IAF SPACE SYSTEMS SYMPOSIUM (D1)
Technologies to Enable Space Systems (3)

Author: Ms. Sapna Rao
Lockheed Martin (Space Systems Company), United States, sapna.rao@lmco.com

Dr. Christine Edwards
Lockheed Martin (Space Systems Company), United States, christine.m.edwards@lmco.com

DIGITAL TWIN AND ARTIFICIAL INTELLIGENCE ENABLING INNOVATIVE SPACECRAFT DESIGN, DEVELOPMENT, AND FLIGHT

Abstract

The space industry is beginning to implement digital twin to design, develop, and test spacecraft. Digital twin encompasses the entire spacecraft lifecycle and digitally links the spacecraft architecture, design, mission conops, test, validation, and more. This enables digital twin to incorporate new and unique features, such as automated and cascading updates across the system. Systems analysis is also enhanced by using higher fidelity models of interfaces between subsystems and components. Additionally, spacecraft design within digital twin allows for simulations and frequent testing earlier in the design process. This paper details these applications and introduces how digital twin provides the foundation to incorporate artificial intelligence and machine learning (AI/ML).

The fourth industrial revolution is well underway. Machine learning and artificial intelligence are advancing at a rapid pace and transforming industries, and digital twin is one such example. It provides the foundation (data, structure, and environment) to incorporate AI/ML and the latest data-science approaches to further enhance the capability and potential of digital twin. Lockheed Martin recognizes this symbiotic relationship and is performing cutting-edge research to develop and implement AI/ML within digital twin for critical areas. These key applications include cognitive assistants, fault and anomaly detection, spacecraft health monitoring, feature detection, and data utilization. Cognitive assistants aid in the design process through AR and VR, and during flight through voice recognition. Fault and anomaly detection exploits the vast amount of data collected during spacecraft test to improve detection accuracy and speed. Spacecraft health monitoring aids the mission operations team to detect and predict spacecraft health issues during flight, which informs future software patches as well as hardware improvements on subsequent spacecraft. Feature detection enables spacecraft to identify key areas on planetary bodies for landing, sample collection, and triangulations for location determination. Data utilization includes best practices in data science around collecting and analyzing data, as well as extracting key insights from the data for life-critical applications. All of these AI/ML enabled applications are part of digital twin and this paper will dive deeper into each of these areas.