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TALON AND CRADLE - SYSTEMS FOR THE RESCUE OF TUMBLING SPACECRAFT AND ASTRONAUTS

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Dunning Idle V, Ph.D.

Advanced pressure suit and tool designs are beginning to allow extravehicular astronauts to repair space vehicles and so increase mission life and system reliability. A common spacecraft failure that is a severe challenge to the rescue mission planner is loss of attitude control resulting in tumbling motion. If an extravehicular astronaut flying the Manned Maneuvering Unit (MMU) "falls" into a tumble, the result could be loss of life.

TALON (Tumble Arresting Large Oscillation Nullifier) is a device capable of capturing a target in an uncontrolled three-axis tumble. CRADLE (Concentric Rotating Astronaut Detumble Lifesaving Equipment) is a similar device sized to rescue a suited astronaut. The two rescue vehicles work on the same basic principle. They are structural shells with articulated limbs which can surround a tumbling target and thus align both the chaser and target centers of mass (CM).

Adjusting chaser mass geometry to match the target principal Inertia Moment Ratios (IMRs) enables the chaser to spin up into a torque free tumble that is identical to that of the target. The target will be motionless in the chaser frame and thus be easily grappled.

To automate TALON or CRADLE requires a knowledge of the target attitude, attitude rates, and inertia moment ratios. These can be obtained through computer analysis of data provided by either stereo video cameras or a laser range finder. By observing three non-colinear target surface points, we can use standard numerical estimation techniques to derive the target tumble state parameters, as well as the location of the center of mass.

Initializing the estimator requires *a priori* information concerning the target state. Consecutive body frame attitude can be used to find the direction and magnitude of angular velocity. This information, along with the direction of target angular momentum, can be used to find the locations of principal axes of inertia, as well as the ratios between principal moments of inertia. Searching for the body fixed point that travels the smallest distance in inertial space over the observation interval will lead to the location of the target CM.