Implementation of FPGA-Based Acquisition of Weak GPS Signals

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INTRODUCTION
With the wider applications of GPS, higher technical requirements for navigation performance have been brought up. A new method based on FPGA is presented and tested to determine its acquisition performance in environments such as in the urban canyons, tunnels and inside buildings. The motivation for this work is to demonstrate that software GPS receiver, which has become the focus of experts in recent years for its operational flexibility and systematic compatibility, can acquire very weak signals efficiently. Such technologies offer an attractive route to the development of quick positioning technology for high-sensitivity software GPS receiver under shadowed conditions in the future.

GPS SIGNALS ACQUISITION
Characteristics of GPS L1 signal are reviewed. Under bad operating environments, GPS signals are usually attenuated and too weak for conventional method to acquire. This paper proposes a batch processing based method to deal with the problem of weak GPS signals acquisition. The method takes advantage of FFT and IFFT algorithms, aiming to search weak GPS signals in frequency domain instead of traditional time domain for rapid acquisition. However, even the latest generation of multiprocessor-based computers can hardly complete the huge correlation computation in real-time. With the development of high speed microprocessors, FPGA provides a solution.

FPGA-BASED DESIGN
FPGA is an excellent candidate for developing real-time software GPS receivers due to its excellent computational capabilities and rapid reprogrammability. The generic model of logic block, which is the fundamental unit of FPGA, is illustrated. According to FPGA structures and typical FPGA design flow, the design procedure of FPGA-based acquisition method is presented. And how large scale correlators are produced is discussed in detail. During the process, the most challenging task lies in the efficient structuring of the design logic so that the device and its architectural features are best utilized to yield an optimal implementational solution. In addition, the detection threshold for determining the presence of a signal is investigated based on the statistical distribution of the signal and noise parameters.

EXPERIMENTAL RESULTS
In the beginning, code generator and carrier generator are simulated to get modulation signals and demodulation signals, which will be mixed with the input data stream. Then batch processing technique is used to acquire weak GPS signals. Compared to traditional series search method, this technique can acquire signals with carrier-to-noise ratio of 21 dB-Hz, and noise is almost leveraged out. All other things being equal, increasing sampling rate can achieve the same goal. However, as sampling rate increases, computation burden becomes heavy. So considering computation efficiency, it is suggested that the method combining batch processing technique and high sampling rate technique properly be used to acquire weak GPS signals.

CONCLUSION
FPGA-based signal acquisition method has demonstrated successfully in a lab setting. The method can not only acquire signals with low carrier-to-noise ratio, but also decrease acquisition time. With many other advantages including high gate density and low cost, it is believed that FPGA will play a more and more important role in developing real-time software GPS receivers.

REFERENCES