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FEASIBILITY STUDY ON ENABLING TECHNOLOGIES FOR DESIGNING A SYNTHETIC APERTURE RADAR PAYLOAD ON A NANOSATELLITE FOR MONITORING WATER LEVELS IN FLOOD PRONE AREAS OF NIGERIA.

Abstract

The Nigerian Hydrological Services Agency identified soil moisture as a significant contributor to flooding in Nigeria in its 2020 annual flood outlook report. Swift access to accurate soil moisture data using radar remote sensing data collection techniques has improved flood risk management in the region. These techniques provide higher-resolution images independent of weather conditions, making them preferred over traditional methods like gauge observation and expensive equipment like echo sounders. The use of Synthetic Aperture Radar (SAR) payloads on nanosatellites for cost-effective, fast and continuous monitoring of water levels is a promising approach. However, the design of such a system poses challenges to fit the restrictions on size, weight, power, and cost (SWaP-C) of a nanosatellite. This paper identifies and perform a feasibility study on enabling technologies to design a Synthetic Aperture Radar (SAR) payload on a nanosatellite for the purpose of monitoring water levels in flood prone areas of Nigeria. This methodology consists of stages. Initially, SAR dataset user requirements for Kogi State, Nigeria, are evaluated to

define key mission parameters such as coverage, image mode, swath width, revisit time, and resolution. Next, current SAR payload designs and advances are assessed to determine the architecture that best meets these user requirements. Shortlisted payload designs are then subjected to a feasibility study for integration on a nanosatellite bus ranging from 3-Unit to 6-Unit Cubesats. A constraint-driven design process is employed to generate system specifications from the feasibility study results. The specifications are then used to design a SAR payload that integrates on a nanosatellite bus. Finally, Systems Tool Kit; a software used to model and analyse space systems, is used to test the conceptual integrated design to validate the mission's feasibility. The outcome of this research is a comprehensive SAR dataset user requirement document, tailored to the hydrological characteristics necessary for monitoring water levels in Kogi State, Nigeria. Furthermore, technical reports and a feasibility study are presented, evaluating SAR payload sensors and designs that satisfy the user requirements, with emphasis on their integration onto a nanosatellite bus. The conceptual design specifications and test results are also presented in detail. Finally, summary and discussion of the outcomes, including the encountered challenges and recommendations are presented. These results provide technical insights and a framework for designing future SAR nanosatellite missions to detect and predict flood events to enable a fast early warning system that will aid in flood prediction and management.