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EXPERIMENTAL VALIDATION OF INITIAL ORBIT DETERMINATION AND TRACKLET CORRELATION METHODS BASED ON ADMISSIBLE REGIONS

Abstract

With the ever-increasing activity in space, and the accompanying prospect of increasing numbers of space debris, the need for a space object catalogue is becoming apparent. One of the main activities in cataloguing is that of finding the orbit of unknown or previously lost objects, also referred to as catalogue generation. This paper is concerned with catalogue generation from optical measurements. Optical instruments are widely used in ground-based space surveillance and tracking (SST), and are well suited for future space-based SST missions. One of the main challenges in catalogue generation from optical measurements is the so-called tracklet-to-tracklet correlation, or tracklet linking, problem. From a tracklet, that is, a short series of measurements from the same object, two angles and the corresponding angle rates can be extracted, providing four independent measurement components. To perform an initial orbit determination (IOD), however, at least six parameters must be estimated, hence more than one tracklet of the same object is required. The challenge here is the fact that we do not know a priori which object (known or unknown) a tracklet belongs to. The admissible region approach provides a convenient framework in which to address this problem. In the context of space debris, the admissible region of an optical tracklet is the set of allowed range and range rate pairs, under the assumption that it belongs to an Earth-bound object. Sampling the admissible region is essentially the selection of hypotheses for the orbit of the measured object. These hypotheses can then be tested against other tracklets to establish a level of credence about correlation status with the respective tracklet. Since its introduction, several extensions and adaptations have been proposed. This paper aims to provides an overview of the available methods. The various methods are validated using real-world data and their performance is assessed using a diverse set of optical measurements spanning several months. Subsequent IOD using the correlated tracklets of the observed objects is also performed. Various IOD methods are considered, and the results are compared against the known orbits of the objects. The data is generated by the Airbus Robotic Telescope located in Extremadura, Spain, operated by the SSA team at Airbus Defence and Space, Friedrichshafen.