IAF SPACE SYSTEMS SYMPOSIUM (D1)
Interactive Presentations - IAF SPACE SYSTEMS SYMPOSIUM (IP)

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MULTI-SOURCE SENSOR FUSION: CHALLENGES AND OPPORTUNITIES FOR THE FUTURE OF SPACE OPERATIONS

Abstract

The number of satellites in orbit has risen exponentially over the last decade, and the availability of new launch capacity and the use of new technologies indicate that number will continue increasing. Conversely, the rise in the number of orbiting bodies will increase the spatial density per altitude, thus increasing collision risk and the potential for more debris in orbit. As a result, the operational volumetric freedom of movement and precision of entering a specific orbital location becomes more critical. The need for a multi-faceted information flow about the location, state, and movement of objects in orbit is now more critical than ever. This article aims to identify and characterize the different information constraints for interaction information between more than one orbiting body. In particular, we will focus on the information available for object detection and feature object extraction. We also summarize the different sensing technologies and their interaction with the sensing variables under space conditions to provide the current state-of-the-art (SOA). As an initial investigation, we look at fusing some of those sensing systems together that may provide heuristics that can be unique to each object. This approach has several advantages, combining different sensing techniques (active and passive) and types of information (light, temperature, shape, etc.). Furthermore, it can be more robust because not all the sensing variables change under the same conditions. Moreover, different sensors can detect different features of an orbiting body. This paper will showcase an initial laboratory demonstration to explore potential capabilities and collect measurements from different sensing systems under changing environmental conditions. Preliminary results show an increase in object detection using this approach compared with each individual sensor. We will present initial conclusions with the challenges and opportunities of using this approach in space operations and propose steps to improve and validate either new sensor modalities or methods to fuse existing ground and space sensor information to maximize knowledge for on-orbit satellites.