12.S56 GPS: Where Are You?
Fall 2008

12S56: GPS Applications

GPS Applications

- Look broadly at general application areas
  - Communication, Power grids, timing
  - Tracking and shipping
  - Personal navigation
  - Mining and engineering
  - Safety of life
- Precise GPS applications for geophysics
- Some useful links:
  http://gpshome.ssc.nasa.gov/
  http://www.gpsworld.com/

Overview

- General overview

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http://www.mitrecaasd.org/ For examples:
http://www.gdgps.net/monitoring/index.html

Communication/Power Grids

- General applications in these areas are based on timing

- Coordination of power grids requires precise knowledge of time to keep the alternating power in phase.

- Communications: Often a billing issue but new regulations require 911 position information (first deadline already missed)

Tracking and Shipping

- Many applications are being in this area
- Knowledge of locations of vehicles
- Tracking information on packages
- Route information
- Maintenance infrastructure (i.e., change the oil every 3000 miles–GPS not only keeps track of number of miles covered but also average speed (actually complete history of speed).
- Positional and motion information that can feed back into many areas.

Personal Navigation

- Saw an example of this is class excursion
- When linked to accurate maps and information (such as restaurants, hospitals etc) can be very effective in personal navigation
- Currently available in many cars (~$1000 option typically). Small portable car systems ~$90-$500.
- Combined with cell phone communication of traffic conditions allows alternate routes. Possibility of vehicles communicating back.
- Possible congestion solution is to better use available roads.

Mining and Engineering

- Usually carrier phase application with few centimeter accuracy

- Control of bull dozers and graders for getting correct cut and fill surfaces. Automatic systems exist that allow operator to following precise depth profile

- In open-cut mining: Vehicle location and control of mined area (i.e., just mine to bottom of ore layer).

- Combined with GIS (Geographic Information System) allows yield to be monitored.

Safety of life

- Marine navigation in rescue (especially if the rescue's were using GPS)

- 911 service (especially in non-urban regions)

- Dispatcher information on vehicle locations and road and traffic conditions (Cambridge fire department uses such a system).

- Operator information on near by vehicles (police especially)

Aviation

- Wide-area-augmentation system (WAAS): few meter positioning in US. Not approved yet for aviation but signals are available

- 26-station tracking network in US provide input for average corrections to be transmitted from Geostationary satellite.

- On-runway/taxiway tracking of aircraft: Major problem at airports currently.

- Local -area-augmentation system (LAAS) still several years away but will allow landing in inclement weather.

Farming

- Major application area.
- Harvest yield by position
- Precise fertilizer application
- Boundary issue (farm all of land and not be stopped by fences).

Precise applications

- Meteorology: Monitoring atmospheric water vapor
- Space craft navigation (both coarse and accurate orbits). Shuttle has GPS receivers
- Attitude control and positioning digital aerial photography and laser scanning.
- Geophysical applications: We will spend some time in class looking that the plate boundary observatory (http://pboweb.unavco.org)
- Use the Gamit/Globk Matlab tools

Spring term UROP

- Our research group (Geodesy and Geodynamics Laboratory) works on many GPS projects. Freshman advisees can participate in a spring term UROP associated with this research.
  - Web pages for the group and related GPS projects:
- http://www-gpsg.mit.edu/~tah/cont98g/cont98.html
- http://www-gpsg.mit.edu/~tah/MIT_IGS_AAC/
- http://pboweb.unavco.org/
- http://reason.scign.org

Possible UROP Topics

- Analysis of Plate Boundary Observatory (PBO) strain maps:
  - Use daily position changes in the PBO sites to make a strain map (dl/l). Sequences of strain maps can be used to animate deformation.
  - Maps could be made for Stada Hyperwall System
- Transient detection algorithms for PBO
  - Use of time-series of positions to look for spatially correlated "anomalous" changes
- Methods of displaying precise positioning data
  - Outreach to public on how precise positioning data affects their lives.

Timetable

- Basic timetable
    - Over IAP discuss possible topics and roles of each person in group
    - Beginning of spring semester prepare written proposal to UROP office
    - During spring semester work on project with aim of completing and implementing by the end of semester.
    - Possible continuation of UROP over the summer