Lab 1 -- Ship Reference Frame Integration

Due date April 19th, 2022 --- submit your pdf to MyITSClassroom (In MsWord use save as--pdf). Individual submission.

Questions can be e-mailed to dg.pratomo@gmail.com.

Procedure: Run one version for the Knudsen attitude and one version for the EM710 attitude. They will be slightly different because the <u>EM710 heave already has induced heave included</u>.

1. Download all the data and Matlab routine from *MyITS Classroom*.
2. Create a common time format for the attitude, tides, and GPS (i.e: decimal hours).
   - This doesn't need to be decimal hours but use something so that you can associate each epoch of the GPS and tides which each epoch of the attitude, the attitude acts as the master file since we need to do calculations for each attitude epoch.
3. Do a linear interpolation for GPS lat long and height to get an appropriate position for each epoch of the attitude file. This is necessary because GPS only records its position every second, while the attitude is at a higher frequency (i.e: interpolate between position at seconds 4 and 5 to get the position at seconds 4.5).
4. Use the same approach as step 3 to get a tidal height for each attitude epoch.
5. Use the offsets along with heading pitch and roll to get the coordinates of each sounder and the GPS antenna in the navigation frame (apply the three rotations in the proper order -Tait Bryan convention-).
6. Convert delta N and delta E to delta lat and delta long using formulas 1 and 2. Delta Z remains a linear unit.
7. Use the new offsets to reduce the 3D GPS position to the reference point (RP) then from the RP down to the sounder. The end result should be a 3D position for each sounder, although the ellipsoidal height will be replaced with the height above chart datum.
8. Calculate the height of the each sounder above chart datum, make sure that heave, induced heave (the change in Z due to the rotations), tides, and draft are all accounted for. Pay attention to the positive direction of each value and remember that EM710 heave already includes induced heave.

Formulas:

1. dLat = dN/M
2. dLon = dE/(N*cos(Lat))

<u>Which</u>:

M = Radius curvature of the meridian section,
N = Prime vertical radius of curvature/Normal
dN = delta Northing,
dE = delta Easting,
dLat = delta Latitude
dLon = delta Longitude

Deliverables:

Repeat for Knudsen sounders (33 kHz & 200 kHz), then EM710 Tx and EM710 Rx.

1. Lat vs. long of the sounders and GPS antenna on the same plot. Show a zoomed in section so that it displays the separation [2 plots].

2. Plot of the pitch vs. UTC time [2 plots].
3. Plot of roll vs. UTC time [2 plots].
4. Plot of heading vs. UTC time [2 plots].
5. Heave vs. UTC time and induced heave vs. UTC time on same plot (one for the 33 kHz and one for the 200 kHz, not necessary for the EM710) [2 plots].
6. Height variation of a sounder from GPS (remove the mean GPS height from all epochs) vs. UTC time, and total heave (heave + induced heave) vs. UTC time on the same plot. Do once for 33 kHz or 200 kHz, and once for EM710 Tx or Rx (include which sounder you choose in the plot title). [2 plots]
7. Height above chart datum vs. UTC time of each sounder [4 plots].
8. EM710 heave vs UTC time and Knudsen total heave vs UTC time on the same plot [1 plot].

Total of 17 plots.

(Be sure to include comments for each step in your code, helps if you like part marks!)

Discussion:

1. Show the survey area (using Google maps?) where this data was collected.
2. Discuss the positions of the GPS antenna vs. the positions of the sounders and why it varies with time.
3. Discuss the difference in height above chart datum between the 33 kHz and 200 kHz sounders, why do they vary by different amounts?
4. Explain induced heave. Is pitch or roll the dominant source in this dataset?
5. Discuss the differences between height variations of the sounders calculated using GPS ellipsoidal heights and using the motion sensor.

some tips ...

1. Make sure to put all your data into common time formats. The Knudsen file is in Newfoundland time (add 2.5 hours for UTC) it also has an 8.59 second clock drift (subtract 8.59 seconds).
2. Work in a right handed coordinate system.
3. Rotate for heading then pitch then roll, the order matters!!
4. Heave from the EM710 attitude file already includes induced heave.
5. Plots should have title, labelled axis and a legend.
6. Run one version of the code for the Knudsen echosounders, and one version for the EM710.
