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# DEVELOPMENT OF OPTIMAL DESIGN FRAMEWORK FOR SATELLITE STRUCTURE

**Abstract**

Satellites are exposed to harsh conditions during its lifetime from launch to operation. Design of such a space structure should be guaranteed in the view of its reliability and survivability. Meanwhile the cost to launch is closely related to the total mass of satellite system so that the minimization of mass is very important issue. To get the best design of satellite bus system usually parametric studies are conducted. But it takes tedious efforts.

Here we implemented optimization framework based on graphic user interface environment so that once initial design was given, it is automatically improved to have better fitness. Designer can easily and rapidly improve the details of satellite bus system.

Initial FEM model is made to have about 10M DOF by the preprocessor, MSC.Patran. Once pre-design data is imported into the optimization framework, design variables are selected among thicknesses of panels and platforms, dimensions to determine shapes of cross section of longeron and rail. Then, later FEM data for every modified design are automatically generated by framework.

The framework adopts in-house analysis program so that hundreds of precise simulations are utilized to evaluate stiffness, strength and stability. In terms of constraint conditions, the first natural frequency of the design case should be over particular frequency which is exciting vibration by launcher. In this work, it is taken as 18Hz. Moreover, it is given high acceleration during initial launching stage. The structure should endure enormous quasi-static acceleration load. Thus maximum allowable stress of some part such as a bolt should be limited. Also struts supporting nadir platform and propulsion tank should not be bifurcated by compressive loading. Consequently, The FEM analysis module conducts simulations of normal mode analysis, linear static analysis and linear buckling analysis for the individual design case.

Optimal design of satellite structure based on high-fidelity simulation with large number of design parameter and with large number of DOF takes long time for function evaluation and it is required to avoid local minimum. Particle swarm optimization algorithm, which is based on the social behavior metaphor, is gaining attention as non-gradient based global optimization methods. It is suitable for our problem.

In the point of external appearance, status and temporary results are displaced on window at every updated step, while the program is running. Mass history with time can be checked in pop-up window in real time. History of each design variable can be checked switching the pull-down menu. All of those user interface were implemented with Open-CASCADE, OpenGL-based open source library.