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The Development of Modularized Post Processing GPS Software Receiving Platform

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Abstract: Modularized GPS software defined receiver (SDR) platform has many advantages of applying and modifying algorithm. Classical GPS receiver uses many hardware parts (such as RF front, correlators, CPU and others) which process tracked signal and navigation data to calculate user position, while SDR uses RF front only. SDR use software modules, which run on general purpose CPU, to implement same function. SDR does not need changing hardware part and it does not limited by hardware capability when applying new processing algorithm. The weakness of SDR is that software correlation takes lots of processing time. In these days, however, the evolution of MPU (or DSP) and the minimization of general purpose CPU increase competitiveness against the hardware GPS receiver.

This paper shows studying for modulization of GPS SDR platform and development of the GNSS SDR platform using MATLAB. It focuses on post processing SDR platform which is usually adapted in research area. The main function of SDR is GPS signal acquisition, signal tracking, decoding navigation data and calculating stand alone user position from intermediate frequency (IF) down converted sample data. Each module of SDR platform is categorized by function for applicability.

Keywords: Software defined receiver, SDR, GPS, modulization

1. INTRODUCTION

Classical GNSS receiver is consist with RF parts, correlators and CPU; these are adapted to process navigation data and calculate user position. SDR uses software modules that have same functions as hardware parts. The SDR's modules are able to run on general purpose CPU platform. It is very easy to modify algorithm by software revision. It has advantages that it can be easily applied another process or navigation resource without hardware change. SDR will get more and more powers in competition with classical GPS receiver because of the rapid improvement of MPU and DSP. This paper shows studying for modulization of GPS SDR platform and development of the GNSS SDR platform using MATLAB. First, we explain characteristics and functions of each module and then, discuss about experiment result with real received IF sample data.

2. STRUCTURE OF SDR

GNSS software receiving platform calculates user position using C/A code from IF sample data which is saved in mass storage. The main functions are divided into signal acquisition, signal tracking, navigation message decoding and calculating navigation solution. Pseudorange, generated from C/A code tracking result, is used when navigation module calculates standalone user position. The processing unit is 1ms length of IF sample data that is the same as the period of C/A code.

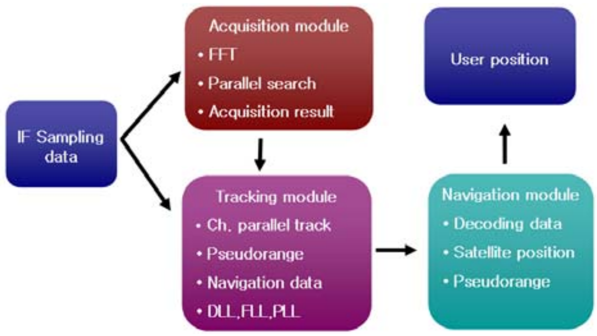

Fig 1 The structure of SDR categorized by function

3. SIGNAL ACQUISITION MODULE

In this research, we adapt parallel searching algorithm based on FFT to signal acquisition. Fig 2 shows the concept of signal acquisition module. The resolution of code acquisition depends on sampling frequency. The acquisition module contains look up table which consists of carrier and code, and FFT implementation related tools. The results of FFT process for carrier and C/A code are stored in loop-up table with 1ms unit.

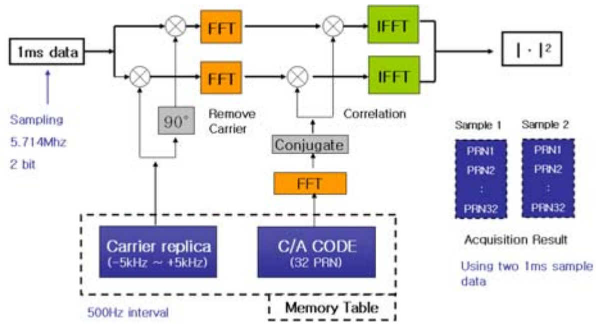

Fig 2 Block diagram of signal acquisition concept

4. SIGNAL TRACKING MODULE

The signal tracking module starts to track GPS signal precisely using initial satellite signal information which is transferred from signal acquisition module. Each tracking channel has 6 correlators to get early, prompt, late correlation for each I-phase and Q-phase. Chip spacing, loop filter's order, bandwidth and update rate are flexible parameters that can be changed by receiver specification.

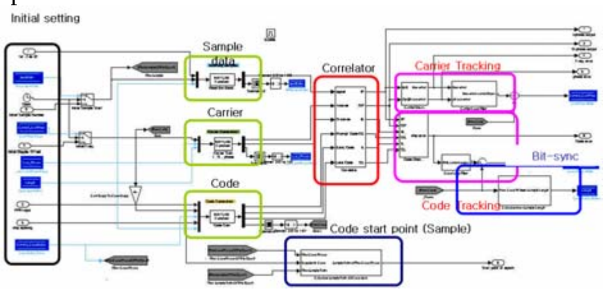

Fig 3 Signal tracking module using Simulink

5. NAVIGATION MODULE

The first step of Signal navigation module is to decode navigation data using I-phase and to calculate precise pseudoranges. The correlation result of I-phase and its sequence of sample data are transferred from tracking module to calculate navigation. Then, the tracking module calculates user position using precise pseudoranges and decoded satellite ephemeris data.

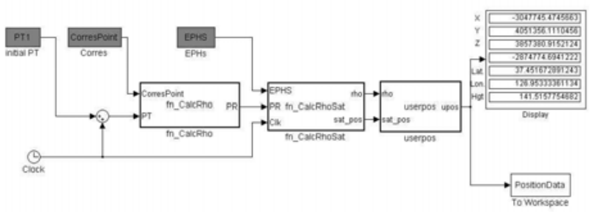

Fig 4 Navigation module using Simulink

6. TEST RESULT

The SDR module is tested using received signal which is sampled in 5.714MHz rate and 2bit quantized. The satellite signal was received using a static antenna. User position data are calculated in 50Hz. The test results are presented in Fig 5 and Table 1. The test result data are not filtered and are not compensated by ionospheric bias.

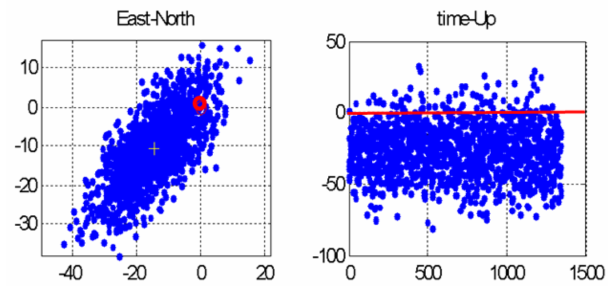

Fig 5 SDR test result in ENU

Direction	Bias (m)	STD (m)
E	-14.38	9.10
N	-10.55	9.31
U	-26.13	17.95

Table 1 SDR test result

7. CONCLUSION

This paper shows about how to modulate and develop SDR using MATLAB. The post processing GPS SDR calculates user position using C/A code from down converted IF sample GPS data. All functions of SDR are separately coded by module to modify and to adapt easily. The test result shows that the navigation solution is properly solved by using SDR from IF sample GPS data.

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