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# AUTONOMOUS ORBIT DETERMINATION FOR PERIODIC ORBITS AROUND BINARY ASTEROID

**Abstract**

It is estimated that about 16% of Near-Earth Asteroid are binary systems. Studying on binary asteroids and the periodic orbits around them have special configurations in the natural dynamics as well as the formation mechanism of celestial bodies in the Solar system. While due to the sophisticated dynamic environment of the binary system, the orbit determination of spacecraft on periodic orbit in proximity to binary asteroid can be difficult to achieve. Besides, because of the unstable condition of periodic orbits around L2 point, high precision of orbit determination based on Earth observations is hard to acquire.

This paper investigates the feasibility of autonomous orbit determination of spacecraft on periodic orbits in proximity to binary asteroid 1996 FG3. Near-Earth object 1996 FG3 is a rare-type carbonaceous binary asteroid as well as a potential hazard to Earth. In this paper, taking the irregular asteroid gravity field into account, the equation of motion, the effective potential and the periodic orbits family of FG3 are first studied. Following this, autonomous navigation of spacecraft on various periodic orbits family are achieved via crosslink range measurement. Different orbit determination precisions of periodic orbits family are compared and analyzed. Besides, the potential to correct model errors (e.g. the gravity coefficients) is discussed. Dynamics-based observability analyses are performed to show how the irregular gravity of the binary asteroid contributes to the orbit determination. The results illustrate that the position and velocity errors can both converge, and the 3-sigma orbit determination accuracy over 7 days can be as accurate as 100m if taking two orbiters.

The results of this paper have a good reference for the periodic orbit autonomous navigation of binary asteroids, and can be applied to scientific explorations on other small celestial bodies.