Paper ID: 5261

ASTRODYNAMICS SYMPOSIUM (C1)
Mission Operations (3)

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GNSS-BASED SATELLITE NAVIGATION STRATEGY FOR GEOSYNCHRONOUS ORBIT AND TRANS-LUNAR ORBIT

Abstract

Even though the GPS (Global Positioning System) is the only fully operational as of 2009, many countries are trying to build up the GNSS (Global Navigation Satellite System) to provide autonomous geo-spatial positioning with global coverage.

The Russian GLONASS is a GNSS in the process of being restored to full operation, whereas The European Union's Galileo positioning system is a GNSS in initial deployment phase, scheduled to be operational in a few years.

Since the GPS was originally designed for positioning and navigation uses on and near the Earth, recent experiments and researchs have expaned the use of GPS for satellite orbit and attitude determination from low Earth orbits to geosynchronous orbit(GEO) or high elliptical orbit(HEO)[1-3]. GPS has been used extensively for satellites in low Earth orbit, and a few commercial receivers exist that can provide reliable and efficient onboard navigation solutions.

In their current form, these receivers may not be directly applicable to HEO and GEO missions because of important differences in the vehicle dynamics, signal levels, and geometrical coverage. To provide acceptable performance at high-Earth altitudes, some significant changes need to be considered for existing GPS receiver architectures. The following improvements are needed for a GPS receiver intended for operation in HEO/GEO orbits: stable clock, robust navigation model, criteria on dilution of precision (DOP), high gain antennas to improve signal visibility at high altitude, weak signal tracking, etc.

Recently, some researches have been initiated to track GPS signals even to the surface of the moon although GPS signals are known to be effective up to the earth-moon L1 (1st Lagrange) point and its signals are not achievable with current GPS receiver technology.[4-5]

In this paper, a novel strategy for satellite orbit determination in GEO or trans-lunar orbit up to the L1 point based on GNSS signals from either GPS or GLONASS or Glaileo is proposed.

Firstly, GNSS signal availibity is to be analyzed: number of GNSS SVs(space vehicles) that can be simulataneously acquired, length of time period when no GNSS SVs can be acquired, predictable acquisition threshold in the GNSS receiver.

Secondly, geometric dilution of precision (GDOP) will be investigated in order to ensure the positioning accuracy of the satellite.

Thirdly, the orbital position is estimated from the measurement data of visible GNSS SV positions. Filtering techniques such as Extended-Kalman Filter, Uncented-Kalman Filter can be used to get a better information on orbital location.

The orbit model for the COMS(Communication, Ocean, and Meteorological Satellite), which is a hybrid geo-stationary satellite being developed by KARI (Korea Aerospace Research Institute), will be used for this simulation under the assumption of GNSS receiver installed on it.

In addition, trans-lunar trajectory based on direct lunar transfer approach which was used in apollo program will be used for this simulation.

Reference

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