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Author: Dr. Anselmo Bettio
Stellar Project Srl, Italy

SPACE EDGE COMPUTING CHANGE DETECTION THROUGH AN UNSUPERVISED TRAINED U-NET

Abstract

Change detection algorithms applied to Earth observation images can be used to monitor and detect sudden critical events such as floods, fires and oil spills. Nowadays, change detection processing is done on centralized data centres on Earth only after the time spent by the satellite to fly over the next ground station and to download the high-volume images. This makes change detection useful for damage assessment, but not handy for real time detection and monitoring of such events. In recent years, the emerging solution is edge computing in space, that allows to process data onboard the satellite itself. By analysing the earth observation images locally, the amount of data to transmit back to Earth is minimized, significantly reducing latency, and allowing a faster decision-making process in critical situations.
Since satellites have limited computing power, memory, and energy compared to ground-based systems, the change detection must be done by lightweight algorithms designed for low resource consumption and to be run on radiation-hardened and energy-efficient hardware. In this work, VPU technology has been selected, because it has low power consumption, and it is specifically designed for accelerating convolution neural network tasks for image processing.
In this paper, a U-net convolutional neural network is trained with a dataset created in an unsupervised manner. In particular, a novel GLCM-PCA-SFCM algorithm is used to segment a large quantity of both SAR and optical images with diversified characteristics in terms of territory type and climatic season. This dataset has been divided into a training set, validation set and test set. The model has been successfully trained with the first two sets resulting in 90 % accuracy. Then, the trained U-Net has been implemented the Movidius Myriad 2 VPU, which was qualified for space missions by ESA with the Phi-Sat mission. Finally, the pre-trained U-Net loaded into the Myriad 2 VPU has been evaluated in terms of accuracy with an image test set never seen by the model: the results in terms of accuracy are between 80% and 90%. The data volume of the output segmented image results to be 87% less than the input image. This makes it possible to downlink a ready to use segmented image to the ground in few seconds, allowing a faster response to sudden and critical territory changes.