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OPTIMAL ARCHITECTURES FOR A MARS HELICOPTER DRONE: EXPLORING THE DESIGN SPACE WITH GEEGLEE

Abstract

As we envisage new space exploration missions and innovative space systems, it is crucial to make the right architectural choices. Indeed, it is well-known that the early design decisions are the main drivers for the life cycle costs of a system. More generally, architectural choices determine the technical and economic performance of a programme, and hence its success. Not only can bad architectural choices require costly design iterations, but they can even lead to project failure. On the other hand, good architectural choices will boost the technico-economic performance of a system and provide a competitive edge. State-of-the-art design methods mainly focus on optimizing concepts and exploring the design space for a few candidate architectures. The preceding down-selection of architectures, when not completely overlooked, often involves brainstorming alternatives for each functional module and rapidly selecting a few combinations of these alternatives among the combinatorial architectural design space. The resulting architecture candidates usually consist of a few breakthrough architectures as well as a few derivatives of existing architectures.

In this paper, we identify optimal architectures for a Mars helicopter drone, with a focus on the architectural choices regarding the main functions, such as the lift generation function. We implement an innovative methodology, supported by Geeglee®, a software tool that explores the architectural design space and enables the user to identify the best system architectures. From a set of alternatives for each main functional module, Geeglee® automates the generation of the combinatorial architectural design space and the evaluation of the performance for the thousands of architecture alternatives. Beforehand, a systems engineering approach is used to formalize the Geeglee® input models and to capture the disciplinary expertise in order to evaluate the dozens of relevant performance criteria. The resulting architectural design space for the Mars helicopter drone is then integrated to the Geeglee® Engineering Intelligence Platform, an interactive decision-making environment which enables the user to navigate through the design space, define constraints on the various performance criteria, play what-if scenarios, perform trade-offs, and identify the architectures that best answer the needs while minimizing the risk for the subsequent design phases.