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THE SELF-REFUELING REJUVENATOR: AN AUTONOMOUS PROBE FOR EXTENDING SATELLITE LIFE

Abstract

The world is rapidly advancing in the field of space technology, with the increasing number of satellites orbiting our planet. However, many of them are running low on fuel and nearing the end of their operational lives. To tackle this challenge, we plan to provide a design architecture for an innovative refueling probe that can refuel itself from an in-orbit fuel station and navigate with precision to reach targeted satellites. The probe is equipped with advanced Guidance, Navigation, and Control (GNC) Systems that use sensors, gyroscopes, accelerometers, and star trackers to determine the spacecraft's position, orientation, and velocity relative to the target satellite. Specialized sensors, such as LIDAR, radar, and optical cameras would accurately measure relative distance, relative velocities, and alignment with the target satellite during the rendezvous and docking process. Autonomous Rendezvous and Docking (ARD) systems plan and execute docking maneuvers. The docking mechanisms, such as docking ports, capture mechanisms, and docking rings, secure the spacecraft to the target satellite and enable the transfer of fuel as well as oxidizer. This AI-based probe can adapt to unforeseen obstacles and implement safety protocols to prevent any potential damage to the satellite or its surroundings. With its advanced capabilities, it can operate autonomously which would significantly reduce the need for human intervention and enable cost-effective satellite refueling missions. However, it is important to note that the probe can only provide refueling services to satellites that have their fuel port compatible with its design. Thus generating a need to standardize some of the propulsion subsystems like fuel ports in the future development of satellites to make the most of this technology. This technology promises to make satellite operations more sustainable and efficient, ensuring that we can make the most of our space assets for years to come.