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ALTERNATIVE ORBITS FOR IMPROVING LUNAR NAVIGATION SERVICES

Abstract

With the renewed interest in missions to the Moon, key technologies are required to ensure the success of these missions. In particular, the demand for reliable, accurate positioning and navigation services will be fundamental for the successful outcome of some missions. With several major space agencies collaborating to develop reliable, interoperable navigation systems beyond Earth orbit, the choice of system architecture can have a significant impact on the functionality and performance of the system. This paper discusses two potential approaches to improving coverage and availability of navigation signals for Lunar missions - the use of an optimised constellation in Lunar orbit, and the use of navigation satellites at the Earth-Moon Lagrange points. The advantages and limitations of each technique will be discussed, alongside analysis of simulation results into these two techniques.

The study of the potential design requirements and expected performance of the Lunar GNSS constellation, through the methodology of multi-objective optimization is also included; by numerically simulating the orbits, and using the position dilution of precision (PDoP) as the figure of merit to optimise.

Alternatively, the use of navigation satellites located near the stable Earth-Moon Lagrange points to improve the geometric distribution of weak navigation signals has been studied, and simulations show an improvement in GNSS coverage and performance in regions on or near the Moon. With several satellites located near the L2, L4, and L5 points, the geometric dilution of precision can be improved by at least two orders of magnitude compared to navigation signals originating from terrestrial GNSS satellites alone.