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AN APPROACH TO GROUND BASED SPACE SURVEILLANCE OF GEOSTATIONARY ON-ORBIT-SERVICING OPERATIONS

Abstract

On Orbit Servicing (OOS) is a new class of space missions which could extend the life of orbiting satellites by fuel replenishment, repair, or repurposing, and which could possibly reduce the rate of space debris generation. The success of the Orbital Express and ETS-VII missions, as well as the proposed Phoenix mission, shows that autonomous robotic satellite servicing is a possibility for future space activity. In geostationary orbit, satellite life extension by fuel replenishment, satellite inspection, antenna and solar array deployment correction, and electronics replacement offers new economic possibilities for satellite operators.

While there are considerable benefits to OOS missions, OOS operations pose a unique challenge for the optical space surveillance community. In a potential OOS mission occurring in geostationary orbit two satellites (the client and servicer) approach one another and begin performing proximity operations in tight formation flight with separations less than 200 meters. A ground based observer, observing the pair at long range, cannot separate and distinguish the two objects using traditional CCD imaging approaches. The two objects would appear merged on the detector plane as the inherent resolving power of the telescope and detector, coupled with atmospheric seeing, limits the ability to resolve and separate the two objects.

This paper discusses the progress of a doctoral thesis to address this observational problem where two geostationary objects cannot be differentiated as they separated by less than the seeing conditions at the observer's location. This paper explores cases where client and servicing satellites are in unforced relative motion flight (co-elliptic drift and Clohessy-Wiltshire football motion). Tools are described that exploit speckle interferometry to 1) determine the presence of a secondary in the vicinity of the client satellite and 2) estimate the servicing satellite's relative motion relative to the to the client. Experimental results are shown where observations of two co-located geostationary satellites, used as OOS observational proxies, were collected using the Mont Megantic 1.6m telescope equipped with a high frame rate Electron Multiplying CCD. The use of speckle interferometry can lead to an affordable means to determine the positions of satellites involved in OOS formation flight without need for adaptive optics approaches to resolve the two objects.