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SPACE OPERATIONS SYMPOSIUM (B6)
New Space Operations Concepts and Advanced Systems (2)

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DEEP LEARNING FOR EVENT DETECTION: AUTONOMOUS OPERATIONS FOR INTERPLANETARY MISSIONS

Abstract

The history of Artificial Intelligence covers more than five decades, alternating periods of great enthusiasm and prosperity with periods of skepticism. In recent years, Artificial Intelligence has entered a new period of scientific relevance, with countless applications being developed in several scientific fields: medicine, security, speech recognition, image classification and more. The reason behind this progress is clear: Artificial Intelligence allows the implementation of algorithms that origin directly from human knowledge, emulating human behaviors and improving them. Despite the diffusion of these algorithms in several fields, Artificial Intelligence in space engineering has yet to find a defined sphere where it emerges from the competition of other algorithms. Nonetheless, several key directions where Artificial Intelligence has been applied have shown incredible progress in the last decade: mission replanning, fault detection, payload data selection and prioritization can be cited. The paper presents the key advancements and applications developed at Politecnico di Torino in the field of Artificial Intelligence for Space Mission Autonomy, focusing in particular on autonomous event detection during interplanetary missions. The key technology that lies behind the presented research falls in the category of Machine Learning, and in particular in the field of Deep Learning. This technology is used to perform event detection for missions around asteroid and comet objects, performing autonomous detection of key events such as plumes, impacts and changes in brightness. The algorithm, developed in Matlab, is presented and described into details, covering aspects of the design of the network, considerations on its performances, training dataset construction and training strategies. Finally, the algorithm is ported on an embedded board representing the spacecraft Command and Data Handling subsystem. The resulting Hardware-in-the-Loop simulation is described, where a CMOS Image Sensor is used as a sensor to perform the event detection in situ during the mission. The research demonstrates the feasibility of the presented training approach thanks to the embedded implementation described.