Project Write-Up

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1 Mathematical Approach

We closely followed Homework 1. Thus implementing the formulas we developed in the code from this homework. This involves Newton's method, least squares, and solving linear systems, derivatives, and gradients.

2 Our Programs

Both programs read and extract data from the data.dat file. The read.me describes how to compile and run the python scripts.

2.1 Satellite

This program reads vehicle locations/times and generates all positions/times of satellites that are considered above the horizon. It converts geodesic to Cartesian coordinates. Once, we grab each satellite we compute its Cartesian coordinates through Newton's method, accounting for the time it takes for the signal to be transmitted between the satellite and receiver. Then we take the dot product to find whether the satellite is above the horizon relative to the vehicles position. Then if it is above the horizon it will print the satellite's time and position. And auto-closes once it has run through all the vehicle positions.

2.2 Receiver

We read in the satellite data. Because of how we id the satellites we can figure out which satellites correspond to vehicle positions, keeping track of where the satellites go with an array of start indices. After creating the start index array we can look at the satellites as subsets that would correspond to an approximated vehicle position. For each subset of satellites we would use Newton's method and least squares to approximate the vehicle location and time. We iterate through until the step is 1cm. After calculating this new position, we rotate the position "back in time" t_v seconds so that we can convert it to geodesic

coordinates. The program prints off the result and a receiver log file. After each subset of satellites has been read and calculated the program closes.

3 Interesting and Challenging things

1. Hessians (and Jacobians) get very nasty to deal with very quick.
2. Like writing any program, debugging and testing is the most time consuming part. Having a way to quickly test correctness in the results was very important. To make it easier, we had written python scripts that would help test our programs.
3. The math was difficult to understand at first, but with the help of homework 1 and professor Alfield, we were able to implement python code with ease.
4. Unit conversions are fun to figure out. (If they work)
5. If calculations go wrong, it is really hard to figure out where they went wrong without debugging tools.
6. It was interesting to have to remind ourselves that transmission of data is not as instantious as we like to think, given that the ground track of the satellite "lags" behind it.
7. Using programs (such as Numpy) to make a job easier is very important which will lead to error reduction, because a lot of these programs are tested and proven to work.