Adaptive High-Performance and Reliable Distributed Computing for Data-Driven Algorithms in Earth Observation

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Description of Proposed Research

Constellations of SmallSats (e.g., CubeSats) have been proposed for improving capability and reliability, and providing significant improvements in temporal and spatial coverage in earth observation (EO) applications. EO presents a huge potential for service improvements in agriculture, forestry, mapping, and transport.

The SmallSats in a constellation generate huge volumes of data from cameras, sensors, and scanners. The PlanetScope satellite constellation, which consists of over 150 CubeSats launched between 2016 and 2018, with each CubeSat capturing over 2 million 3-metre-resolution earth image frames per day, provides an example of the big data involved in earth observation. Moving forward, such constellations are expected to be the order of the day.

For real-time response and to save on the bandwidth required to transmit data to ground-based stations, on-board critical data processing capability should be provided. Moreover, because the satellites are operating in the harsh environment of space, the on-board avionics are prone to radiation-induced faults. Therefore, the reliability of the avionics, and consequently, of the data processing, must be ensured.

The huge volume of data that needs to be processed calls for high performance, which can only be met by hardware-based computing devices. The proposed project aims to tackle this problem by developing a single-board computing platform that is inspired by AI. The project will involve studying the data from multiple on-board sensors and investigating data processing algorithms, such as data compression algorithms, including specific types of Dynamic Learning Neural Network (DLNN).

Proposed Programme of Work

- Analysis of sensor data and investigation of data processing algorithms
- Development of AI algorithms for SmallSat constellation control and workload management
- Development of a single-board computing platform and supporting framework for low-power, high-performance, and reliable data-driven distributed processing in SmallSats
- Investigation of the aspect of the ground-based station
- Testing and benchmarking of the platform and algorithms