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Author: Ms. Aysha Alharam
Bahrain Space Agency (BSA), Bahrain

Mr. Yaqoob Alqassab
Bahrain Space Agency (BSA), Bahrain

Ms. Reem Senan
Bahrain Space Agency (BSA), Bahrain

A NOVEL ON-BOARD AI-BASED ADAPTIVE IMAGE PROCESSING AND COMPRESSION FOR
EARTH OBSERVATION CUBESATS

Abstract

CubeSats have been widely developed due to their appealing characteristics, including comparatively low costs and shorter development cycles. Besides their many advantages, CubeSats have limitations in the available power, volume, and data rate for downlink. Earth observation CubeSats missions are getting more sophisticated than before, and thus, their computing capabilities must be intelligent and robust to allow these complicated scientific missions. Nowadays, CubeSats utilize high-resolution cameras which requires a high data rate for downlink. Meeting this requirement would cause an increase in power consumption due to high transmission power. Many of the captured images by CubeSats for earth observation missions are useless, and they might take days to be fully downloaded. Some of these images are cloudy or noisy images, therefore, preprocessing images for quality before the transmission will save the bandwidth for downloading for ground analysis. Artificial intelligence contributes to different areas and is applied to many space mission design and operation challenges. This study aims to utilize AI in maximizing bandwidth utilization by proposing a novel on-board adaptive AI-based compression and image processing for earth observation CubeSats. This system combines the use of deep learning algorithms along with the k-means algorithm to process captured images for cloud detection and image compression without losing resolution. The image compression depends on several factors, such as the image resolution, noise, and cloud. If a cloud is detected in the image, the algorithm will compress the image to the minimum resolution, which can be downloaded for archiving purposes. A flag will be set in the data to indicate cloudy or noisy images for the user's preference. The system has been tested on a commercial off-the-shelf embedded system to verify its functionality in space. The result shows that the system was perfectly functioning with a 98