Software Defined GPS Receiver

FUNCTIONAL DESCRIPTION AND SYSTEM BLOCK DIAGRAM

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Introduction

The Global Positioning System (GPS) consists of 32 medium earth satellites broadcasting on two different frequencies. The broadcasting frequency examined in this project will be the civilian L1 frequency which operates at 1575.42 MHz. The data sent includes the ephemeris data for calculating satellites flight paths, satellite identification number also known as coarse/acquisition (C/A) code, and satellite health statistics. Using the delay from different satellites earth centered earth fixed coordinates position is found by solving for X, Y, and Z. If a receiver's clock is not aligned with a satellites clock, then an incorrect delay time will be used for the calculation. Thus time bias is resolved. To solve for these four variables, a minimum of 4 satellites is needed.

This project is to explore Global Positioning System (GPS) algorithms that can run on an x86 Personal Computer (PC). On of the major reasons for this is that current hardware implementations use algorithms that work for the general case. Software allows for switching between algorithms depending on the received signals strengths. For example, the signals received from the satellites will be different depending upon your surrounding environment. An area surrounded by buildings will have multipath effects that an open field will not. Also if a receiver is traveling then the Doppler Effect on frequencies needs to be accounted for.

This project is a continuation on last year's project by Tony Corbin. The project successful in determining position however was unable to provide continuous updated positions.

The algorithms areas explored will include signal conditioning, satellite acquisition, and satellite tracking loops. Outside libraries looked at will include position, and velocity calculation

Goals

The goals of this project include the following items

- Use received GPS L1 signals to determine position using a PC.
- Continuous GPS solutions in real time.
- Comparison of different GPS algorithms.
- Analysis of different GPS algorithms for possible improvements by using parallel programming techniques.
- Cost benefits of software defined GPS vs Hardware receivers.

High-Level Block Diagram

Figure 1 High level block diagram

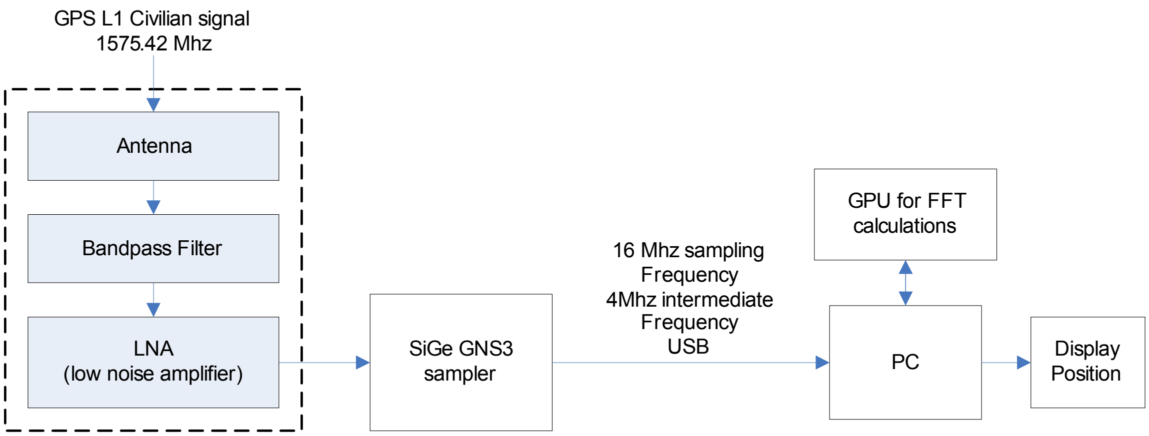
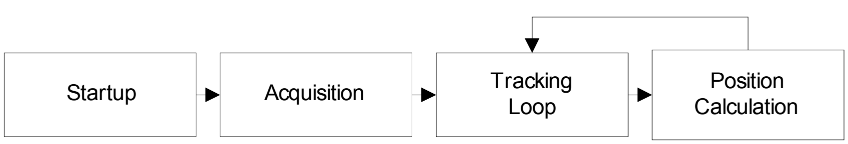


Figure 1, displays the high-level block diagram for this project. GPS L1 signals are received through the Antenna stage. The SiGe GNS3 sampler takes the signal from the antenna, down converts to an intermediate frequency (IF) of 4 Mhz and provides a sampling rate of 16Mhz to a USB port on a pc. The PC will then perform algorithms on the incoming message to determine position, and then display such data. The GPU is used to assist in the signal processing.

Software Processing

The software for this project is shown in Figure 2. The software searches for satellites in the acquisition phase, then tracks the satellites as they move, and finally provides a position estimate once enough data is collected from the tracking phase. In order to obtain continuous updates the software then returns to the tracking loop.

Figure 2 High level overview of the software



Conclusion

This project will make use of existing software defined GPS project as a starting point and expand upon it. Several of the core algorithms used will be modified inside of the existing project. Understanding of communication theory, GPS communication scheme, and programming are all needed to accomplish this project. This project will provide further insight into these areas.