECG Signal Analysis: MATLAB Implementation

The MATLAB code below reads ECG data from the MIT-BIH Arrhythmia Database, plots a segment, and calculates heart rate and key intervals:

```
[sig, Fs, tm] = rdsamp('mit bih/100', 1);
plot(sig(1:3600, 1));
duration_sec = 10; % seconds
num_r_peaks = 13;
heart_rate_bpm = (num_r_peaks / duration_sec) * 60;
fprintf('Heart Rate (bpm): %.2f\n', heart_rate_bpm);
r_peak_indices = [78 371 664 948 1232];
rr_intervals = diff(r_peak_indices);
mean_rr_samples = mean(rr_intervals);
fprintf('Mean R-R Interval (samples): %.2f\n', mean_rr_samples);
mean_rr_seconds = mean_rr_samples / 360;
fprintf('Mean R-R Interval (seconds): %.4f\n', mean_rr_seconds);
p_peak_indices = [311 605 885 1164 1467];
pp_intervals = diff(p_peak_indices);
mean_pp_samples = mean(pp_intervals);
fprintf('Mean P-P Interval (samples): %.2f\n', mean_pp_samples);
mean_pp_seconds = mean_pp_samples / 360;
fprintf('Mean P-P Interval (seconds): %.4f\n', mean_pp_seconds);
```

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
```

Annotated ECG Segment

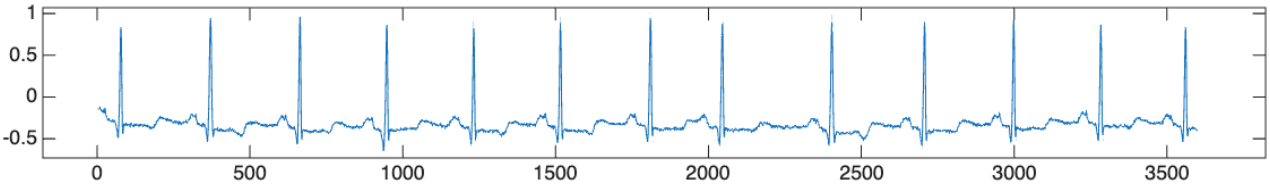

Figure 1: ECG segment with R- and P-peaks.

Result & Discussion

The analysis yielded:

- **Heart Rate:** 78 bpm
- **Mean R-R Interval:** 288.5 samples (0.80 s)
- **Mean P-P Interval:** 289.0 samples (0.80 s)

These results, obtained using MATLAB and WFDB Toolbox, confirm accurate peak detection and fall within normal adult ranges. The close agreement between RR and PP intervals indicates a regular sinus rhythm in the analyzed ECG segment.

References

[1] J. R. Hampton, *The ECG Made Easy*, 9th ed. Elsevier, 2019.

[2] G. B. Moody and R. G. Mark, "Mit-bih arrhythmia database," https://physionet.org/content/mitdb/1.0.0/, 1992, physioNet. [Online]. Available: https://physionet.org/content/mitdb/1.0.0/