TEXAS A&M UNIVERSITY

LAB 5 – GPS ACCURACY AND CORRECTIONS

Grading: 50 points

LEARNING OUTCOMES

1. Students will be able to apply point differential corrections from a basestation GPS to a Rover GPS unit.
2. Student will understand how differential correction works with a GPS system by understanding the steps taken in post-processing differential correction of GPS points.
3. Students will develop their own post-procession differential GPS software equations.
4. At the end of this exercise, you should be able to explain the basics of how differential post-processing of GPS observations is accomplished.

ACTIVITIES

Introduction and Data Collection

In this lab you are going to differentially correct 20 GPS points that were collected along the dune toe at Padre Island National Seashore, Texas. You will be post-processing the points using a set of base station points. The base station was set up on the beach close to the visitor center. Texas A&M students collected points extending from the visitor center beach access to the non-driving/driving divide on the island using a second roving GPS unit.

The purpose of this exercise is to provide you with an example of how differential correction works with a GPS system by understanding the steps taken in post-processing differential correction of GPS points. While this lab uses Excel to do the computations to help you understand the principles behind differentially correcting GPS data, in the real world you would use commercial software such as the Trimble Business Center or open source solutions such as RTKLib or PGSTk. UNAVCO maintains a list of GPS/GNSS post-processing tools at http://www.unavco.org/software/data-processing/postprocessing/postprocessing.html in case you are interested.

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COMPUTATION

All data required for this assignment can be found within the Lab Assignment 5 folder on eCampus.

You will need to download the two .csv files from eCampus and import the observations into an Excel spreadsheet to complete the exercise.

Necessary files:

1. **Lab5_base_station.csv**
   - contains GPS observations at a fixed base station acquired at different times.
2. **Lab5_roving.csv**
   - contains the locations made from a roving GPS on the dunes at Padre Island.

Both files are comma-delimited (.csv) and contain four columns:

1. <u>Time stamp</u> indicating the time the point was collected (a single number)
2. <u>X coordinate</u> of the measured location (meters UTM Zone 14N)
3. <u>Y coordinate</u> of the measured location (meters UTM Zone 14N)
4. <u>Elevation</u> of the measured location (meters above sea-level).

SUBMITTAL

Once you have answered all questions, submit your answers through eCampus. In completing the assignment, please write out equations and enter your results in using the appropriate link in. Please refer to eCampus for the assignment due date.

Questions

In answering your questions please round your answers to three decimal places. You should also spend a few minutes thinking about the accuracy this represents if you are working in the UTM coordinate system. The question you should be asking yourself is “are three decimal places adequate for this application?”

1. (5 pts) Calculate the average Easting, Northing, and Elevation of the base station measurements. *Calculated and Displayed on Lab5_Base*

2. (5 pts)

Step	Action
1	**Plot:** the base station measured points and the average base station location. *-Done, see Lab5_Base* -Note: Remember to ensure that your X and Y axes have identical scaling. For example, if your X axis is labelled every 10 m, make sure that your Y axis is also labelled every 10m and you retain the same spacing between marks.
2	**Calculate:** the difference in Easting (m), Northing (m), and Elevation (m) for each individual base station measurement to the average base station location, which you calculated in Question 1. *-Done, see Lab5_Base* -Note: You should think about the fact that these differences vary over time and hence a time-varying correction needs to be applied in order to differentially-correct your rover points. These differences are your correction factors for a GPS measurement collected by the roving GPS receiver at the corresponding time.
3	**Search:** through the roving GPS points and match each of the roving GPS measurements with the base station measurement that was collected at the same time. *-Done, see Lab5_Rover*
4	**Calculate**: the corrected Rover GPS coordinates by adding the correction factors that you just computed to the raw Easting, Northing and Elevations that were acquired by the roving GPS unit. *-Done, see Lab5_Rover*

3. (10 pts) **Plot:** your uncorrected and corrected roving GPS points on the same plot using their Easting and Northing coordinates. As with your previous graph, ensure that your X and Y axes are scaled the same so that your plot is not elongated horizontally or vertically.

   Done, see Lab5_Rover.

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4. (5 pts) **Describe:** how the corrected rover GPS points compare to the raw rover GPS points.

   Description of corrected vs raw points discussed next to charts in Lab5_Roving as well.

   Point Correction Analysis: While both northing and easting approached a half chance for needing correction in either language, Eastern had a tendency to need more Eastern adjustment, while Northern had a tendency to need southward adjustment. The degree of changing for each is very low for both, rarely going over a 1-meter direction.

5. (5 pts) **Calculate**: the 3D distance between the uncorrected roving GPS points and the corrected roving GPS points using Equation (a) below. What is the average 3D distance between a raw roving GPS point and its corresponding corrected roving GPS point?

   a. Distance(m)=√((X_1-X_2)^2+(Y_1-Y_2)^2+(Z_1-Z_2)^2)

      Average 3D Distance Calculated in Lab5_Roving: 1.653704675 m

6. (10 pts) Would there be any issue if the base station were located about 10 miles away from the roving GPS receiver? If so, what is the issue and why is it important? If not, why is there no issue with the roving receiver being more distant to the base station?

   While there have been studies shown that signal degradation is a possibility if the rover is even 10km, much less miles, The degree of said degradation is very minor and easily correctable. Based on theory however, there is no set reason why rover distance should be an issue as long as the coordinates of the base station are as accurate as possible. If the base station is correct, the degradation just means that you would need more samples to get a better average location for the rover at a distance.

7. (10 pts) Would there be any issue if the base station were located 100 meters higher or lower than the roving GPS receiver? If so, what is the issue and why is it important? If not, why is there no issue with a difference in elevation between the roving receiver and the base station?

   The same principle applies for the theory section of the previous question. As long as the elevation coordinate of the base station is still correct, the vertical distance between the base station and rover should not matter. The only issue that could come up are a) issues with the elevation mask of both devices not lining up properly and b) the rover and base station might encounter more situations where the signal between them is obstructed and angled, which may create some inaccuracy.

Extra Credit

(5 pts) What type of differential correction is used for this lab assignment? How might one additional base station improve the accuracy of the roving GPS survey? How might two additional base stations further improve the accuracy of the roving GPS survey? (5 points)

This lab uses the RTK (RealTime Kinematic) type of differential correction, as indicated by the base/rover setup. The use of 2 base stations to one rover allows the rover to get an initial measurement from one base and a verification from another. While this could be extended to more than 2, the returns in terms of accuracy would diminish and there would also be more of a chance that there was a base station that's not properly located.

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