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DESIGN AND IMPLEMENTATION OF AN INTELLIGENT REMOTE SENSING PAYLOAD FOR CUBESAT APPLICATION

Abstract

The design an Earth observation and disaster mitigation mission and the associated payload must address the requirements of turnaround time between the acquisition of the image data and the availability of analytic information. Recently, the arrival of on-board intelligent processing techniques such as edge computer and deep learning has enabled a much shorter turn-around time. It is further desired that such an intelligent remote sensing payload that contains camera, onboard processing, and communication device can be miniaturized for small satellite or CubeSat missions so that the overall cost can be reduced. The paper describes the design, implementation, and preliminary test of a remote sensing payload of a CubeSat that employs edge intelligence in the satellite to shorten the turnaround time and relax the requirement on data downlink of imaginary data. The payload is required to perform edge intelligence for landslide detection and cloud segmentation. Even though these detection tasks are not extremely difficult in theory, the limitations on computational resources, power, and communication bandwidth for CubeSat result in some design challenges. In the design, a lite neural network is developed to perform the on-board inference. For the hardware design, an AMD A8 processor is adopted to realize the data operations such as inference, compression, and restoration. The payload indeed contains a high focal-length telescope, a CMOS detector, and the data operation board. An important design consideration of the payload is the training of the model. The neural network is trained on ground by using existing data and captured data. After training, the model is uplinked to the satellite for inference. The neural network is implemented by using OpenCL program and the near real-time performance can be achieved. A partitioning scheme is thus developed so that a balance between model complexity and communication load can be achieved. The paper will also discuss the design of the learning network, the payload prototype, and preliminary airborne test result of the payload.