Navigation Coordinate Sample Calculation

Please review Appendix A of the lab manual to get familiar with the terms latitude and longitude. In that Appendix, one "minute" of latitude is described as one nautical mile, which is about 6076 feet. This is a very useful coordinate system to mariners since nautical miles and "minutes" of latitude are interchangeable, simplifying distance calculations.

The Appendix goes on to say that a thousandth of a minute is therefore about 6 feet. You will see that when you use GPS receiving hardware there are various ways to express the latitude and longitude and that thousandths of a minute is a common form for these terms.

As an example, the coordinates of the Resnick Memorial near the entrance to Hamerschlag are: 40 degrees, 26 minutes (‘), 31.5 seconds (“) latitude and –79 degrees, 56 minutes, 46.1 second longitude. In this coordinate system, there are 60 seconds in one minute and 60 minutes in one degree of latitude or longitude. We can convert these coordinates to other forms or it may be necessary when using navigation equipment to convert coordinates to this format.

If we preferred the coordinates above in the degrees and minutes format, the calculation would be as follows:

Latitude: 40° 26’ 31.5” =>

But 31.5” x (1’/60”) = 0.525 minutes, so

40° 26’ 31.5” = 40° 26.525’, and

Longitude: -79° 56’ 46.1” = -79° 56.768’

We could even express coordinates only in degrees:

40° 26.525’ = 40.442083 degrees,

since 26.525 minutes is 0.442083°

Doing the reverse calculation is just as easy:

40.442083 degrees = 40° + 0.442083 minutes = 40° 26.525’

Coordinate Calculations for Position Changes

Keep in mind the fact that 1 nautical mile, or one minute of latitude, is about 6076 feet. One second on latitude is therefore 1/60 of a nautical mile or about 100 feet.

Now that The U.S. government has shut down the intentional addition of random errors in the signals transmitted from the satellites (known as selective availability), most GPS readings taken with inexpensive commercial GPS receivers are accurate to within about 100 feet. This remaining location uncertainty is due to signal propagation anomalies. The government retains a second GPS channel at another radio frequency that eliminates most of these errors but that option is not available in our case.

The accuracy of our measurements is therefore within about 1 second of latitude. While latitude changes about 100 feet per second of change, longitude distance-per-unit varies with location. Near the North Pole, you could vary your longitude by 360 degrees by walking a circle around the pole, while at the equator you would need to travel more than 24,000 miles to change your longitude by 360 degrees. In our area, one second of longitude is about 78 feet, within the range of GPS accuracy. Therefore if we know coordinates of one location, like the Resnick Memorial, we can estimate the coordinates of another: Wean Hall is about 200 feet north, or a change of about 2 seconds of latitude. Its coordinates are therefore approximately:

Wean Hall: 40° 26’ 33.5”, -79° 56’ 46.1”

As another example, if we move 700 feet to the East, the longitude will change by about 9 seconds. Note that a movement East in this example is a move towards the zero reference line in the U.K., so the negative offset from zero is reduced, i.e. –79 56’ 46.1” is reduced to –79 56’ 37.1”. When doing these position change calculations, think carefully about whether you are moving closer or farther away from the equator or the zero longitude reference in the UK and decide if the magnitude of the coordinate should increase or decrease. The entrance to Hamerschlag Hall is roughly to the East, with Wean to its North and Porter to its South, so campus position changes should result in coordinate changes and coordinate calculations that are consistent with these directions.

GPS Readings

The average error of 100 feet is only that: an average. Some readings will be extremely accurate and some readings will be grossly in error. It is wise to consider the reasonableness of readings and to discard those that are clearly wrong. Tracking more satellites takes more time but leads to better accuracy, as does doing your own averaging of readings. One way to do this is simply to take several readings after your position fix seems to have stabilized. This allows the receiver to acquire more satellites and for you to use only the latest fixes in your calculations. This extra effort does produce better accuracy but it consumes both time and battery power, so plan your measurement efforts carefully! Good luck.