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ENABLING GENERAL ORBITAL TRANSPARENCY BY OPEN-SOURCE ORBIT-DETERMINATION OF CUBESATS AND OTHER SOURCES

Abstract

The long term growth and sustainability of Low Earth Orbit (LEO) depends on keeping the issue of space debris under control. The Key to this challenge will be increased transparency that makes enables verifiable visibility of objects in orbit by third-parties and the operators own mission. With this knowledge and situational awerness, the mission operator has control about the mission and can minimize the risk of the own mission and inform third parties faster and directly and thus last minute avoidance and ultimetaly it will reduce space debris.

With the increase of mega-constellations and more cubesat missions, it will become essential for all participants in orbit to know their objects. And mainly these cubesat missions are not yet all able to receive their TLEs adequately fast or are able to determine their orbits themselves. This creates times of blindspots when the CubeSats pose a higher risk for the space community. Additional second-sources of TLEs are needed and can help the community.

With the open-source movement, the expertise of orbit determination is now globally available, verifiable and expandable. The OrbitDeterminator tool is developed for these reasons and can be used to determin orbits of different objects by different inputs. The OrbitDeterminator is part of the Distributed Ground Station Network for tracking CubeSats by their radio-frequency emssions. So the initially developed algorithms uses pseudoranges and doppler-shift patterns. During several expansions, further inputs like ranges, angles-only has been added allowing to use it for other silent objects. So classical optical observations of natural lights and reflections or even laser emissions becomes possible. In this way, the community can use OrbitDeterminator not only for satellites, but also for space-debris and are able to determine orbits of all relevant sources at their hands as second sources in addition to other available sources. By this, risk assesment becomes more robust and reliable. The paper will show how fast and with what accuracy and precision the user will be able to determine orbits of rf-emmiting objects of known cubesats, of objects with unkown drag coefficiants like space debris and light-reflecting sources of mega-constellations like Starlink.

The DGSN project was started within the SmallSat-Design-Studies at the Institude of Space Systems (IRS), at the University of Stuttgart. It is part of the annual Google and ESA Summer of Code campaigns. And it is a PhD-research topic at the Institute for Photogrammetry (IFP) at the University of Stuttgart