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SATELLITE AND OTHER STAR-LIKE OBJECT DETECTION, RECOGNITION AND (RE-)IDENTIFICATION VIA MACHINE LEARNING FROM EARTH-BOUND OPTICAL OBSERVATIONS FOR FAST ORBIT DETERMINATION OF EVEN SATELLITE TRAINS

Abstract

With more and more objects in Earth orbit orbital knowledge of these objects becomes more and more relevant for Space Traffic Management (STM). With dedicated smallsat rideshare missions such as SpaceX Transporter missions, that deliver 100+ satellites and other (later defunct) objects into space, a fast way of detection, identification and orbit determination is required for STM to include these new objects into their management decisions. With optical sensors (visible and infrared) and permanent monitoring by governmental, commercial and open-intelligence groups, more and more data is available and needs to be fastly processed. With the currently fastly progressing machine learning there are new tools and methods that supports a fast processing of the available big-data to obtain this satellite orbital knowledge.

This paper will show how different machine learning methods (including deep learning using PyTorch) were studied by their applications for satellite detection, identification and orbit determination. They are assessed by their performance to find star-like objects in optical images, how they handle movement, and how they filter out unwanted features like object blinking, light (change of darkness) and environment (clouds, other objects like planes). It will be discussed how the performance speed is between data measurement and final results to see if they can be used for fast preliminary orbit determination within half a day.

The used measurements will be taken from open-data sources and commercial of the shelf hardware. The focus lies on using open-source software that is state of the art within the global machine learning community. It will be shown how such a process flow can be integrated into existing STM systems and workflows.

This project is a cooperation between the Machine Learning User Group Stuttgart (MLUGS.de), the Makerspace Esslingen e.V., and the Distributed Ground Station Network (DGSN) by AerospaceResearch.net. It is part of a PhD-research topic at the Institute for Photogrammetry (IFP) at the University of Stuttgart for the open-source orbit determination of any signal received from orbit (radio or optical). It is derived from previous studies from the NASA International Space Apps Challenge and Google and ESA Summer of Code in Space campaigns.