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FLIGHT TRAJECTORY AND RECOVERY OPTIMIZATION OF A MODEL ROCKET THROUGH A SYSTEM OF ACTIVE AND PASSIVE STABILITY ELEMENTS DESIGNED FROM TENSEGRITY STRUCTURES

Abstract

In Costa Rica, the practice of rocketry is hindered by several reasons, one of which is the irregular topography of the territory and the existence of vast protected areas that are mostly adjacent to populated zones, making it challenging to find launch spots that comply with international safety regulations. In response to this problem, this research aims at presenting an innovative design containing both passive and active stabilization elements using tensegrity principles in its structure, in order to adapt rocketry to the conditions of the locality. In that manner, it is proposed to analyze the interaction between the set of integrated systems to optimize the flight and recovery of model rockets in reduced areas safely and effectively, while decreasing the impact on the communities and their surrounding environment. Analogously, the proposal consists of two main elements: a fuselage with the ability to absorb and redistribute impact energy based on tensegrity principles, allowing for better control of the vehicle during recovery; and fins that use flat tensegrity to improve the rocket's aerodynamic performance, by adapting themselves to specific conditions of the environment at each flight stage, as a means to minimize possible deviations caused by changes in the inclination angle during flight or air resistance during descent. In addition to this, it is suggested to include secondary elements for an assisted rocket's stability optimization, such as thrust vector control (TVC) to keep the motor's thrust parallel to the vehicle's longitudinal axis and a parachute with adjusted dimensions to control the descent speed, while also reducing the horizontal displacement rate caused by air resistance, which will be compensated for by the previously suggested fuselage during the fall, absorbing the impact to protect the payload. Furthermore, the development of these elements created from tensegrity models, offers an opportunity to the rocketry practicing people around the world who are in surroundings as topographically challenging as those in Costa Rica. To this extent, we would be able to create accessible and easily controllable systems to optimize flight and recovery trajectories, as well as improve the rocket's aerodynamic performance.