High Fidelity Simulation of GPS measurements for Space-based Navigation System Design

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ABSTRACT
As Global Positioning System (GPS) technologies were first adopted in a space-base navigation system in the mid 1990s [1], GPS-only and hybrid navigation systems (GPS integrated with other sensors) have been blooming in space-borne navigation fields. At the stage of preliminary scheme and algorithm design for the system, a high-fidelity and precise software GPS simulator is a necessary and feasible testing facility in laboratory environments in consideration of the tradeoff of cost and performance.

The paper presents a software GPS receiver simulator on the L1 C/A code and carrier signal, for space-based navigation system design. The simulator, coded in MATLAB language, generates both C/A code pseudorange and carrier phase measurements in the Earth Centered Inertial (ECI) frame. In the paper, mathematical models are formulated to simulate the GPS constellation and to generate GPS measurements, i.e. pseudorange and carrier phase measurements.

Several effective measures are investigated and taken in the paper to rationalize the high-fidelity simulator. First of all, for a given simulation progress, the Ephemeris data term whose time is closest to the simulation time would be picked out from the Ephemeris data file. Secondly, almost all possible errors are included in the simulated GPS measurements, and we have attempted to analyse the weight of the errors effects on different simulated space scenarios and the GPS satellites visibility. Moreover, an ionospheric model for GPS tracking of Low Earth Orbit (LEO) satellites proposed by Montenbruck [2], is induced into the simulator. Especially, to achieve creditable pseudorange measurement of space environments, the range rate incurred by the high speed of space GPS receiver is considered [3]. Formulae of the rage rate for space applications are specified.

Such a simulator has been facilitating our current work for designing a space integrated GPS/INS (Inertial Navigation System) navigation system. Consequently, it will promote our possible future research on space-based navigation system.

INTRODUCTION
SIMULATION OVERVIEW
GPS CONSTELLATION MODEL
GPS MEASUREMENT GENERATION FOR SPACE APPLICATIONS
GPS SATELLITES VISIBILITY
SIMULATION RESULTS
CONCLUSION
REFERENCES