ABSTRACT

Global Positioning System (GPS) is one of the most widely used wireless systems for navigation. A GPS receiver has to lock on the satellite signals to calculate its position. The process of locking and tracking satellites requires heavy computation, which consumes both time and power. The dissertation focuses the design and development of fast and uninterrupted low power consuming software based GPS receiver under the compressive sensing framework. Compressive sensing is recently developed technique that exploits the sparsityness of the signal and acquires a signal with less number of samples and reconstruct the signal with optimization techniques. This thesis addresses the development of various algorithms that includes (a) *sub sampled Fast Fourier Transform (ssFFT) based GPS acquisition algorithm and Improved ssFFT based GPS acquisition* (b) *Sub sampled based GPS tracking algorithm* (c) *ssFFT based complete SGR design* (d) *Sub-sampled Kalman Filter based GPS tracking algorithm* and (e) *validation of proposed system.*

Acquisition is most important process and a challenging task for identifying visible satellites in designing software GPS receiver. This research presents faster GPS acquisition via ssFFT. This algorithm exploits the properties of Fourier transform, decimator and sparse FFT, that reduces the number of computations. The computational complexity of proposed algorithm is 'd log d' times faster than the conventional FFT based acquisition algorithm, where 'd' is an integer down sampling factor. The simulation results shows that the computation time for acquisition is 8.5571 times faster than that of conventional FFT based algorithm for down sampling rate d = 12.

The main goal of tracking is to synchronize a locally generated PRN code (C/A code) or replica of the transmitted PRN code with the incoming signal which is same as the acquisition. This thesis designs an effective and efficient tracking algorithm based on *sub-sampled technique* in time domain and focuses on demodulation of GPS signal with less tracking computation time. The proposed algorithm exploits the property of recently developed Random Demodulator which efficiently extract the features of received signal and has an improved in computation time by 34.022% against the convention tracking based algorithm.

The research focuses on design and development of complete Sub-sampled based Software Defined GPS Receiver (ssSGR) that combines the sub-sampled based acquisition, sub-sampled based pull-in-frequency and sub-sampled based tracking algorithms. For sampling frequency, $f_s = 1$ MHz (*acquisition*) and 5 MHz (*pull in frequency*), resulting computation time is $T = 3.4684\,\text{sec}$, resulting time improvement by 19.14%. Her the signal is tracked with loss of first 100 samples but it is recovered after 100 samples.

Further this research design a GPS carrier tracking using sub *sampled Kalman filter based FLL assisted PLL* for processing a weak carrier signals during scintillation. Compared with the traditional PLL, sub sampled KF PLL varies the bandwidth depending upon the noise. Results show that the considered system can operate continuously without losing phase lock even over periods of signal outage. In simulation, visible satellites with a PRN 6, 10, 17, 23, 26, 28 channels are acquired and are completely tracked. For PRN number 28, due to 180° phase measurement errors, loop started to slip half cycles, and eventually it completely lost carrier lock. The sub sampled Kalman based PLL starts to have significant problems when the two $[I;Q]$ clouds approach close enough to the origin to cause the phase measurement error standard deviation to be a significant fraction of 90°. Thus, sub sampled Kalman based PLL will track more robustly during scintillation induced power fades than a PLL for a signal that carries data bits. The navigation position is calculated by processing data obtained from proposed acquisition and tracking algorithms.

The performance of the ssFFT based GPS acquisition is compared and evaluated using different signal to noise ratios. The Validation of proposed algorithms is done using multipath effects and by adding different signal to noise ratios. The performances of the ssFFT based GPS Acquisition are compared and evaluated using different Signal to noise ratios (SNR) in harsh environmental conditions. The simulation results show that the considered system can operate continuously without fail even with very weak GPS signals. Same acquisition results have been obtained with SNR values of -10 dB, -8 dB, -5 dB, -4 dB, -1dB, -1dB and 1dB for subsampling factor of 0, 2, 4, 6, 8, 10 and 12 respectively. The proposed algorithm contibutes towards the exact positioning required in various applications such as fisherman, cell phones, missile guidance, vehicle tracking, and disaster management.