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# IDENTIFICATION OF NEAR-EARTH ASTEROIDS USING MULTI-SPACECRAFT SYSTEMS

**Abstract**

Through numerous survey efforts over the past decades, humanity has achieved substantial knowledge of the near-Earth asteroid (NEA) population. Nevertheless, survey completeness at small asteroid sizes is still limited, and unannounced impacts, such as the 2013 Chelyabinsk meteor, are common enough to warrant further identification efforts. Because of the limitations of Earth-based surveys, several works have already investigated a NEA cataloguing survey from deep space using a single spacecraft. We propose an extension to this idea, where a multi-spacecraft system in orbit around the Sun is utilized to perform such a survey. This offers several distinct advantages over a single spacecraft system, such as a decrease in blind spots due to solar interference, faster asteroid orbit determination through triangulation, and the possibility for more advanced search strategies.

A survey simulation tool was developed to predict the expected survey completeness for a range of design parameters of the survey using a sample population of NEAs. Investigated parameters include the number of spacecraft; their payload, either visual light or thermal infrared telescopes; and the semi-major axis, eccentricity and mean anomaly of their heliocentric orbits. At each timestep in the 5-year simulation, the tool calculates the target and background signal from each asteroid to each spacecraft. From these, the signal-to-noise ratio is determined which is used in a probabilistic detection model. Lastly, if sufficient detections are established in a 90-day period, the asteroid is labeled as identified.

Initially, co-orbital configurations of spacecraft are studied, where all spacecraft are located in the same orbit, but spaced apart. It is found that a circular orbit with the spacecraft distributed evenly across the orbit provides the best results and that thermal infrared telescopes outperform visual light telescopes in all conditions. The optimal semi-major axis increases with increasing number of spacecraft, starting at 0.9AU for a single spacecraft, increasing by 0.03AU per additional spacecraft. The findings are supported by a novel hypothesis that relates the expected survey completeness to the volume of space in which NEAs at varying limiting magnitudes can be effectively detected. Non-co-orbital arrangements are investigated using a preliminary Bayesian optimization process and so far indicate no significant performance increase compared to the co-orbital configurations. As a general conclusion, performance predictions indicate that a multi-spacecraft system of 2-3 spacecraft will identify 40-60% more NEAs than a single spacecraft, with strong diminishing returns for larger numbers of spacecraft.