Space Situational Awareness at the Australian National University

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ABSTRACT

The Advanced Instrumentation and Technology Centre (AITC) of the Research School of Astronomy and Astrophysics of the Australian National University (ANU) has built instrumentation for ground-based astronomical telescopes for many years. The AITC has been developing instrumentation for the 4-meter Australian Astronomical Observatory telescope in Australia, the 8-10 meter Gemini, Subaru, and Keck telescopes in Hawaii, and the 8-meter Very Large Telescope and 25-meter Giant Magellan Telescope in Chile.

In more recent years, the AITC has expanded its endeavours to include space applications, notably the ground based monitoring of satellites and space debris. Such space situational awareness (SSA) activities are built upon the AITC's mature and internationally recognised expertise in lasers and adaptive optics as well as emergent technologies which are currently developed in the following fields of research:

Adaptive Optics

Adaptive Optics (AO) is a technique initially developed for astronomy to enhance the performance of ground-based telescopes. It can also be applied to track and image satellites and space debris at Low-Earth Orbit (LEO) and Geostationary Orbits (GEO).

The AITC has developed AO-enhanced imaging capabilities to gather information about the attitude and shape of objects in LEO providing significantly improved accuracy over standard imaging techniques. AO-enhanced telescopes can also deliver vastly improved position estimates of GEO objects by allowing higher accuracy comparisons with catalogued star positions via astrometry. The performance is enhanced by using a laser to create an 'artifical star' at 90 km height called a laser guide star. The AITC is currently developing the 4th generation of laser guide star systems making such a system smaller, more affordable and more efficient. Within the scope of the work of the Space Environment Research Centre, the AITC is also applying adaptive optics to precondition a more powerful laser to be able to nudge a debris object out of its orbit should a collision with that debris have been predicted.

Telescopes and Detectors

Robotic wide-field telescopes show significant potential for the automated survey of the sky for objects in orbit. The AITC has been developing several astronomical detector systems that are well suited to dual-use not only for astronomical, but also for space debris and satellites observations. Avalanche photodetector technology designed for infrared astronomical imaging and installed at the ANU 2.3m telescope can apply lucky imaging techniques to track Geostationary satellites.

Additionally, research telescopes dedicated to optical communications with satellites will be able to conduct survey activities when not actively performing communications tasks

Antarctic Observatories

The AITC is actively promoting the creation of an SSA observatory in Antarctica through international collaboration and staff with experience of the frozen continent. Antarctica is uniquely placed for observation of spacecraft in a wide variety of orbital regimes – particularly those in sun synchronous and polar obits. Antarctica offers exquisite atmospheric stability and optical transmission combined with a very dark background and long observation periods.

Radio Frequency Signal Processing

Steerable microwave receivers combined with the AITC's high performance computing facilities allow research into passive radar surveillance and the high precision position determination of radio emitters in orbit. The correlations between optical and wideband RF measurements are also being explored for object characterisation and identification.

This paper details ANU's research activities in the above areas providing satellite and debris tracking capabilities in the Southern Hemisphere.