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# SMALL ASTEROID OPTICAL NAVIGATION USING KNOWN LANDMARK RECOGNITION

**Abstract**

Optical navigation using machine vision techniques is a key enabling technology for future space exploration missions that require pinpoint landing capability. The vision segment of the navigation chain may perform a combination of feature tracking and known landmark recognition, which together enable determination of the spacecraft motion from frame to frame and correction of the accumulated drift error.

The autonomous recognition of surface landmarks using images is a formidable task. Challenges include deriving landmark descriptors and recognition metrics that are robust to variations in the illumination and viewing angles, and determining when certain landmarks are obscured by intervening terrain. Existing methods may rely on craters or other such features as landmarks, but the presence of these cannot be guaranteed on small Solar systems bodies such as primitive asteroids.

We present a landmark mapping and autonomous recognition algorithm tailored to small asteroid missions, and developed in the context of the Marco Polo-R GNC system development study. Our method uses the sites of prominent Harris corners to provide stable known landmarks. Using an estimate of the spacecraft/asteroid frame transformation, the system performs an aided search for landmarks in the images and uses the detections to refine the position and attitude of the spacecraft. By triangulating the landmarks to obtain a rough surface mesh that tightly fits the asteroid surface, the system enables robust determination of the visible set of landmarks and can operate on any shape of asteroid including highly concave.