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Author: Mr. Joshua Critchley-Marrows
The University of Sydney, Australia

Dr. Xiaofeng Wu
The University of Sydney, Australia
Prof.Dr. Iver Cairns
The University of Sydney, Australia

AN ARCHITECTURE FOR A VISUAL-BASED PNT ALTERNATIVE

Abstract

The security and authenticity of Position, Navigation and Timing (PNT) for management of Low Earth Orbit (LEO) satellites has never been more crucial. With the growth of enormous mega constellations, and the increased activity of malicious actors in the space arena, PNT systems will need to be strengthened. Radio frequency (RF)-derived PNT is the dominant form being used in space today, leveraging off Global Navigation Satellite Systems (GNSS) and ground tracking infrastructure. Even though these mechanisms are highly accurate, they are also easily jammed and spoofed from malicious sources, as well as being limited in coverage and availability. Utilizing visual-based methods can be more reliable and not as restrictive.

Stars and celestial mediums have long been considered in attitude determination applications. However, a combination of these sources are being considered for positioning, where operating in tandem provide an ability for relative positioning to the celestial medium center. Visual light communication sensors are also being treated as a form of inter-satellite communication links. Akin to networks adopted in indoor positioning, laser pulses between each diode maybe used as a form of ranging. Simple satellite light glints could also support positioning if the satellite is identifiable and orbit known.

This paper proposes an architecture for a visual-based PNT alternative to support mega constellations, including future LEO GNSS constellations. The system presented is to be treated as a back-up and/or complimentary system to RF ranging, overcoming the primary systems identified limitations and risks. The application to terrestrial systems such as ships and aircraft, as well as lunar craft, is also treated. Essential parameters will be considered in the context of performance, such as availability and reliability, as well as accuracy and precision.