Computation of Receiver Position using Pseudorange Measurements and Satellite's Position Data

(Revision: Orig)

1 Introduction

GPS is a vital element of the global services which has become a next big revolution after the internet and cell phones. The free, open, and dependable nature of GPS has led to the development of hundreds of applications affecting almost every aspect of modern life. GPS technology is present in everything from cell phones and wristwatches to bulldozers, shipping containers, and ATM's. This technology boosts productivity across a wide swath of the economy which includes communication networks, banking systems, financial markets, power grids, safety of life services. GPS is vital to the Next Generation Air Transportation (NextGen) that will enhance flight safety and increase airspace capacity.

There are more than 30 GPS satellites encircling the Earth in medium Earth orbit (MEO). The GPS receiver gets a signal from each visible GPS satellite which includes the exact transmission times. By subtracting the transmission time from the reception time, the GPS can tell how far it is from each satellite. The GPS receiver also computes the exact position of the satellites which is included in the received signal. Given the travel time of the GPS signals from more than three satellites and their exact position in the sky, the GPS receiver can determine the user position. It can also compute the user velocity based on Doppler.

There are different ways of calculating the GPS receiver position from the given receiver-satellite ranges. The most used methods are the least squares algorithm and Kalman filter. Each of these has its own pros and cons. There are various kinds of Kalman filter based estimators, which use stationary receiver, low dynamics, and high dynamics models for the receiver motion that are commonly used in GPS receivers, and cover a wide range of applications.

2 Objectives

The objectives of this project are:

1. Learn basics of GPS and its raw data which includes pseudorange measurements.

2. Collect the raw data from GPS receivers which using:

   (a) A stand-alone GPS receiver
   (b) A mobile phone equipped to provide raw GPS data
3. Process the data to arrange it in a suitable format for computational algorithms
4. Develop an efficient algorithm to compute the receiver position using pseudorange measurements from four satellites
5. Extend the above mentioned algorithm to compute the receiver position using pseudorange measurements from all the available satellites
6. Design a user-friendly interface (front end) to present the track of the moving platform
7. Write User Manuals for the following:
   (a) Data Collection and processing for the stand-alone GPS receiver
   (b) Data Collection and processing for mobile phone

3 Requirements

1. Strong background in mathematics especially in linear Algebra. Basic GPS is preferred.
2. Good proficiency in software development and programming. Use of Matlab is preferred.
3. Strong analytical ability and writing skills