IAF SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Engineering - Methods, Processes and Tools (2) (4B)

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LARGE LANGUAGE MODEL APPLICATIONS TO SPACE SYSTEMS ENGINEERING

Abstract

Recent developments in large language models (LLM) have made them the topic of much media coverage and made the technology accessible to the general audience, including space systems engineers. Past research has explored the application of Natural Language Processing to space systems, notably engineering document analysis. Most of the research has focused on two areas: requirements engineering and analysis of documents from space systems engineering project reviews. The literature on engineering requirements covers use cases of information extraction, requirement quality assessment, and requirement template conformance. The literature on project review documents has mostly focused on information extraction, automated (or assisted) system model generation, and populating databases with the intention of reuse. In this paper, we develop a much larger scope of assistance applications enabled by large language models and focus on their generative power. We carry out a full analysis along the System Engineering V-model and point out interesting applications within the scope of the new language models while illustrating with real examples. We show both where we expect LLMs to make a major impact through new functionalities that were previously not available, but also where LLMs are unlikely to make any disruption at this moment in time. The phases where we expect LLMs will make the largest impact is the stakeholder expectation, requirement generation, and functional and logical decomposition phase. It will also be relevant for the generation of test procedures. LLMs will play a smaller role in the modeling and simulation phases of the preliminary and detailed design phases. During the system assembly, integration, and test phase, it will be useful in assisting the understanding of assembly drawings, instructions, and procedures. In the operational phases, LLMs will assist in retrieving relevant past information through the intuitive interface of natural language. We finalize our discussion on warnings about the validation steps that will be required ahead of the industrial-scale application of LLMs to assist with Systems Engineering.