Paper ID: 89157
oral

22nd IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Space Debris Detection, Tracking and Characterization - SST (1)

Author: Mr. Przemysław Żoładek
Cilium Engineering, Poland

Dr. Arkadiusz Chimicz
Poland
Mr. Arkadiusz Raj
Cilium Engineering, Poland
Mr. Jakub Lipiński
Cilium Engineering, Poland
Ms. Marta Kwiatkowska
Cilium Engineering, Poland
Mr. Jakub Suchecki
Cilium Engineering, Poland
Dr. Stanislaw Kozlowski
Cilium Engineering, Poland

ENHANCING SPACE SITUATIONAL AWARENESS THROUGH VERY AND ULTRA-WIDE FIELD OF VIEW OPTICAL SYSTEMS

Abstract

The ever-increasing population of space objects, including active satellites, debris, and near-earth objects (NEOs), presents a significant challenge for space situational awareness (SSA) and space traffic management. This study focuses on the deployment and operational efficacy of very and ultra-wide field of view (V/UWFOV) optical systems for the detection, tracking, and characterization of space objects. Leveraging a combination of quantitative and qualitative methodologies, this research evaluates the observational capabilities of these systems through extensive data collection and analysis almost 3 years.

The methodology encompasses a detailed examination of observational data acquired from a single pair of V/UWFOV optical triangulation stations as well as a network of such stations distributed globally. The analysis involves a comprehensive assessment of the systems' ability to detect and track objects on Low Earth Orbit (LEO) and describes conditions of observing at other orbital regimes including both 2D and 3D measurement strategies, with the latter being available exclusively with optical triangulation. Additionally, the study delves into the data processing pipeline, edge and cloud computing approaches, including synthetic tracking for dealing with low SNR scenarios.

The results of this study reveals the enhanced observational capabilities of V/UWFOV optical systems, highlighting their proficiency in achieving high coverage and detection rates of space objects. The findings demonstrate the systems' effectiveness in observing a diverse class of space objects, from small debris of 15 cm to large operational at LEO. Furthermore, the analysis of photometric characteristics provides valuable insights into the objects' sizes, albedo, and rotational properties, contributing to a deeper understanding of their physical and operational state.

A network of VUWFOV stations significantly amplifies the observational capacity, enabling near-continuous monitoring and tracking of objects, which is critical for timely and accurate SSA. The study also showcases the strategic placement of these stations to optimize coverage and data fidelity, thereby enhancing the quality and reliability of space object cataloging and tracking.

In conclusion, the adoption of V/UWFOV optical systems represents a substantial advancement in the field of SSA. This research not only contributes to the enhancement of space safety and sustainability but also provides a scalable and effective solution for addressing the growing challenges of space traffic management. The implications of these advancements extend beyond operational improvements, offering a foundation for future research and development in space surveillance and situational awareness technologies.