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DESIGN OF EARTH-MOON L2 RELAY CONSTELLATION FOR LUNAR FARSIDE EXPLORATION

Abstract

Lunar farside is the focus of the present and future lunar exploration, which is testified by the upcoming CHANG'E-4 mission of China in the middle 2018. To solve the issue of relay communication in the future lunar farside exploration, the paper studied design of Earth-Moon L2 relay constellation. Constellation concepts are first brought forward based on the periodic orbit around the libration points, including uniform phase constellation, homo-family constellation and hetero-family constellation. With the concepts used, several constellations with different phase and configuration are constructed with the Earth-Moon L2 periodic orbits. Second, for measuring the coverage performance of relay constellation, the time coverage factors are defined for the Earth-Moon L2 periodic orbit and constellation, respectively. Based on the time coverage factors, the performance index is presented for the multiple coverage of the relay constellation. Finally, the coverage performance is analyzed for the constructed relay constellations. Furthermore, the hetero-family constellations with multi relay satellites are designed with optimization of coverage performance. According to the research, the following conclusions can be drawn. 1) Using the homo-family constellation with two relay satellites, the lunar farside can achieve a full single coverage on the south/north polar and a full double coverage on the central equator zone. 2) Using the homo-family constellation with three relay satellites, the lunar farside can achieve a full double coverage on the south/north polar. 3) Using the hetero-family constellation with two relay satellites, the single coverage is better than 90 percent for the south/north polar and high latitude area of the lunar farside. 4) Using the hetero-family constellation with four relay satellites, the whole lunar farside can achieve a full single coverage. However, the best performance cannot be simultaneously achieved for the low and multiple coverage. This research can be beneficial to the further utilization of libration points and the future exploration of the Moon and other celestial bodies in the solar system.