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SYMPOSIUM ON TECHNOLOGICAL REQUIREMENTS FOR FUTURE SPACE ASTRONOMY AND SOLAR-SYSTEM SCIENCE MISSIONS (A7)
Technology Needs for Future Missions, Platforms (3)

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ASIST: ASTEROID SYNTHETIC IMAGING AND SPACE TRACKING

Abstract

Near-Earth objects, particularly near-Earth asteroids (NEAs) whose orbits cross that of the Earth, pose a significant threat and have been suggested as possible causes of planetary-wide extinction events in past geological timescales. More recently, the 2013 explosion of the Chelyabinsk asteroid over Russia was a timely reminder of the ever-present threat posed by asteroids. Russia has recently announced plans to modify Inter-Continental Ballistic Missiles (ICBMs) to make them capable of intercepting and destroying NEAs before they impact the Earth's surface. However, the major challenge still remains of accurately detecting near-Earth asteroids and determining their orbits.

Current asteroid detection and orbit detection methods rely on conventional imaging, where an asteroid is imaged over a long-exposure period using up to three exposures. Unfortunately, the long exposures necessary to image these faint objects introduces significant "smearing" of the asteroid image, especially those asteroids with smaller (¡0.6 miles) diameters and high velocities, and hence inaccuracies in its position and velocity measurements.

The ASIST approach proposes the use of synthetic aperture imaging techniques to greatly improve NEA position and velocity determination from CCD images. The technique involves the use of multiple stereoscopic images taken at a high frame rate, then post-processing the image frames to assign the detected photons from the asteroid over subsequent frames into the same tightly-grouped pixels. This creates asteroid images of greater apparent magnitude, with a decrease in smearing.

To demonstrate the application of this technique, a joint NASA JPL-University of Colorado research team proposes launching a JPL-developed ASIST CCD-imaging system on board a Colorado Space Grant Consortium (CSGC) RocketSat sub-orbital sounding vehicle, to test the technology and processing techniques, with the aim of increasing the Technology Readiness Level (TRL) of the current sensor system, and testing the ASIST technology under launch and high-jitter (vibration during imaging) environments.

This paper will present a preliminary description of the ASIST imaging system, the image processing techniques used to post-process the CCD images, and the plans for the suborbital in-flight demonstration campaign. Such technology development and evaluation will prove crucial for the development of future solar system astronomy / space science missions with near-Earth asteroid detection and orbit determination as their primary targets.