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POSITION, VELOCITY AND TIME COMPUTATION BASED ON MULTIPLE DATA SOURCES IN THE LUNAR ENVIRONMENT.

Abstract

The ever-growing interest of University Research and Industrial entities in lunar exploration is raising many challenges in every technical field and in particular in the navigation domain, with the ultimate objective of reaching deeper horizons such as Mars. As a matter of fact, the capability of precisely positioning on the Moon surface or surroundings appears critical for the safety and efficiency of future lunar missions. So far, the navigation technology has reached a high level of accuracy, availability and reliability on Earth with the development of several GNSS constellations (i.e. GALILEO, GPS, GLONASS, BEIDU, etc.). However new issues are appearing with the ambition of creating such an autonomous navigation system around the Moon, where such a high number of navigation satellites will not be available. One of the most important challenges for a lunar navigation system is to provide a PNT service with a limited number of satellites orbiting around the Moon that is able to satisfy the user performance needs. The purpose of this paper is to provide an assessment of different algorithms computing Position, Velocity and Time (PVT) of typical lunar users, considering a lunar navigation system made up of four satellites in ELFO orbits. In order to take into account the low availability of a reduced satellite constellation and the accuracy needed considering also manned missions, measurements from additional sensors embedded on lunar users will be integrated in the computational algorithms. Starting from what has been done in the scientific literature, the most common PVT estimation techniques based on Weight Least Square (WLS) and Extended Kalman Filter (EKF) algorithms will be combined with embedded sensors measures in order to compute a precise and reliable PVT estimation of the user. The study is based on the integration of sensor measurements (e.g. altimeter, Inertial Measurement Unit (IMU) and camera) in the positioning estimation algorithm considering the following Lunar representative users:

- a dynamic user on the moon surface, located on the Moon South Pole area;
- a user landing on the South Pole area;
- a low lunar orbit trajectory.