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Author: Mr. Lorenzo Feruglio
Politecnico di Torino, Italy, lorenzo.feruglio@polito.it

Mr. Loris Franchi
Politecnico di Torino, Italy, loris.franchi@polito.it
Mr. Christian Cardenio
Politecnico di Torino, Italy, christian.cardenio@studenti.polito.it
Dr. Sabrina Corpino
Politecnico di Torino, Italy, sabrina.corpino@polito.it

NEURAL NETWORKS FOR PLUME DETECTION: INTERPLANETARY CUBESAT CASE STUDY

Abstract

CubeSats have been a rapidly increasing technology in the past decade, with a significative increment in the number of applications, both from universities and from the industry. In the last few years, this type of spacecraft has been pushed towards a new direction: interplanetary missions. Numerous examples of mission concepts for interplanetary CubeSats have been presented, ranging from lunar missions (such as LunaH-Map, Lunar IceCube, Lunar Flashlight) to Mars missions (MarCO) and asteroid missions (COPINS, NEAScout).

Several challenges undermine the feasibility and the good success of these missions: two of the most critical ones are limited data rates available on CubeSats, and the necessity of performing autonomous operations.

This paper deals with the latter problem: autonomous on board operations for a CubeSat class satellite, and in particular with external event detection, performed by processing images acquired by a camera sensor. The objective of this work is to demonstrate the capability of neural networks to successfully detect the emission of plumes from a comet-like body, and to identify the orientation of such emissions, with the intent of providing accurate information to the GNC system of the spacecraft and the science community, be it either for avoidance manoeuvre planning or for enhanced science operations to investigate the unpredictable event.

The paper presents the description of a feed forward, online trained neural network developed in Matlab, trained with a image dataset taken from a 3D model of an asteroid emitting plumes in several directions. Results of the paper demonstrate that the use of neural networks to increase the autonomy of a satellite, when dealing with event recognition, is feasible and provides interesting results. In addition, the proposed algorithm can be further coupled with GNC algorithms towards the development of an autonomous interplanetary small satellite.