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DATA FUSION APPLICATION FOR IMPROVING ORBIT DETERMINATION AND RE-ENTRY PREDICTIONS

Abstract

Re-entries of space objects are common occurrences, which take place every day; however, the risks related to these events are marginal for both people and ground infrastructures. Nevertheless, the re-entry prediction of uncontrolled objects is a key capability in order to opportunely monitor the decaying of large intact spacecraft and upper stages which, in particular cases, could pose a risk for people on the ground, such as the uncontrolled re-entry of the Chinese space station Tiangong-1 in 2018. Surveying and providing early warning of uncontrolled re-entries of large space debris is one of the main objectives of the EUSST support framework adopted by the European Commission in 2014. This initiative is implemented by a Consortium initially formed by five European Member States (France, Germany, Italy, Spain, United Kingdom), and expanded from 2019 with three additional EU Member States (Poland, Portugal, Romania). The EUSST service provision is facilitated by the EUSatCen and the three SST services, Re-entry, Collision Avoidance and Fragmentation, are provided by different member states. Italy is currently in charge of Re-entry and Fragmentation services, and the current national architecture of the system is expected to evolve to improve their provision. In this perspective, an added value for the system can be given by the implementation of data fusion between radar and passive optical sensors. This technique could supply additional information about the object's dynamics (i.e. attitude motion, tumbling rate and tumbling axis orientation), which is a critical point for the uncontrolled re-entry of massive objects; moreover, it may be helpful for more refined predictions during the final phases of the decay. In addition to that, a network of sensors specifically dedicated to re-entry has the benefit of supporting the orbit determination and propagation accuracy for the whole EUSST Consortium service provision. The enhanced tracking capabilities achievable through the integration of radar and optical data have been investigated with an observation campaign conducted by tracking different re-entering objects. The acquired measures have been analysed by employing innovative data fusion techniques, and exploited to improve the orbital estimates of the objects. The solutions reliability has been verified through additional independent data and subsequent measurements. For each case, a comparison between the proposed approach and analogous scenarios not involving data fusion has been performed. The results, that will be exposed in detail, show the data fusion technique to provide a dramatic improvement in terms of orbit determination and re-entry prediction accuracy.