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Author: Mr. Ryota Inoue
Hokkaido University, Japan

ORBITAL DEFLECTION METHOD OF POTENTIALLY HAZARDOUS ASTEROIDS USING THE INTERACTION BETWEEN TWO ASTEROIDS

Abstract

Humankind needs a new method of controlling the orbit of an asteroid in order to avoid an Earth-asteroid collision because existing technology cannot achieve the specifications of a spacecraft which previous methods need for an asteroid of over 100 m in diameter. Typical previous methods include Kinetic Impactor, which impacts a spacecraft to an asteroid and Gravitational Tractor, which uses the gravity acting between a spacecraft and an asteroid.

Therefore, this work attempts to propose a new method of controlling the orbit of an asteroid and to discuss the feasibility of the proposed method. In order to discuss the feasibility, this work will clarify the specifications of the required spacecraft by carrying out mission design and flight system design in the proposed method. This paper proposes the new method and presents the way of mission design.

The proposed method uses the force acting between a hazardous asteroid (HA) and another small asteroid (SA). The SA takes the place of a spacecraft of Kinetic Impactor and Gravitational Tractor. The following is the procedure. 1) The spacecraft launched from the Earth goes to the SA. 2) The spacecraft rendezvous with the SA. 3) The spacecraft controls the orbit of the SA and the SA goes to the HA. 4) The SA deflects the HA by altering the momentum of the HA. If the HA is 1 km in diameter and the SA is used as an impactor of Kinetic Impactor, the SA of about 12 m in diameter (about 1800 t) has to impact the HA 10 years in advance at relative speed of 20 km/s.

The proposed method has two advantages over previous methods. One of them is that the spacecraft launched from the Earth in the proposed method weighs less than that in previous methods. The other is that the SA, which alters the momentum of the HA in the proposed method can go to the HA more easily than the heavy spacecraft, which alters the momentum of the HA in previous methods.

The following is the procedure of mission design. 1) Setting the orbital elements and the mass of the HA by reference to the potentially hazardous asteroids. 2) Narrowing down the list of Near-Earth Asteroids to the options of the SA which can easily go to the HA. 3) Designing the trajectory of the CA leading to the HA by using Direct Collocation with Nonlinear Programming.