A Software Model for GPS Receiver Signal Processing Blocks Used in Educational Environment

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Overview

- Introduction in GPS
- GPS receiver
- Simulation of GPS DSP processing
- Results using Matlab
- Compatibility under Octave
- Future work
- Conclusions
Introduction in GPS

- Well known acronym (Global Positioning System)
- Coordinate calculation using a set of satellites (theoretically minimum 4)
- Three segments: space segment, control segment, user segment
Introduction in GPS

Space segment:

- Satellites in orbit – 26600 km altitude
- Transmitting 2 signals – L1, L2
- L1 at 1575.42MHz with a QPSK modulation modulated by a known Gold code of length 1023 the C/A code, with a rate of 1.023MHz (civilian code).
- L2 at 1227.6MHz, with a BPSK modulation of the carrier by the P(Y) code (military)
Introduction in GPS

Control segment
- 5 surveillance stations around the globe, 1 main control station called the Master Control Station

User segment
- authorized users (military)
- non-authorized users (normally civilians)
GPS receiver

Block schematic

Hardware Frontend

RF chain → ADC

Subframe ident.

Tracking

Acquisition

Ephemerid. & pseudorange

Satellite position

User position

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GPS receiver

- **Processing**
  - Real time implementation
    - Programmed logic: DSP, RISC Processors
    - FPGA
  - Simulation
    - Used to test new architectures or algorithms
    - Test benches – performance evaluation of hardware architectures
    - Educational purposes (our goal)
GPS receiver

Hardware implementation - FPGA
Simulation of GPS DSP processing

- Based on programming environment
  - Matlab-Simulink (eventually Octave)
  - C Environment
- Important issue: chosen Model
- Our case: GPS code (Kai Borre [6])
- Input data: open data sets like in RINEX (Receiver INdependent EXchange Format) family.
Results - simulation under Matlab

- Reference code optimized for Matlab
- Compatibility “guaranteed”
- Blocks already implemented:
  - Random code generation for different satellites
  - Observation files
  - Navigation files
C/A code generation

C/A code obtained through multi-realization G1 and G2.
Compatibility under Octave

- Some compatibility issues
- A specific goal for our work - verification of compatibility for the GPS code
- The same modules implemented also under Octave
- Our goal – to have all modules full functional under Octave
C/A code – Octave version

secventa G1

secventa G2

cod C/A obtinut prin inmultirea lui G1 cu G2
Future work

Transforming the “stop and go” work in an “ongoing” work
Implementation of all modules
test the modules under Matlab and Octave
Add a RF frontend for real signal capture
Going to a Rapid prototyping solution using DSP or FPGA (see the new versions of Matlab) – Real–time workshop
Conclusions

- GPS – a well-known technology with complex digital signal processing
- Most implementations are concentrated on efficiency and cost, ignoring the transparency of the technology
- Our implementation - educational aspects
- Useful in the future to support the work in promising future projects like Galileo