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MULTI-FACETED AI MODEL FOR COMPREHENSIVE SPACECRAFT OPERATIONS

Abstract

The spacecraft industry is going through a rapid change in eco system with more and more opportunities now available for private industries to venture and commercialize the space sector. This has led to inventions with the main aim to cut down the cost of operating spacecrafts with the use of AI technologies. As AI has grown leaps and bounds in recent times owing to tremendous research outcomes, its potential has reached nooks and corners of every possible industry. With the above aim in mind we propose a complete architecture for spacecraft operations to reduce the human involvement and to provide more insights for making timely actions when human involvement is in need. Spacecraft operations involves all the process to maintain a space asset in orbit to carry out the intended payload operations designed as part of the space asset. It involves making the mission plan of operations to be carried out and the preparation of commands for the plan and the overall monitoring of the satellite telemetry for any anomalous signatures. We propose a multi-faceted AI model to achieve all these requirements. Basically, we have a Data visualization model to analyse and visualize the telemetry data, a deep learning based model for identifying anomalous signatures in the satellite telemetry and a AI agent based on LLM for providing assistance in mission operation planning. Thus comprehensively allowing for a complete package to handle mission operations management. The data visualization model has the capability to analyse the entirety of telemetry data and provide the user with various format options for better understanding of the data. The anomaly detection model utilizes all the latest LSTM based autoencoders and the options to switch to multiple other strategies as needed like GANs or Transformers based for anomaly detection. This provides timely alerts for corrective actions to be carried out to protect the space assets. Lastly, we have a Llama based LLM agent for providing assistance to the users in mission operations planning and management. Combining, all the three packages has provided us with an efficient tool to automate the process in spacecraft operations and thus reducing the overall cost of the ground segment operations.