NASA DART Mission: a preliminary mathematical dynamical model and its nonlinear circuit emulation

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Abstract. On the last September 22nd, 2022 a NASA Spacecraft try to deflect the orbit of the asteroid Dimorphos orbiting around Didymos. The orbit of Dimorphos had been shortned of about 32 minutes with respect to the original one. In this communication, it is proposed a simple mathematical model that allows to emulate the DART mission behavior.

Introduction

The problem is approached referring to the Kepler two-bodies problem. That leads to a set of six differential equations model in the state-space representation. The model is highly nonlinear and the condition that emulates the experiment is approached by varying the initial condition of the small mass asteroid during its dynamical behavior. The numerical problem has been approached both by using the Eulero methods and the classical 5th order Runge Kutta algorithm [1]. Moreover, it is in progress the realization of an analog electronic circuit emulator of the system that allows to realize faster and qualitative more efficient experiments.

Results and discussion

The obtained results derived by a trial and error procedure leading to suitable results compared with the experimental trajectory given from NASA [2].
The preliminary study is addressed to stimulate the interest of researchers in approaching the deflection of asteroids as a trajectory control problem and to work on the model of the coupled asteroids in order to have a reliable simulation platform also including hybrid configurations with both digital and analog computational units.

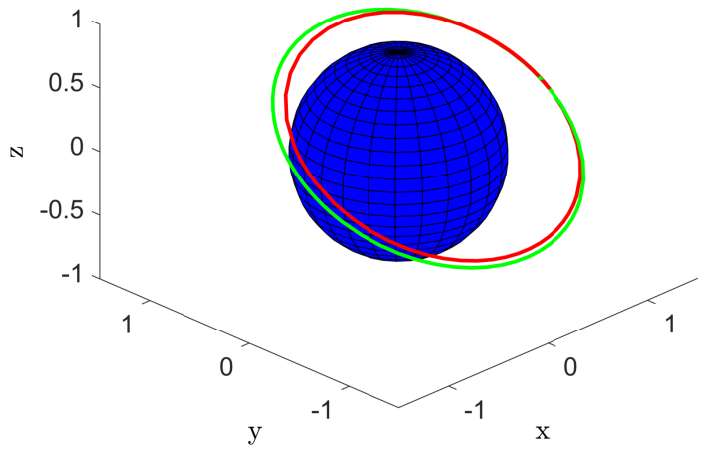

Figure 1: Experimental results of modeling DART mission: original trajectory (green curve), controlled trajectory (red curve).

References

[1] Curtis, H. (2013). Orbital mechanics for engineering students. Butterworth-Heinemann.
[2] `https://www.nasa.gov/press-release/nasa-confirms-dart-mission-impact-changed-asteroid-s-motion-in-space` (accessed on November 25th, 2022)