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EARTH OBSERVATION IMAGE SUPER-SAMPLING USING DEEP LEARNING TECHNIQUES FOR SMALLSAT MISSIONS

Abstract

Technological developments made in the last decade have enabled widespread use of deep learning algorithms in several applications and fields. Oftentimes, these algorithms (mainly in the form of neural networks) outperform other classical approaches to the same problem, and thus, implementing neural networks to suitable problems has become an interesting and valuable research topic.

One of the applications in which neural networks vastly outperform classical algorithms is that of image super-sampling, also known as super-resolution (SR). SR consists on taking one or more low-resolution (LR) input images and outputting a high-resolution (HR) image. There are two families of techniques regarding SR, one that uses a single input image, called Single-Image Super-Resolution (SISR) and another that uses several input images, called Multi-Image Super-Resolution (MISR). Within each family, there are many deep learning algorithms depending on the architecture of the neural network that is being used.

Current trends in the Space sector are allowing an ever-increasing number of small-scale satellites to embed optical payloads and obtain Earth Observation data. However, mass and size limitations constrain the resolution of these images. Applying Deep Learning Super Resolution algorithms to the data can enable these payloads to obtain more scientifically useful images without increasing the cost or complexity of the mission.

Apart from the advantage of obtaining higher resolution approximations of the images obtained by the same instrument, applying the Super Resolution Neural Network in the on-board computer can decrease the amount of data that has to be sent through the downlink to the ground station. This, in turn, simplifies satellite operations and also relieves long-term on-board storage constraints.

In this paper, we review several Neural Network architectures suitable for Single-Image Super-Resolution and Multi-Image Super Resolution. A selection of an architecture that can be efficiently implemented in a Cubesat on-board computer has been made. Then, an early implementation of the network has been developed in an embedded computing platform representative of those common in Cubesat missions.