INTRODUCTION

The use of Global Positioning System (GPS) receivers is of great importance for a wide range of applications: navigation in ground or aerial vehicles, launchers, satellites; precision agriculture, seismic measurements, logistics, to name a few. Nonetheless, commercial GPS receivers often have performance limitations for certain applications where, for example, refresh rate of the receiver’s solution is not fast enough for navigation purposes or additional data is desirable as observables like pseudoranges, carrier wavelength shift or carrier Doppler shift in order to use advanced navigation techniques like tightly-coupled navigation algorithms. In other areas, for example, seismic measurements, high-rate GPS solutions are needed to provide precise, real-time positions of displacements.

RECEIVER FRONT END

The front end module conditions GPS RF signal so it can be subsequently processed in real time by the field programmable gate array (FPGA) modules.

SEARCH MODULE

Search algorithms are applied to the IF signal in order to determine if a given satellite is present, i.e. it is in antenna’s line of sight and if this is the case, its C/A code phase relative to local C/A signal replica and carrier frequency displacement.

If signal is correlated with a local replica composed by the IF carrier mixed with a given C/A code for a predetermined satellite, C/A code phase and carrier frequency of the local replica are then varied and the value of correlation of both signals is calculated for each pair.

The variation of both parameters constitutes a bidimensional domain, i.e. a matrix, through which the IF signal is tested. Octave scripts were written to implement the described algorithm and applied to a real GPS IF signal. If a given satellite is not present a ‘flat’ correlation matrix is obtained. Inversely, if a given satellite is present a correlation matrix with a distinctive peak can be distinguished. This procedure can be repeated for each satellite in order to obtain which ones are present in a given IF signal.

CONCLUSIONS

GPS L1 search and tracking modules were designed, verified and validated with synthetic and real signals. Methodology adopted proved to be useful in development of the receiver blocks and, presumably, it could be adapted for design of FPGA-based communication systems blocks.

Additionally, use of FPGA resources was modest: 5% slices were used for the search module and 3% for the tracking module demonstrating that description of the modules in the low level using a FSMD architecture was adequate for this purpose. This encourages that the receiver can be implemented in a low-middle range FPGA thus reducing component costs.

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