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Terminal Guidance Design and Simulation for Asteroid Guided Collision Missions

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With the development of asteroid capture technology, a novel concept of planetary defense has recently been proposed. This concept plans to redirect a smaller asteroid (α Asteroid) and to drive it to collide with a larger Near-Earth-Object (β Asteroid) which has the potential to impact the Earth. Compared to the traditional kinetic impactor that is directly launched from Earth, this technology takes the advantage of using much greater natural kinetic energy to eliminate the risk of asteroid impact. Since the kinetic impactor carrying asteroid has very large mass($> 1 \times 10^5 kg$) and high relative speed($> 5km/s$), the terminal guidance system should be highly precise and have strong real-time performance.

So far, no rigorous algorithm design and accuracy analysis have been performed for the terminal guidance system of the mission mentioned above. It is not clear how the huge mass of the α asteroid and other key parameters will affect the propulsion requirements and the guidance accuracy during the terminal guidance phase. Therefore, the feasibility of this concept still needs further discussion. In this paper, the method of proportional guidance and predictive correction guidance is used to design the terminal guidance strategy of the asteroid guided collision mission, and a Monte Carlo simulation is carried out in order to validate the reliability of the guidance system. The effects of maneuver timing and impact target point selection on guidance performance are studied. In addition, the sensitivity of the terminal guidance accuracy to the mass of the α asteroid along with the size and shape of the β asteroid is also analyzed in detail.

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