Challenges of Life Support/Medical Support for Human Missions (8)
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TECHNICAL REQUIREMENTS FOR AUTONOMOUS AI-ENABLED HEALTHCARE DIAGNOSTICS IN SPACE

Abstract

Purpose: As crewed space exploration missions aspire to reach interplanetary destinations to Moon, Mars, and beyond, they will require multidisciplinary engineering capabilities with increased safety, efficiency, autonomy, and sustainable logistics. The convergence of clinical decision support systems (CDSS) and artificial intelligence (AI) for deep space exploration will provide the crew with increased autonomy regarding their diagnostic and therapeutic needs during their missions. AI and Machine Learning (ML) algorithms will shift the way health assessments are performed specifically in therapeutic areas such as primary care, cardiology, ophthalmology, and more. There is a widely acknowledged gap between the ability to process big data onboard spacecrafts to improve diagnostic capabilities, the lack of symptomatic data resulting from the impact of microgravity and radiation on human pathophysiology, and the difficulties to maintain ground to spacecraft communication in clinically meaningful timeframes.

Methodology: In this project, we describe the technical aspects of the on-board systems and introduce an AI framework that will support automated diagnostics and interpretable image recognition with evidence-based medicine guidelines. We will categorise the different types of medical data sourced from imaging modalities (ultrasound units), molecular diagnostics (e.g. microfluidics, lab-on-a-chip assays, biomarker tests), biosensors (e.g. wearable technologies, biomonitors, implants), and other routinely-conducted tests to provide an integration guide into routine clinical workflow of AI-enabled diagnosis. To improve prediction for diagnostics, we should feed the algorithm data from simulated models and preventive care procedure guidelines that process synthetic ML data in cases where data from space-related abnormalities cannot be retrieved. By starting with simulation models, we can identify predictors for early disease detection. Identification of predictors will allow for the design of early prevention strategies.

Results and Conclusions: This project documents the technical requirements, the implementation process, and functional aspects for the creation of a system architecture and interface strategy that incorporates AI algorithms into CDSS with increased specificity and autonomy in space. This research enhances our understanding of space medical challenges associated with the diffusion of CDSS into healthcare provision in space, as well as provides practical guidelines on the implementation of AI/ML tools through easy-to-use interfaces with unparalleled autonomy for quality-of-care onboard spacecrafts.