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ML-BASED EVENT SEARCH ALGORITHMS IN THE GAMMA SWARM EXPERIMENT

Abstract

One of the most important aspects of data analysis at the Cubesat gamma-ray observation experiments (including constellations) is to compress data before sending it to the ground. In this work, we will consider utilization of Machine Learning methods to recognize high quality data and ignore empty and noisy packets.

Gamma Swarm is a compact distributed 3U Cubesat system, aimed to detect and localize gamma ray transients in the low Earth (LEO) orbit and relying on real-time direct intersatellite communication. The Swarm will detect Terrestrial gamma-ray flashes (TGFs) from the Earth's atmosphere, which are generated during thunderstorms and are not fully studied yet, as well as Gamma-ray Bursts (GRBs), which come from the outer space. The swarm consist of 4 satellites with intersatellite link, and each of satellites will carry on five 64-pixel gamma ray detectors. The project have two stages – the first four satellites are going to be launched to ISS in the late 2021, while the second four are planned for 2023.

In this paper, we try to improve useful data selection efficiency by machine learning approaches into Cubesat On Board Computer. Gamma Swarm On Board Computer is designed to provide maximal calculation resources within 3U satellite power consumption constraints. It has low power core (Cortex M4F), able to be powered on continuously, and high power core (Dual Cortex-A15), which may be used for on board training. We simulate different types of real gamma ray transients signals in our system, as well as different "non signal" events (charged particles penetrations, EM shower events, SAA), and investigate efficiency of on board trained LSTM network to select and recognize events with largest self-information.

We will report on the effectiveness of this approach, since it is well known that ML analysis comes at extra power consumption cost. This cost will be traded against energy needed to transmit noisy data. The goal of the project is to optimize communication of genuine Gamma Ray burst data to the ground and demonstrate this approach for future deep space exploration.