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Author: Mr. Marc Prat
UPC - Politechnical University of Catalonia, Spain

AN EVOLUTIONARY DESIGN METHOD FOR OPTIMIZING SPACECRAFT

Abstract

The design of spacecraft is a complex task involving many people, many months, and many different tools. So any method that could make this step easier and faster would be a really interesting field research. This is the case of Evolutionary Algorithms.

The process-led management of requirements, and their iteration into design decisions, is a continual struggle between risk mitigation and project budget. The present project examines alternative tool concepts that can accelerate certain design activities and simplify trade-off analysis by taking advantage of a simulation of natural evolution. Evolutionary algorithms, including in particular genetic algorithms, mimic natural selection by evaluating a particular individual's fitness within a population, and allowing characteristics of that individual to be passed to future generations with a certain probability as a function of the fitness. Although it may not seem obvious that Evolutionary Algorithms can solve optimization problems, the application of the technique to numerous problems across a wide diversity of fields has shown that it really does. The ultimate proof of the utility of the approach possibly lies with the demonstrated success of life on Earth.

This paper reviews the application of genetic algorithms to spacecraft design, highlights the strengths and limitations, and shows how an evolutionary tool can be incorporated into the traditional design lifecycle of a space mission. This is followed by the design and results of a prototype tool developed at UPC, including a comparison of the results obtained with the real projects already flown. Finally, the applicability of evolutionary computing in other phases of the mission lifecycle is also discussed, and the paper concludes with recommendations and lessons learned.