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# OPTIMIZATION OF COMPONENT DISTRIBUTION IN A PICOSATELLITE BASED ON INERTIAL CONSTRAINTS

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## ABSTRACT

The design, development and implementation of picosatellites, have become one practice that promotes the interaction of different areas from engineering, and begin to be important in countries that do not have an important aerospace development. This type of projects is highly restrictive to the available space and the total mass, considering that, as low cost experimental payloads, it must take just a little useful space in the commercial launchers. Therefore, the distribution of the elements within the structure of the satellite becomes critic and it is needed the control about the total mass. Additionally, with the purpose of improving the attitude behaviour control of the satellite at the space, it is required a distribution of the mass in the structure, looking for the coincidence of the centre of gravity (COG) and centre of mass (COM), as well as assuring a safe launching that it does not cause damages associated to the vibrations.

The diversity of elements that compose the electronic cards, and other elements of the mission such as cameras, wheels of inertia, power systems etc, all of them made with a great variety of materials, sizes, shapes and particular locations, produces a completely heterogeneous distribution of mass. In order to control the mass distribution, with a minimum weight and static and dynamical performance above lower limits, it is needed to optimize the configuration of the satellite elements; the main goal is to establish the best location of electronic cards and additional elements in a defined and restricted space in the picosatellite structure.

The task involves defining a multiobjective optimization problem of minimum mass, coincidence of centres geometric and mass and controlled static and vibrational behaviour. The technique that better comes near to the conditions of the problem, according to the previous reviews, corresponds to the evolutionary algorithms [1],[2].

The selected evolutionary algorithm was a genetic algorithm (GA) adjusted for multiobjective optimization problems, the work was based on the Genetic Algorithm Multi Evolutionary (GAME) described in [3] and [4], and adjusted for constraint

handling properly,[5]. The objective functions were minimum mass and minimum difference of COG and COM, subject to inertial, [6], [7], statical, dynamical, collision and functional constraints, [3].

Initially the team worked with a model of dispersed masses around an origin of coordinates, which contributed to create the problem using FEM. Later with a 3D CAD models, different distributions was represented which included the structure of picosatellite and basic elements of electronic cards, it was assigned materials to the most of elements in order to use material densities in the problem. At the end, it was defined the useful parameters for working properly with the purposed optimization problem. The problem solution, was developed using a *Matlab* interface, the model using simple forms gave good results however it was needed a long time to obtain acceptable configurations. The model was refined for including complex electronic cards, only the variation of distribution was restricted just for one coordinate axis (y axis) in order to obtain faster solutions. The model was proved with different configurations and let obtain good results for implementing at the real model. At this time the final configuration of the payload is not finished because the critical design stage of the project is not finished yet, however the model is still running for the new applications.

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