Paper ID: 87038
oral
student

IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Interactive Presentations - IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (IP)

Author: Ms. Anna Marzullo
Thales Alenia Space Italia (TAS-I), Italy

Dr. Giorgio Fasano
Thales Alenia Space Italia (TAS-I), Italy
Mr. Marco Berga
Thales Alenia Space Italia, Italy
Dr. Maria Antonietta Perino
Thales Alenia Space Italia, Italy

LUNAR CONSTELLATION OPTIMIZATION

Abstract

In recent years, with the increasing number of missions to conduct human space exploration, the Moon is considered as an important milestone to evaluate new technologies, showing the need for navigation capabilities for low lunar orbiters, lunar landers, and human missions. In this scenario, the European Space Agency's vision is represented by the Moonlight initiative, which aims to develop a European-led provision of communication and navigation services to support the next generations of institutional and private lunar exploration missions. In this context, the importance of developing a high-level definition of optimized constellation architectures is even more evident. Inspired by Moonlight, this research deals with the design of optimal constellations around the Moon, able to guarantee navigation and communication services for a local area on the lunar surface and to allow Earth communication.

The problem consists in analyzing the motion of a group of satellites around the Moon in order to calculate the time intervals of visibility of each satellite with respect to the target points on the Moon and the Earth. The scenario considers a variable total number of satellites and a grid of target points on the lunar surface. The goal of the model is to minimize the dilution of precision parameters related to navigation performance. At the same time, the visibility of at least four satellites from each single point (on the lunar surface) must be permanently guaranteed.

The analysis starts with the implementation of the dynamic model of each satellite, including the orbital perturbations. The formulated model is then used to evaluate the navigation parameters with respect to the grid of target points. The constraints considered are the elevation angle of visibility from the Earth and from the lunar grid points, and the maximum altitude of the satellite on the lunar surface. The optimization method adopted is based on a black-box approach, added to a global optimization algorithm, able to achieve a minimum of dilution of the precision parameters related to specific satellite configurations. The study is implemented in the Matlab (MathWorks) environment and the solutions obtained are validated using Ansys System Toolkit (STK) software, comparing the solutions obtained with other constellations, i.e. Moonlight, presented in previous works and articles.