48th STUDENT CONFERENCE (E2)
Student Conference - Part 1 (1)

Author: Mr. Ilia Chichkanov
Skoltech Space Center, Russian Federation

Dr. Georgii Gaikov
Skolkovo Institute of Science and Technology, Russian Federation
Dr. Anton Ivanov
Skolkovo Institute of Science and Technology, Russian Federation

DEEP LEARNING-BASED CUBESAT PHOTODIODE ATTITUDE DETERMINATION AND CONTROL SYSTEM WITH ON BOARD TRAINING

Abstract

Using star trackers and sun sensors for determining attitude provides good accuracy but significantly increases the project cost for small satellites. Photodiodes placed on every face of the CubeSat can be an alternative to other sensors. However, there are factors which reduce accuracy such as planet albedo, which also requires complex light reflection models depending on the satellite's position and many other factors.

We offer a novel method of satellite attitude determination: machine learning based analysis of illumination level of each satellite side. In case of neural network implementation, factors such as reflected from the Earth's surface sun light become advantages. In this work we propose a system consisting of six photodiodes, low power Cortex M4F microcontroller with large size Flash memory, able to run simple networks, and a single-board computer, which can do neural network training, compiling and uploading new code on microcontroller during the satellite flight.

Skoltech is leading a consortium of universities to launch a swarm of 4 satellites in late 2021. We will acquire in-orbit data on classic ADCS (sun sensors, magnetometers, IMUs) and use these data to train a neural network (NN) on the ground. Trained NN will be deployed on-board as experiment. In this paper, we will develop simulation of the photodiodes data and corresponding reflections. Neural Network will be trained using these data and then we can use actual hardware to experiment with attitude determination. We will better understand performance of this method on hardware and precision it may reach.