ABSTRACTS (MASTER THESIS)

Orbital Deflection of Potentially Hazardous Asteroids Using Space Environment

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The aim of this study is to propose methods to deal with the potential threat posed by the asteroid with Earth collision probability.

The first method is a kinetic energy impactor (KEI), which impacts an asteroid with a projectile at a high relative velocity to deflect the asteroid. Our capabilities of deflecting such asteroid would be constrained by a reaction mass of a propulsion system. To solve this problem, we assumed an electric solar wind sail (E-sail) as a propulsion system. The E-sail uses the solar wind dynamic pressure to produce a continuous thrust without consuming fuel. To calculate the orbital motion of the E-sail, we proposed a calculation model considering the relations between E-sail attitude and its thrust direction. In addition, we suggested a new orbital maneuver not changing sail plane's angle but controlling thrust magnitude. Trajectory optimizations for E-sail KEI were performed on a fictional impact scenario, which was comprised of a million tons of asteroid detection on January 1, 2015, and the Earth impacting on January 1, 2030. The results showed that the projectile could yield the relative impact velocity up to 14 km/s and cause the deflection distance of 8000 km at the predicted Earth collision date.

As a second method, we studied a Coulomb force attractor, which tows the asteroid by means of Coulomb force produced by artificially charging both a spacecraft and the asteroid. By introducing the results of previous study, such as charging technique for the asteroid and magnitude of Coulomb force, we formulated the dynamics of the problem. Through numerical simulations, the performance of the Coulomb force attractor was examined. The results showed that a 500 kg spacecraft charged to 20 kV could achieve about 800 m change in orbit of a million tons of asteroid charged to -20 kV with a completion time of 1 year. This value was about 1.3 times better than the result of traditional gravity tractor. By performing this simulation for the fictional impact scenario, the resulting deflection distance was also investigated. The deflection distance became about 6 km and this value would be enough for performing the pre gravitational keyhole deflection missions, which make the asteroid orbit away from the small region.