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IMPROVING ACCURACY OF LEO OBJECTS TWO-LINE ELEMENTS THROUGH OPTICAL MEASUREMENTS

Abstract

Two-Line Elements (TLEs) of LEO objects, consisting in the object orbital parameters released by NORAD, are often characterized by low accuracy and short-term reliability. This is mostly due to sparse tracking data and relevant contribution of either unmodeled or poorly modelled perturbations of the orbital dynamics. Frequent updates of the dynamic state estimate are necessary for Space Situational Awareness (SSA) analyses and reliable orbit propagation.

The optical Orbit Determination procedure represents a possible approach in order to increase TLE accuracy by processing ground-based optical measurements. In case of one-site observations, fast passes, together with possible bad weather conditions, can lead to a set of largely sparse measures, consequently leading to the impossibility of calculating consistent orbit determination solutions.

The S5Lab research team has developed an orbit determination algorithm aimed to improve TLEs accuracy by exploiting multiple-sites optical observations. The developed algorithm receives as input the astrometric solutions of different sites images, in order to integrate them to produce an improved orbit determination solution in TLE format.

The considered observatories, which belong to the S5Lab monitoring network, are MITO (Rome, Italy), RESDOS (Avezzano, Italy) and EQUO OG (Malindi, Kenya). These telescopes locations allow to acquire less sparse data and increase fit time spans, eventually allowing to track multiple arcs of the same orbit.

Moreover, the observatories configuration provides redundancy to the data acquisition devices and it increases the optical data availability, even when coping with the different meteorological conditions of

the observatories regions. Therefore, a higher accuracy in determining the target orbit is achievable, when acquiring data from the described observatories, due to the increased number of astrometric measurements.

The developed software validation has been performed by analysing pre-fit and post-fit residuals with respect to reference measures taken during a LEO objects monitoring campaign performed between December 2017 and March 2018.

The analysis has demonstrated that the algorithm improves the state estimate accuracy on multiple test cases that will be described in detail.

This paper will describe the developed algorithm for optical data integration and TLE improvement. In addition to the integration theoretical model, the validation campaigns and the used observatories features will be exposed. Finally, future perspectives and expected outcomes of the next observation campaigns will be discussed.