# ABSTRACT

Close Proximity Spacecraft Maneuvers Near Irregularly Shaped Small-bodies:
Hovering, Translation, and Descent

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Recently there has been significant interest in sending spacecraft to small-bodies in our solar system, such as asteroids, comets, and small planetary satellites, for the purpose of scientific study. It is believed that the composition of these bodies, unchanged for billions of years, can aid in understanding the formative period of our solar system. However, missions to small-bodies are difficult from a dynamical standpoint, complicated by the irregular shape and gravitational potential of the small-body, strong perturbations from solar radiation pressure and third body gravity, and significant uncertainty in the small-body parameters. This dissertation studies the spacecraft maneuvers required to enable a sampling mission in this unique dynamical environment, including station-keeping (hovering), translation, and descent.

The bulk of this work studies hovering maneuvers, where equilibrium is created at an arbitrary position by using thrusters to null the nominal spacecraft acceleration. Contributions include a numerical study of previous results on the stability of

hovering, a definition of the zero-velocity surface that exists in the vicinity of a hovering spacecraft (for time-invariant dynamics), and a dead-band hovering controller design that ensures the trajectory is bounded within a prescribed region. It is found that bounded hovering near the surface of a small-body can often be achieved using dead-band control on only one direction of motion; altitude measurements alone are often sufficient to implement this control.

A constant thrust strategy for translation and descent maneuvers appropriate for autonomous implementation is also presented and shown to accurately complete maneuvers in the vicinity of the initial position. Sensitivity analysis studies the effects of parameter uncertainty on these maneuvers.

The theory presented within is supported throughout with numerical analysis (software tools are described within) and test cases using models of real small-bodies.