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Author: Mr. Andreas Hornig
University of Stuttgart, Germany

Prof. Dieter Fritsch
Institute for Photogrammetry (IFP), University of Stuttgart, Germany

AN OPENSOURCE METHOD FOR FAST PRELIMINARY IDENTIFICATION AND ORBIT-DETERMINATION OF INDIVIDUAL (CUBE/SMALL) SATELLITES IN SUPER-CLUSTERS DEPLOYED FROM RIDESHARE LAUNCHES

Abstract

CubeSats and smallsats are revolutionizing the space industry with their new applications and their sheer numbers. The deployment of so many satellites together in super-clusters from one rideshare launch is creating new challenges to single satellite operators and ultimatingly to the full space traffic management. To reduce risk of collisions and space debris, and to allow operators to detect and identify their satellites early, further collaboration between the operators and the tracking organizations is needed within the scope of the newly-forming Space Traffic Management.

By current state of the art identification and determination methods, it took about 5 weeks until the last of the 140 satellites that were deployed during SpaceX's Smallsat Rideshare Program mission "Transporter1" were fully listed on US-NORAD databases. The high density of the satellites within the super cluster flight path made this challenging. With prior knowledge of the deployment sequence by the launcher, knowledge of special characteristics of the satellite active/passive radio and optical emissions and knowledge by the satellite operators' orbital knowledge themselves from on-board GNSS, the speed of individual identification of satellites varies and can be faster than 5 weeks and within a few days.

But in general, faster identification is needed not only to start commissioning earlier and allow the new-space business models to be active and being profitable, but also to integrate the satellite into said Space Traffic Management network.

For this, the Distributed Ground Station Network (DGSN) is in commissioning. DGSN is a global network of groundstations for receiving radio-signals of CubeSats. It applies open-source methods to determine the origin of the rf-signal by data-fusion. With the DGSN, pseudoranging and doppler-shift is used from multiple stations to determine the orbits. The paper shows how the first identification candidates can be obtained by combining the two inputs with the public ITU filings of the frequencies. With further knowledge by the operators or NORAD-data the remaining candidates can be obtained. And by long-term observations the orbit determination is specified. Due to the open-source approach, the software allows validation of results, collaboration between different organisations and scaling the level of sharing of knowledge.

The DGSN project was started within the SmallSat-Design-Studies at the Institute 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.