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Development of a simulation model to estimate the risk of an asteroid colliding with the Earth, based on the trajectory, velocity of the asteroid, and the location of the Earth

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Asteroids are small bodies that orbit around the sun on trajectories that are dominated by solar gravitational attraction. Predicting trajectories of asteroids traveling into the inner solar system is a necessity to mitigate the risk of potentially threatening asteroids to Earth. Inverse problem and the least square method are the foundation for most of the orbital computation methods developed over the past decade. Including linear, semi-linear, and non-linear methods, various new solutions to the inverse problem of orbit computation have been devised throughout the past few years. Asteroid observations from ground and space observation centers using radar, laser, and other methods have gained the interest of scientists. Many types of research have been carried out on determining trajectories for Near-Earth asteroids but further studies are being done to find a more accurate method. The main aim of this research was to develop a computer simulation model to predict the asteroid trajectories. The model was developed using basic equations of an ellipse in a 2-D cartesian coordinate system. Eccentricity, perihelion distance, semi-major axis, inclination, mean anomaly, period of an asteroid and a term introduced to cover the perturbation effects were used to create the equation. These results were obtained only considering the sun's gravitational attraction force on the asteroid. The developed equation was used to create a computer simulation model. This simulation can predict the distance between Earth and an asteroid up to several future decades so that we can identify the potentially threatening near-Earth asteroids early enough to take an action. Data obtained using the simulation were compared with the data available in the NASA JPL small body database browser website. The mean percentage error for distance between Earth and a given asteroid at a given date was below 20% for each asteroid compared to available NASA data. This research was conducted as an initial step to develop a more efficient and precise trajectory determination model than the existing ones. The accuracy of this simulation model can be increased by incorporating the gravitational effect of other planets, nearby asteroids, and the effect of solar wind into the perturbation term.

Keywords: potentially hazard near Earth asteroids, asteroid trajectory determination

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