AEM 667 Project 1

GPS Positioning System Design

Learning Objective

The purpose of this project is to implement a differential positioning system using data from the Global Positioning System (GPS).

Sensor Data

The .zip file provided contains the following files for GPS data on the 20th of October, 2011

- pseudoranges and carrier phase measurements from nine GPS satellites as measured by a NovAtel SuperStar II GPS receiver and the corresponding GPS transmission times for several minutes of data (icp_sat<#>.txt where # is the PRN)
  - data_base (static)
  - data_rover (kinematic)
- broadcast ephemeris of all GPS satellites during that day (brdc2930.11n);
- ECEF solution from SuperStar II for Base receiver (ecef_rx0.txt);
- ecef_rx, icp, and rinex_2-11 format text files; and
- MATLAB and Python utility functions for processing the data.

Project Assignment and Deliverables

For this project, in MATLAB or Python, perform the following.

1. Compute the averaged *Base* receiver position based on the ECEF solution from the SuperStar II.
   - Use averaged Base position as NED frame origin.
2. Compute the Line-Of-Sight (LOS) vectors from the *Base* and *Rover* receivers to the GPS satellites in NED coordinates.
   - Use the GPS satellite positions at each time step in the icp files using the ephemeris given in the broadcast RINEX file for the GPS satellite orbital parameters.
3. Compute the reference satellite at each time step in the icp files as the GPS satellite that achieves the highest average altitude, i.e., the highest elevation angle and most negative Down coordinate, across the time history of the NovAtel data file.
4. Estimate the *Rover* position in NED coordinates using the double-differenced pseudorange technique.
   - Use the least-squares technique with the linearized measurement model for each time step of the NovAtel data file; and
   - Use the *Base* position to form the LOS vectors in the measurement matrix.

5. Estimate the *Rover* position in NED coordinates using the double-differenced carrier-phase technique with three (or four) solutions.
    - Use the least-squares technique with the linearized measurement model to estimate the relative position, clock error, and cycles for the entire time history of the NovAtel data file;
    - Use the *Base* position to form the LOS vectors in the measurement matrix; and
    - Compute the position using the float solution, the rounded float solution, and the geometry-free solution for the integer ambiguity.
    - (Optional - Extra 3 points) Compute the position using the LAMBDA method using the provided MATLAB and Python toolboxes from TU Delft.
6. Plot the estimated *Rover* positions in NED coordinates.
    - One plot or subplot of the North vs. time for each method labeled in a legend.
    - One plot or subplot of the East vs. time for each method labeled in a legend.
    - One plot or subplot of the Down vs. time for each method labeled in a legend.
    - One plot of the North and East coordinates for each method labeled in a legend.