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ARCHITECTURE OF A GENERATIVE DESIGN TOOL FOR SPACECRAFT AND USER
FRONT-END IMPLEMENTATION THROUGH A CHATBOT SMART DESIGN ASSISTANT

Abstract

This work presents the architecture of a generative design tool that supports decision-making during the conceptual design of space missions. The tool generates the technical specifications of a spacecraft given a high-level mission statement expressed in natural language by the user. The tool includes a chatbot front-end which can be employed by users to query the model and ask questions on the design of the mission of interest. The work demonstrates the utility of the tool both as means of a design aid for engineers but also for augmentation of the dataset and underlying language model themselves.

The work is in the frame of the design and construction of space missions and spacecraft, which have evolved significantly over the past few decades. Space mission design processes still rely heavily on human intervention despite the availability of large flight heritage data for varied types of missions and satellites, which can be handled in unprecedented ways by machine learning models. Advancements in computational power and in such machine learning techniques -particularly in transformer architectures for language- offer now however the potential to automate and speed up the design process, reducing even more costs and barriers to access space.

In this paper we demonstrate a use case of our generative design tool prototype focused on Earth Observation missions. The goal of the prototype is to select instruments and provide key technical specification ranges starting from user needs expressed in natural language. Users can interact with the tool through a chatbot implementation. The bot provides opportunity for user feedback to further refine the answer provided by the tool and converge iteratively to a technically feasible solution. Future iterations of the tool will include broadening the scope to a wider variety of satellite missions, as well as extending the scope of the tool to additional tasks in the conceptual design process, such as translating technical specifications to a CAD configuration model of the spacecraft involved as well as orbit design and other relevant design tasks.