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ARABIAEYE: ENHANCING EARTH OBSERVATION MISSIONS WITH A NOVEL SMALL SATELLITE CONSTELLATION AND ADVANCED DATA FUSION TECHNIQUES - A CASE STUDY ON OIL SPILL DETECTION

Abstract

Continuous monitoring and rapid response has become an imperative for modern Earth Observation missions. However, many missions struggle to provide frequent data collection, particularly in mid-latitudes. In this context, we propose ArabiaEye, a novel concept consisting of a constellation of 16 small satellites equipped with optical and Synthetic Aperture Radar (SAR) payloads operating in tandem configuration (i.e. 8 optical/SAR pairs with one type of sensor on each satellite). The optical payload is anticipated to achieve a 5 meter resolution, while the SAR payload will feature a fully polarimetric sensor with a resolution of 3 meters. With a revisit time of approximately one-day, the constellation is designed to ensure extensive coverage over mid-latitudes. The satellites are distributed across two orbital planes, covering sun-synchronous and mid-inclination orbits. A subtle shift in the Right Ascension of Ascending Node (RAAN) is considered to ensure alignment of the SAR satellite footprint with that of the optical satellite, enhancing the decision-making capabilities of the constellation. Utilising simulations in Systems Tool Kit (STK) software, coverage analysis over mid-latitudes target areas spanning from Morocco to China was conducted, highlighting the significance of mid-inclination orbit in minimising revisit time while maximising coverage. The satellite design includes on-board processing capabilities, enabling real-time data analysis. These will incorporate deep learning techniques to enable cloud masking, image compression, and data fusion. To demonstrate the effectiveness of data fusion, we explore an application for oil spill detection. The paper showcases the improved performance resulting from the integration of data from two separate sources, employing advanced deep learning architectures. Our proposed analysis pipeline leverages innovative techniques to deal with both SAR and multi-spectral Sentinel data, thereby increasing dataset diversity and streamlining processing procedures. Segmentation methods are employed to differentiate between oil spills and optically similar events. Our study underscores both the potential of data fusion techniques as well as the versatility and effectiveness of on-board processing capabilities in satellite missions. ArabiaEye represents a leap forward in Earth Observation, offering a comprehensive solution for rapid, accurate, and timely monitoring across mid-latitudes.