The Hong Kong Polytechnic University

Department of Aeronautical and Aviation Engineering

2024/25 Semester 2

AAE6102 Satellite Communication and Navigation

Assignment 1

Due on 13 March 2024

Developing a comprehensive understanding of GNSS Software-Defined Receiver (SDR) signal processing is crucial for researchers in the GNSS navigation field. You are provided with two real Intermediate Frequency (IF) datasets, which were collected in open-sky area and urban environment, respectively (see Figure 1). The urban dataset likely exhibits typical urban effects such as multipath and non-line-of-sight (NLOS) receptions, which can degrade signal quality and lead to positioning errors. The collected GPS L1 data are described in Table 1. You are required to process and analyze the IF data using any open-source GNSS SDR code.

Submit a technical report and source code via GitHub (Readme.md format) and share the link with Dr. Hoi-Fung Ng, other teaching assistants, and the lecturer by email on or before **13 March 2024**.

A collage of a green field and a city

AI-generated content may be incorrect.

Figure 1. Data collection locations

Table 1

|  |  |  |
| --- | --- | --- |
|  | Opensky | Urban |
| Carrier frequency | 1575.42 MHz | 1575.42 MHz |
| Intermediate frequency | 4.58MHz | 0 |
| Sampling frequency | 58MHz | 26MHz |
| Data Format | 8 bit I/Q samples | 8 bit I/Q samples |
| Ground truth | (22.328444770087565,  114.1713630049711) | (22.3198722, 114.209101777778) |
| Data length | 90 seconds | 90 seconds |

**Task 1** – Acquisition  
Process the IF data using a GNSS SDR and generate initial acquisition outputs.

**Task 2** – Tracking  
Adapt the tracking loop (DLL) to produce correlation plots and analyze the tracking performance. Discuss the impact of urban interference on the correlation peaks. (Multiple correlators must be implemented for plotting the correlation function)

**Task 3** – Navigation data decoding  
Decode the navigation message and extract key parameters, such as ephemeris data, for at least one satellite.

**Task 4** – Position and velocity estimation  
Using the pseudorange measurements obtained from tracking, implement the Weighted Least Squares (WLS) algorithm to compute user’s position and velocity. Plot the user position and velocity, compare it to the provided ground truth values, and comment on the impact of multipath effects on the WLS solution.

**Task 5** – Kalman filter-based positioning  
Develop an Extended Kalman Filter (EKF) using pseudorange and Doppler measurements to estimate user position and velocity.