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Author: Dr. Michael Woods
HEO Robotics, Australia, m.woods1987@gmail.com

Mr. William Crowe
Australia, crowe.william.james@gmail.com

HIGH EARTH ORBIT NECROMANCER FOR NEO CAPTURE AND RETRIEVAL

Abstract

Missions have been planned for asteroid rendezvous and capture that require large spacecraft and long mission times to achieve success. Capturing an asteroid and bringing it back into an earth orbit or into a distant retrograde orbit around the moon will allow for a greater amount of research and development to be performed. We describe a novel technique for a faster and possibly safer NEO capture and retrieval mission for a niche class of NEOs. To achieve this mission a spacecraft is designed named the Necromancer, which consists of a bank of electric engines, an optically tracked harpoon tether with regenerative braking, a docking mechanism as well as a reaction wheel. The technique consists of capturing a retired spacecraft and rigidly securing it to the Necromancer using the onboard docking mechanism, where the retired spacecraft will act as a ballast mass for the capture mission. Once a candidate NEO has been identified the Necromancer and ballast are accelerated to an intercept trajectory with that of the candidate NEO by the onboard bank of electric engines. The spacecraft is then tethered to the asteroid with a harpoon and utilises the ballast mass to achieve a momentum transfer through a Hitchhike maneuver to bring the NEO into an elliptical earth orbit for slow transfer to a final holding orbit. Such a mission could allow for a short lead time between the identification and rendezvous of a potential target asteroid as the spacecraft resides in a High Earth Orbit attached to the retired spacecraft. This research investigates the technology that is available and in development that could be used for such a mission, as well as identifying the NEO niche class that this technique is capable of capturing. The identified niche NEO class depends on both the engine efficiency as well as the tether material, with a time to intercept of approximately 30 days. The current technologies of electric propulsion engines and a Zylon tether, with a ballast mass of 5000kg, the achievable capture of a NEO is limited to a maximum NEO ΔV of $\sim$1km/s with a tether length of 100km. Future technologies with a Carbon Nanotube tether with the same 5000kg ballast mass would be able to achieve capture of an NEO with a maximum ΔV of $\sim$2km/s with 100km tether length.