Investigating Dual Frequency Software GPS Signal Processing for Geodetic-Quality Positioning

Presented By Manuel P. Paul
Mentors: Pedro Elosegui & Antonio Vazquez

1California State University, San Bernardino
2MIT Haystack Observatory
Outline

• Review of GPS
  – Basic Operation
  – Carriers & Codes Transmitted
• Scientific Motivation
• Hardware vs Software GPS Receivers
  – Current Public GPS Software Defined Receivers (SDRs)
  – Application & Testing of Public GPS SDRs
• Field Work
• Next Steps
• Acknowledgements
Global Positioning System (GPS)

GPS is a global navigation satellite system (GNSS) that provides location and time information anywhere on Earth in any weather condition.

Basics:
- 32 GPS Satellites Orbiting Earth
- Each satellite transmits signals that contain codes and navigation data
- GPS receivers analyze the signals and decodes the navigation data
- GPS receiver's position calculation accuracy is often 3-7 meters, but can be improved
GPS Carriers & Codes

By tracking the C/A & P(Y) (or P) codes and the L1 & L2 carriers transmitted from the GPS satellites we can get different position accuracies:

- C/A Code (Coarse Acquisition) → 3 m
- P Code (Precision) → 0.3 m
- L1/L2 Carrier Phase → mm level

P - Code
10.23MBits/sec

C/A Code
1.023MBits/sec
Scientific Motivation

Accurately (mm level, or better) tie together co-located VLBI, SLR, and GNSS stations on the ground to improve the International Terrestrial Reference Frame (ITRF), which would enable future ocean, ice, and land topography missions.

What type of receiver we need:
- Dual Frequency (L1/L2)
- Code Tracking (C/A & P)
- Access to Raw Data
- Calculate Position
- Produce Rinex Files
GPS Receivers

Hardware:
- Closed Designs
- No Access to Raw Data
- Limited Interfaces
- Expensive
- Extra Unneeded Features

Software:
- Open Designs
- Easily Accessed
- Inexpensive
- Personalizable
- Less Electronics Used
GNSS- SDR

Designed by the Communications Systems Division at Centre Technològic de Telecomunicacions de Catalunya (CTTC)

GNSS-DSP-Tools

A git repository made for prototyping GPS algorithms coded in python for acquisition, tracking, and code generators.
Application & Testing of SDRs

GNSS-SDR
- Able to calculate basic position using C/A code
- Able to run in realtime or via data file input
- Coded in C++ made editing code difficult
- Well Designed and Efficient

GNSS-DSP-Tool
- Analyzed data file to give general acquisition
- Coded in python
- Simple L1 & C/A tracking algorithms

<table>
<thead>
<tr>
<th>SDR</th>
<th>L1 Carrier</th>
<th>L2 Carrier</th>
<th>C/A Code</th>
<th>P Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNSS-SDR</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
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<tr>
<td>GNSS-DSP-Tools</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>

Are there any already well designed GPS SDRs that can do L1, L2, C/A, & P code Acquisition & Tracking?
Field Work

- Antenna (L1/L2)
- Hardware
- Rinex Files
- Software Radio
- L1 Data
- L2 Data
Next Steps

- We seek to generate L2 & P code acquisition & tracking algorithms and add them to the already built SDRs.
- Currently working on P code acquisition
- Plan on implementing Z Tracking technique for measuring L2 carrier phase.
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GNSS-DSP-Tools: https://github.com/pmonta/GNSS-DSP-tools
GNSS-SDR: http://gnss-sdr.org/