ASEN 5090 HW9 Due Wed 7-Dec-2016

- Submissions as a “report” to D2L dropbox assignment 09 by 9:30 7-Dec-2016
- Bring a hardcopy to 7-Dec-2016 lecture for in-place grading if desired
- All MATLAB code should be submitted as individual m-files to D2L

This final assignment of the semester completes the process of using GPS pseudorange measurements to form a solution. In HW7 we computed a single position solution (also called a point solution) at one specific time (or “epoch”), focusing on implementing all of the necessary pseudorange corrections, constructing the A-matrix (measurement connection matrix or measurement partials), and investigating how well this process converges to the correct answer given an a priori guess that is far from the truth. In this assignment we compute point solutions for a station over the course of an entire day using each of the measurement epochs given in a RINEX observation file. In addition to the mechanics of solving for position we also will look at the resulting position errors to see how they change over the day. To do this, we solve for the position correction (or relative position) with respect to the known receiver position, at each epoch. Corrections or relative positions like this are often expressed in East-North-Up components, which provide more meaningful interpretation of the position errors as opposed to ECEF X, Y, Z errors. We will use the receiver position given in the obs file header as both the *a priori* guess and the true location.

Models and preparation for solution:

- Use the position given in the amc RINEX header as your initial (*a priori*) guess for the station coordinates. You should assume that this position is correct.
- Set up your code to loop through the entire obs file, working with the data from one epoch at a time.
- For each epoch, loop through the satellites computing the following for each one (these are all based on prior homeworks):
    - The satellite position, expected range, satellite clock correction, and relativity correction based on the parameters in the broadcast ephemeris file and the *a priori* receiver location.
    - To correct for the ionospheric delays use the dual frequency ionosphere-free pseudorange combination P3 which is computed using P1 and P2. *Do not use the Klobuchar model.*
    - To correct for tropospheric delays use 2.5/sin(elevation angle).
- Calculate and store the pre-fit residuals. Remove all satellites below 10 deg elevation and also remove any large measurement outliers in the pre-fit residuals before computing a least-squares solution.

Least Squares Point Solutions:

- At each epoch, use the position given in the RINEX header as your initial (*a priori*) guess for the station coordinates. This will be used to construct your A-matrix as well as the expected range.

- Compute the least squares position and clock solution: dx, dy, dz, b for each epoch of the day. This solution is an adjustment or correction to the *a priori* guess. Do not iterate this, just use the position given in the RINEX header as the *a priori* for each epoch, and solve for a position & clock correction. We will refer to this position correction as the "relative position" in the following.

- Compute the post-fit residuals: dpr_post = dpr_pre – A [dx dy dz b]’

- Rotate the relative position to East-North-Up (ENU also called ENV) coordinates based on the *a priori* position. (Another option is to express the LOS vectors in the A matrix in ENU, then your relative position and P-matrix will both automatically be in ENU coordinates.) Use the *a priori* receiver position as the basis for computing the rotation matrix from ECEF to ENU. You likely used this matrix in your visibility homework near the start of the semester. You will now have a position correction for each time on the obs file (total of 2880 of them because the measurements are output every 30 seconds).

- Compute the East, North, and Up - **DOP** values for each epoch.

- Compute the standard deviation and RMS value of each of the relative position coordinates and the standard deviation of the pre and post-fit residuals over the entire day.

- Compute the results for the mystery site & describe how & why the results are different from amc. Where is it? Iteration will be necessary, but only iterate the second epoch.

What to submit: All of your code, well-commented plus:
For AMC station

1. Print out your solution for the position relative to the *a priori* in East, North, Up coordinates to a precision of 1 cm, and the corresponding DOP values **at time 0:01:00.**
2. Print out the standard deviation and RMS value of each of the relative position coordinates and the standard deviation of the pre and post-fit residuals. These are computed over the entire day, so you should have a total of 5 standard deviations and 5 RMS values.
3. Plot the pre-fit residuals as a function of time (hours) and as a function of elevation (deg). (Do not include outliers.)
4. Plot the post-fit residuals as a function of time (hours) and as a function of elevation (deg).
5. Plot the ENU solutions (m) as a function of time (hours).
6. Plot the DOP values as a function of time (hours).
7. Open-Ended Discussion (1/2 to 1 page) **-** Discuss and explain the results. Use what you have learned from previous assignments to back up your analysis.

For MYSTERY station

8. Print out your solution for the position in ECEF, with 1 cm precision after iteration **at time 0:01:00**. Also print out your solution relative to the ECEF position you found using iteration in East, North, Up coordinates to a precision of 1 cm, and the corresponding DOP values **at time 0:02:00.**
9. Print out the standard deviation and RMS value of each of the relative position coordinates and the standard deviation of the pre and post-fit residuals. These are computed over the entire day, so you should have a total of 5 standard deviations and 5 RMS values.
10. Plot the pre-fit residuals as a function of time (hours) and as a function of elevation (deg). (Do not include outliers.)
11. Plot the post-fit residuals as a function of time (hours) and as a function of elevation (deg).
12. Plot the ENU solutions (m) as a function of time (hours).
13. Plot the DOP values as a function of time (hours).
14. Open-Ended Discussion (1/2 to 1 page) **-** Discuss and explain the results. Describe how & why the results are different from amc. Use what you have learned from previous assignments to back up your analysis.