World Academy of Science, Engineering and Technology
International Journal of Information and Communication Engineering
Vol:11, No:07, 2017

Analysis of Autonomous Orbit Determination for Lagrangian Navigation Constellation with Different Dynamical Models

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Abstract : Global navigation satellite system(GNSS) can deliver navigation information for spacecraft orbiting on low-Earth orbits and medium Earth orbits. However, the GNSS cannot navigate the spacecraft on high-Earth orbit or deep space probes effectively. With the deep space exploration becoming a hot spot of aerospace, the demand for a deep space satellite navigation system is becoming increasingly prominent. Many researchers discussed the feasibility and performance of a satellite navigation system on periodic orbits around the Earth-Moon libration points which can be called Lagrangian point satellite navigation system. Autonomous orbit determination (AOD) is an important performance for the Lagrangian point satellite navigation system. With this ability, the Lagrangian point satellite navigation system can reduce the dependency on ground stations. AOD also can greatly reduce total system cost and assure mission continuity. As the elliptical restricted three-body problem can describe the Earth-Moon system more accurately than the circular restricted three-body problem, we study the autonomous orbit determination of Lagrangian navigation constellation using only crosslink range based on elliptical restricted three body problem. Extended Kalman filter is used in the autonomous orbit determination. In order to compare the autonomous orbit determination results based on elliptical restricted three-body problem to the results of autonomous orbit determination based on circular restricted three-body problem, we give the autonomous orbit determination position errors of a navigation constellation include four satellites based on the circular restricted three-body problem. The simulation result shows that the Lagrangian navigation constellation can achieve long-term precise autonomous orbit determination using only crosslink range. In addition, the type of the libration point orbit will influence the autonomous orbit determination accuracy.

Keywords : extended Kalman filter, autonomous orbit determination, quasi-periodic orbit, navigation constellation
Conference Title : ICDCSMT 2017 : International Conference on Digital Communications Systems and Media Technologies
Conference Location : Singapore, Singapore
Conference Dates : July 04-05, 2017