Paper ID: 40320
interactive
student

ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations (IP)

Author: Mr. Fan Wu
Harbin Institute of Technology, China

Prof. Xibin Cao
China
Prof. Feng Wang
China
Dr. Limin Dong
Harbin Institute of Technology, China
Dr. Huayi Li
Harbin Institute of Technology, China

RELATIVE NAVIGATION FILTER ALGORITHM FOR ELLIPTICAL ORBITS BASED ON ONBOARD RELATIVE MEASUREMENTS

Abstract

A lunar-orbiting dual-satellite system is scheduled to be launched in the next year for ultra-long wavelength radio astronomical observations, taking advantages of the clean electromagnetic environment sheltered by the Moon. Two satellites are planned to fly in formation of elliptical orbits, forming a interferometer with changeable baseline, which requires high precision relative navigation and control. The two satellites are denoted as the “leader” satellite and the “follower” satellite. The follower satellite takes a series of orbit maneuvers to approach the leader one, and maintenance the formation is also done by the follower satellite. As absolute position determinations by ground station are quite rough, relative positioning can only rely on onboard relative measure instruments. Two types of instruments are adopted on the follower satellite: camera to provide azimuth and elevation of the leader one, and radar system to measure the distance between two satellites.

There are many filter algorithms for relative navigation. Most are based on Earth-orbiting formation flying missions, which mainly depend on the absolute positon information provided by Global Navigation Satellite System, and many others focus on circular orbits which is a special case of formation flying missions. The objective of this paper is to design an Extended Kalman Filtering algorithm for relative position estimation for elliptical orbits based on the measurements of those onboard instruments as mentioned above. First, it is assumed for now that only a central gravitational source influences the motion, thus the equation of motion in Cartesian coordinate is derived, and the discrete state transition equation is given using Melton’s state transition matrix. Then, the observation equation is established for the observation vector composed of azimuth, elevation and distance. A Jacobian matrix is used to linearize the observation equation. Finally, following the typical steps of Kalman Filtering, the optimal relative position estimation is given. The algorithm is tested for the lunar-orbiting dual-satellite system via numerical simulation. The results are discussed and analyzed in detail.