Detecting and estimating satellite maneuvers more accurately

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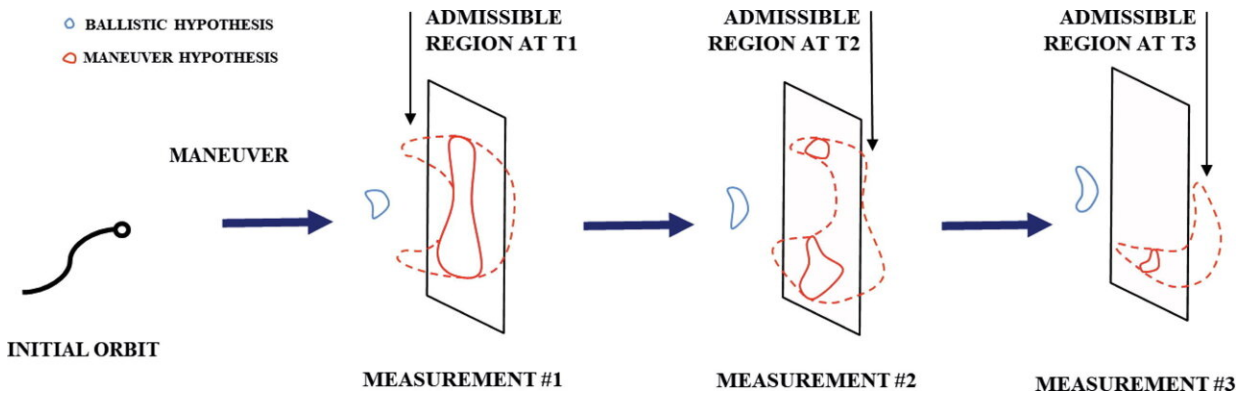

Sketch of the measurement association sequence in the event of a maneuver. The space accessible to the object is given by the admissible control region. Credit: *Advances in Space Research* (2022). DOI: 10.1016/j.asr.2022.02.034

Researchers from the Universidad Carlos III de Madrid (UC3M), Polytechnic University of Milan and the company GMV have developed a new methodology for detecting and estimating satellite maneuvers that improves the operation of the systems currently in use. This development, which is already being tested in operational environments, may help reduce the problem of space debris.

The number of satellites and fragments of space debris in Earth orbit currently amounts to around 30,000, according to the European Space Agency (ESA) and NASA catalogs, although researchers in this field

estimate the real number to be around 100,000. Any object larger than approximately one centimeter can cause serious damage in the event of a collision.

The "space debris" catalogs allow operational satellites to carry out maneuvers to avoid possible dangers. However, these same movements that some satellites carry out automatically can pose a problem, because if they aren't correctly detected and estimated they lead to catalog degradation, which in turn increases the risk of collisions.

"The problem is that there are more and more satellite launches and many of them have autonomous maneuvering capabilities, forming part of constellations of thousands of objects. Therefore, it is very interesting to be able to autonomously detect these maneuvers in order to keep track of the real position of these satellites," explains the researcher from UC3M's Aerospace Engineering Department, Guillermo Escribano, one of the authors of this work recently published in the journal *Acta Astronáutica*.

What these researchers have developed is an algorithm that detects and characterizes these satellite maneuvers more effectively. To do this, they use data from sensors that track the movement of space objects (such as telescopes or radars, for example) and combine them with statistical information.

"The basic idea is to process all of these measurements and correlate them with objects that we already have in the catalog," says Guillermo Escribano. "With this we are able to track them even if the satellites carry out maneuvers we're not aware of," says another of the researchers, Manuel Sanjurjo Rivo, also from UC3M's Aerospace Engineering Department.

This development could be used to improve the accuracy of space object

tracking and cataloging systems currently in use, which could help to reduce the space debris problem, according to the researchers. In fact, the algorithm has already been implemented by the company GMV, where other researchers who are authors of this paper work, to carry out tracking and validation campaigns for space object cataloging systems.

In this context, it is essential not only to have an estimate of the position and speed of objects in space, but also to properly characterize the uncertainty of these estimates by considering the information provided by tracking sensors or even by the spacecraft operators themselves.

"According to the type of information obtained from tracking sensors, whose data update times range around 12 hours, knowledge of the dynamics is essential. Maneuvers therefore pose a challenge to current automated association and estimation systems due to a lack of reliable information about how the object moves," concludes Manuel Sanjurjo Rivo. Hence the importance of the developments proposed in the framework of this research.

Additional work was published in *Advances in Space Research*.

More information: Lorenzo Porcelli et al, Satellite maneuver detection and estimation with radar survey observations, *Acta Astronautica* (2022). DOI: 10.1016/j.actaastro.2022.08.021

G. Escribano et al, Automatic maneuver detection and tracking of space objects in optical survey scenarios based on stochastic hybrid systems formulation, *Advances in Space Research* (2022). DOI: 10.1016/j.asr.2022.02.034

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