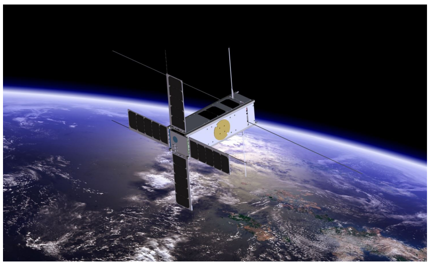
ORBIT DETERMINATION OF A CUBESAT IN LOW EARTH ORBIT



There is an increasing interest in Cubesats for educational and scientific purposes as well as for technology demonstrations. The required precision in the knowledge of the orbit can vary from order of km for educational satellites down to submeter level for geodetic and scientific cubesats. This study investigates the precision with which the orbit of a small object can be determined and propagated based on different observations including the Global Navigation Satellite Systems (GNSS) which provides instantaneous positions and velocities.

Theory

The equation of motion and the measurement model provide the basic framework for describing the motion of a satellite with respect to a ground station. Given an initial position and velocity vector and various model parameters the satellite's position and the expected observations can be computed at arbitrary times. The trajectory and measurement model provides a concise and detailed description of a satellite's motion with respect to an Earth-bound observer.

Satellite orbits will be calculated using the orbit simulator of *Royal Observatory of Belgium* which solves numerically the equations of motions with given initial conditions and input models. The code is written in *MATLAB*. It includes gravity harmonics an atmospheric model and takes into account effects of time variable solar flux. More efficient numerical techniques such as batch and sequential estimation techniques are planned to be be implemented for the improvement of a priori orbit information from an arbitrary set of tracking data and subsequent estimates of the state vector at the time of each measurement.

Orbit determination of an artificial satellite requires as input measurements that are related to the satellite's position or velocity. These data are collected by a satellite tracking system that measures the properties of electromagnetic wave propagation between the transmitter and the receiver. Global Positioning System (GPS) receivers onboard has become the primary tracking strategy for LEO satellites since GPS receivers provide near-continuous observations with excellent geometric information which allow real-time a orbit determination. The comparison of the orbits derived from different GNSS and validation of the orbit accuracies with Satellite Laser Ranging will be considered. The media corrections, due to electromagnetic radiation interactions with the Earth's plasma environment and atmosphere shall also be considered

Applications

Recently, Universite Cote d'Azur started to study the feasibility of a student's CubeSat whose main goal is to transmit data with an optical link to the ground. The mission required the knowledge of the instantaneous position of the satellite with a certain uncertainty before targeting the ground based laser. The Royal Observatory of Belgium in collaboration with Université catholique de Louvain has been working on Geodetic Cubesats projects with payloads including GNSS and Very-long-baseline interferometry (VLBI). The orbit simulations of such cubesats will be performed with the objective to help the design of future missions. We will look in particular to answers the questions: Can a given knowledge of the orbital elements be achieved with the planned tracking configuration? What is the impact of the systematic errors in the tracking methods into the resulting orbit determination accuracy?. The answers to the above questions can be obtained from a Monte-Carlo or covariance analysis.

See also

Details 1
Details 2

Contact

☎ +32-2-3736732
✉ Ozgur.karatekin@observatory.be