HAND-HELD GPS POSITIONING LAB

Due Friday, Oct 11, 2013

OBJECTIVES

- Learn to use receivers and a mapping package.
- Understand capabilities and limitations of GPS for personal navigation.
- Understand typical GPS satellite visibility and effects of satellite geometry.
- Review elements of experimental planning, execution, and data analysis.

OVERVIEW

In this lab we will study GPS from an end-user perspective. That is, you will work with a GPS receiver in the same way that typical users do, primarily viewing it as a black box. In the labs and projects that follow we will go inside the box to study how it performs various functions. In this lab, we will consider the mechanics of personal navigation. If you are on-campus, you are encouraged to work in groups of two. For CAETE students, please work on your own.

1. PERSONAL NAVIGATION

One of the most popular applications of GPS is personal navigation. This includes hikers, automobile navigation, pleasure boating, and other recreational activities. Very sophisticated systems are currently available which include integration of GPS with maps and visitor information, Geographic Information Systems (GIS), wifi positioning, cell tower information etc. Such systems bring GPS technology to the point where it is a utility - that is, under most conditions the user does not have to think about it how it works in order to use it.

The GPS "engines" or "OEM's" driving most personal navigation devices are single card units with very similar capabilities. GPS manufacturers differentiate their products based on the following factors - cost, power, size, weight, number of channels, interface options, acquisition and tracking strategies, and additional features. Note that positioning accuracy is not typically a factor because in most cases, positioning accuracy is driven by the SYSTEM (i.e. the GPS satellites, control segment, and propagation link) rather than the receiver design. One thing that does typically improve accuracy is the use of more receiver channels - enabling the acquisition and tracking of more satellites. Some units are optimized for tracking in poor conditions, i.e. in trees or blockage environments. Additional features might include coarse heading indication, ability to use or output differential corrections.

For this lab students will use Garmin GPS60 hand-held receivers intended for personal navigation. They have the capability to provide route guidance, waypoint and track storage, and limited data transfer to/from a personal computer. Waypoints are positions that the user deliberately “marks”, e.g. like the location of your car or other key landmark. Track data refers to a sequence of positions recorded as you are moving, at regular time intervals or at intervals selected by the receiver automatically. In particular, the GPS60 allows for transfer of waypoints/trackpoints from the unit to a PC via a Garmin-provided software package for plotting and limited data analysis. A limitation of the receivers - for our purposes - are that they do not provide information on which GPS satellites are used in the navigation solution (which can be useful for advanced processing). These units are certainly not the most sophisticated available; however, they have many nice features including a large number of channels, very fast signal acquisition, simple operation, and low cost (~$200). If you have access to another GPS receiver that provides some visibility into which satellites are being used and that can record position for download, you are welcome to use it in addition to, or instead of the Garmin GPS60. **Please talk to Siamak about your alternative plans before investing too much time in the experiments.**

You are to conduct an experiment following a predetermined course (see below), collecting data from the receiver and observing different features regarding performance. The data will then be downloaded from the receiver to a PC for further processing.

Receiver operations

Familiarize yourself with the GPS receiver and its operation (review the manual while working with the receiver), install the software from the bundled CDrom to a local PC and attempt to log data and transfer it to the host. Be sure you are capable of this prior to starting the collection (read through the entire experiment section prior to starting so you know what will be required)! You might want to bring a digital camera while logging data to note locations of interesting results. Be sure you know how to do the following:

- See which satellites are being tracked and where they are in the sky
- Clear and start a new track log (menu page ->"track" option ->clear all previous tracks)
- Set the track interval to a specific time or distance ("setup" record method is "time" and the "interval" is 00hrs 00min 01sec)
- Mark a waypoint
- Turn on/off WAAS aiding and check that it is working properly (Once locked onto the WAAS satellite the signal power bars on the "satellite page" will get a small "D" in the signal power bar.)
- Transfer waypoints and tracks to a PC and convert them to a format for mapping and for your own analysis.

Personal Navigation Experiment

After playing with the receiver for a while, carefully define an experiment to evaluate the performance of GPS for personal navigation. You must clearly state the specific objectives of your experiment, for example – "To evaluate the ease of use and reliability of the Garmin 60 in providing route guidance on city streets (or Highway or campus)" or "To evaluate the ease of use and repeatability of the Garmin 60 for use in hiking the Mesa Trail." Circling the top floor of the parking garage is another good choice. Include items that you think might be an issue - e.g. blockage, interference, etc.

- Your analysis must be quantitative as well as qualitative - i.e. it should provide more specific information than for example, "The unit worked well. I would like to have one." An acceptable quantitative result would be, for example, "In three out of four tests the route guidance led to the correct building. In the fourth case, the adjacent building was incorrectly identified." or "In hiking the Mesa Trail, accuracy was sufficient (or not sufficient) to identify the correct route at intersection of multiple trails near the Enchanted Mesa, but not at Mallory Cave, where there were steep boulders. This can be seen in Figure 4."
- The experiment must involve actual travel - on foot or in a vehicle, pick one or the other. **If a vehicle, the person driving the car should not be looking at the GPS receiver!**
- The analysis must compare GPS results to external reference, e.g. a map or satellite image of the area. You can use your GPS-enabled cell phone for comparison if you like.
- Plan to repeat your experiment as many times as necessary to be able to draw useful and correct conclusions.
- Take pictures and draw sketches of the environment, your equipment, and anything else that might be interesting.
- Record the tracks and/or waypoints and transfer them to a PC using the cable and software included. Use GPS Visualizer or other mapping tool to display your results.
- Take advantage of the fact that you now have access to the GPS almanac and constellation status (Homework 3).

REPORT OUTLINE AND GRADING

	Title Page, Table of Contents
5	Executive Summary - Summarize briefly the objectives, what was done, results, and conclusions. Provide an overview of the rest of your report.
45	Personal Navigation:

- Objectives - State specifically the purpose of your experiment, why this is of interest, and your hypothesis for how it will turn out
- Method - Describe your experimental approach. List the procedures, equipment and software to be used. How many trials are planned and why.
- Experiment - How, where and when you collected data. Relevant information on the receiver mounting, weather conditions, anything else that might affect your outcomes
- Results - Present your results in graphical and/or tabular form. Give relevant statistics and other useful information like the predicted satellite visibility (if relevant). Make it easy for the reader to understand. DO NOT speculate in this section on why the results came out the way they did - that goes in the discussion.
- Discussion/Analysis - Analyze your results. Explain why they turned out the way they did. Compare your findings to your hypothesis.
- (If you do several different types of experiments it is fine to organize your sections by experiment - that is, give procedures, results, discussion for one experiment, then go on to the next one.

5	Conclusions and Recommendations - describe what you learned about how GPS works and recommend changes to the lab, the experiments you designed, or potential for future investigations
	References
5	Style and Clarity - clarity, spelling, grammar, organization, neatness
60	TOTAL

USEFUL STUFF

http://code.google.com/apis/kml/documentation/kml_tut.html