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A GPS SIMULATOR FOR THE DESIGN AND DEVELOPMENT OF A FUTURE LOW-COST GNSS

Abstract

Global Navigation Satellite System (GNSS) is a satellite-based radio navigation system used to calculate users' geographical location anywhere on or near Earth's globe. Since the Global Positioning System (GPS) launch, GNSS has become a vital component in many fields of life, including airline and transport services, shipping and cargo services, the agriculture industry, and private cars, for navigation and positioning. The system uses trilateration technique to determine the user's location by combining information collected from multiple satellites. GPS is a code-division multiple access (CDMA) satellite-based system. Each GPS satellite simultaneously transmits two L-band frequency signals: L1 and L2. In addition, GPS signals include ranging signals and navigation messages. Ranging signals include two components used to determine the distance between the satellite and the receiver. As for navigation messages, it contains ephemeris data, which is used to compute the position of each satellite in orbit, while almanac includes information on the time and status of the entire satellite constellation.

Development and testing of GNSS-dependent systems may be difficult when actual signals received from the satellite are applied. Parameters of such signals are non-stationary as they change with time, weather, satellite's health status, and many other factors. As a result, extensive research is being conducted to build low-cost, small-size, and efficient GPS simulators. Sophisticated GNSS simulators are available on the market, but they are very expensive. This work presents the initial results of a GPS simulator designed by emulating a similar environment (hardware and software) to the GPS satellites. The simulator will enable researchers to test, operate, and experiment on GNSS payloads within a lab environment. It will also help assess some of the most critical errors that GNSS systems experience in space and on the ground, such as satellite clock error, receiver noise, multipath, which pose different challenges.

In the proposed design, low-cost customer-of-the-shelf (COST) components have been used to design the system with a robust algorithm to calculate accurate timing. For the initial simulations, a MATLAB programming environment has been used for the algorithm development, resulting in longer time delays to generate the signal than anticipated. Currently, the simulation speed is being enhanced by utilizing a low-level programming language. However, this may pose additional challenges, and the hardware complexity may increase. When fully completed, the GPS simulator will help build a low-cost GNSS payload design,

with low-cost clocks and better algorithms for accurate timing, specifically for the interplanetary satellite missions.