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GEOMETRICAL COMPARISON OF DIFFERENT LOCALIZATION METHODS FOR LUNAR NAVIGATION EXPLOITING ELFO AND HALO ORBITS

Abstract

In recent years, there has been a renewed interest in lunar exploration involving both the public and private sectors. And as stated in the last update of the Global Exploration Roadmap (GER) several missions are planned for the next decades.

This increasing number of robotic and human missions will provide a multitude of opportunities, but will also present several difficulties. For Example, the current Deep Space Network for spacecraft tracking will be not sufficient to support all the missions since it has inherent limits in terms of complexity, availability, costs and user capacity. To tackle these challenges, a dedicated Lunar Navigation System (LNS) will be mandatory.

ESA and NASA are proposing satellite-based Lunar communication and navigation system deployed in Moon orbit; in this way, lunar vehicles/spacecraft will be able to accomplish more complicated missions and to operate with minimal control from the Earth.

Different solutions, in terms of constellation classes or localization methods, are under study and are proposed in the literature and no decision is currently taken.

In this work, we evaluate and compare the geometrical properties of two promising classes of constellations and the use two different localization methods. In particular, an ELFO and a HALO orbit are evaluated and compared in the case of One-Way and Two-Way localization. Both the constellations are composed of only four satellites to represent a first deployment for in orbit validation or initial operation phases.

With this reduced size of the constellation, it is important to evaluate how much the satellite to user relative geometry affects the final accuracy of the localization and the service availability.

In the full paper, starting from the classical definition of Diluition Of Precision (DOP) used for the One-Way localization, a derivation of the same parameter suitable for the Two-Way localization is done, the two methods are used then to compare the performances of the two constellation classes in terms of availability and DOP at the south Hemisphere of the Moon.

Results show that the Two-Way localization has better performances with respect to the One-Way in terms of both the DOP and the availability. Moreover, the HALO configuration shows higher availability and lower DOP than the ELFO one. More details about the advantages and disadvantages of the

four configurations, considering also other factors such as the capacity of the system or the link budget constraints, etc. will be given in the full paper.