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NEPAL'S MUNAL 1U EDGE AI TECHNOLOGY DEMONSTRATION CUBESAT FOR TARGETED EARTH IMAGE DOWNLINK CAPABILITY USING DEEP LEARNING

Abstract

Earth observation missions require large data to be downlinked and processed on ground. With improvements in processing capacity and power consumption of microprocessors, small satellites now have the capability to preprocess data and store only useful information using Artificial Intelligence. Nepal's Munal 1U CubeSat earth observation mission uses an ARM Cortex STM32H7+ microprocessor to run an extremely lightweight deep learning model that can classify, segment and caption an image taken from space. This paper outlines the design of imaging payload, the novel Convolutional Neural Network (CNN) model and the entire workflow of image downlink. The 16kb CNN tensorflow lite model is trained to classify and then segment images into water, land, space and cloud with 97.6% accuracy with an F1 score of 0.97. The image is captioned and cataloged based on the percentage of water, land, space and cloud. A text file is created with the caption and can be downlinked by the ground operation team. An image is targeted to downlink based on the image's description on the file. The ground operation team gets to downlink targeted images for targeted purposes without unnecessary downlink. Comparative results with previously released CubeSatNet CNN shows that the new model outperforms accuracy by 7% while being only 15% of CubeSatNet size. If the on-orbit demonstration is successful, the model with targeted image downlink capability will drastically improve quality of data downlinked while cutting down operation time by nearly 80%.