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Author: Mr. Diego Pérez Reyes
Instituto Tecnológico Autónomo de México, Mexico, dperezr1@itam.mx

Mr. Isaac Alejandro Pimentel Morales
Instituto Tecnológico Autónomo de México, Mexico, isaac.pimentel@itam.mx
Mr. Luis Felipe Castro Corrales
Instituto Tecnológico Autónomo de México, Mexico, felipecastroc19@gmail.com

A QUANTUM ANNEALING APPROACH TO ANALYZE THE SPACE DEBRIS EVOLUTION IN THE LOW EARTH ORBIT.

Abstract

Recently, and ever since the beginning of space exploration, the number of objects on Earth's orbit has increased drastically. So does the risk of collision between them and future object yet to be launched. In order to prevent such collisions, it is necessary to predict the future development of the debris. This is important, for example, in the telecommunication industry that operates in densely populated regions. To do so, simulations are done based on initial assumptions like the launch rate, the probability distribution of success of post mission disposal measures and the likelihood for catastrophic collisions. Monte-Carlo method is employed for the random sampling of the defined events despite it being computationally expensive. A propagator to determine potential collision partners by processing each object is also needed, demanding more computation power. Quantum computation performs calculations by using devices that take advantage of quantum mechanics phenomena instead of classical physics based electronics. Currently, general purpose quantum computers are far from being practical; nonetheless, special purpose quantum computers can exceed the computational power of their modern general purpose peers. A prominent example is the quantum computer developed by D-wave, which implements the quantum annealing model for optimization problems solving. In this paper a quantum approach to classic analytical models is presented. Classical models are based on source and sink mechanisms, like collisions, launches and explosions. These analytical models can be used to decrease the computational complexity and effort by using pre-computed tables for orbital lifetimes and decay rates. A quantum annealing implementation of quantum computation can be used for Monte-Carlo simulations. The quantum model, by taking advantage of the faster response of quantum computation, can simulate the debris environment with multiple objects, intact and fragmented, on circular and eccentric orbits. The paper concludes by showing the preliminary results and a discussion of the quantum approach, which allows to be fitted against classical analytical models and Monte-Carlo simulations both on results and time.