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Author: Mr. Srikara Cherukuri
Delft University of Technology (TU Delft), The Netherlands, The Netherlands,
srikara.cherukuri@gmail.com

Mr. Kartik Kumar
satsearch.co, The Netherlands, kartik@satsearch.co
Ir Ron Noomen
Delft University of Technology (TU Delft), The Netherlands, R.Noomen@LR.TUDelft.nl
Mr. Narayan Prasad Nagendra
satsearch.co, The Netherlands, narayan@satsearch.co

INTEGRATING HARDWARE DATA INTO SIMULATIONS FOR ATTITUDE CONTROL DESIGN

Abstract

Space mission design is typically split into a series of sequential design phases. During the pre-phase A (preliminary design study), the system/mission definition is translated into functional requirements (subsystem-level). These requirements are used to steer the design process, leading to candidate mission architectures and associated concepts (Concept Exploration Phase; CEP). The identified mission concepts are then traded off at system level, leading to the identification of a preferred mission concept and a possible list of feasible alternatives.

At present, the design process is highly document-centric. Space engineers are typically required to manually copy information from unstructured documents, e.g., technical specifications from PDF datasheets, to obtain the inputs that are necessary to determine concept feasibility through simulations. The large manual effort required to assess feasible concepts within the defined search space in this manner, restricts the ability of the engineer to explore the design space thoroughly and identify a subset of optimal solutions.

In this paper, we explore the use of structured datasheets to automate the process of injecting hardware data into simulation models. This process is denoted ‘Integrated Mission Design’ (IMD). The IMD approach utilizes hardware specifications that are captured within structured datasheets to enable the engineer to programmatically assess the feasibility and performance of different commercial-off-the-shelf products (COTS).

We apply this approach to the design of the attitude control subsystem of a small satellite. Although we do not propose a formal ontology in this study, we define a schema consisting of generalized attributes to describe attitude control hardware like thrusters and reaction wheels. For the purposes of our research, we make use of the satsearch database (https://satsearch.co), which has been built by translating unstructured PDF datasheets into electronic, structured format. Our investigation contrasts the use of IMD to the traditional, document-centric methodology, focussing on robustness and sensitivity analysis.

In future, this research will be explored further to assess the ability of IMD to capture the reasoning of the (sub)system experts within a computerized system. A Digital Engineering Assistant (DEA), powered by IMD, would enable engineers to rapidly assess design options and efficiently identify optimal and robust mission concepts.