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Author: Ms. Jennifer Yeung
Ontario Tech University, Canada

Prof. Carolyn McGregor AM
University of Ontario Institute of Technology (UOIT), Canada

ANALYZING COUNTERMEASURE EFFECTIVENESS UTILIZING BIG DATA ANALYTICS FOR SPACE MEDICINE DECISION SUPPORT: A CASE STUDY

Abstract

The physiological health and wellbeing of every individual crew member is critical to the success of any long duration space mission. In the most predominant space travel in recent years that are the expeditions aboard the International Space Station (ISS), astronaut's physiological data, psychological surveyed data, and the spacecraft's habitable environmental data are periodically monitored by Mission Control, while also providing a range of data for retrospective research studies. This has led to the optimization of onboard environmental control and life support systems, countermeasure exercise programs, and preventive measures, extending human space travel capacities from 90 minutes in 1961 to 180 days or even a year for current day ISS expeditions. Although current methodologies help minimize health impacts for the astronauts pre-flight, during, and post-flight, these impacts are not detected in real-time and there is much that remain unknown for longer duration missions that will last 2-3 years, such as one to Mars. Acquired physiological data from existing onboard equipment is still monitored retrospectively and issues such as intracranial pressure resulting in vision changes for astronauts during spaceflight and post-flight still prevail. Behavioral health and psychological effects due to the isolation, confinement, and social impacts with other astronauts in the spacecraft for periods longer than current expeditions also still remain. Such health and well-being implications are critical for the astronauts themselves to comprehend given the autonomous nature of every mission into space, therefore Autonomous Medical Care development is critical. In recent research, advanced prognostic health management enabled by the online analytics platform, Artemis, has demonstrated its potential in determining health states of astronauts utilizing heart rate variability (HRV) data. However, this environment exists independent to the countermeasure exercise programs that are designed to address adaption challenges. This paper will demonstrate the potential to extend Artemis to incorporate countermeasure data in an effort to adjust the trajectory of the health state of the human body in space over time. The data will be presented as a feedback component within the Artemis platform to enable astronauts in space to assess the impact of the effects of their countermeasure activities in microgravity to bring their health state closer to homeostasis in space and on Earth. A case study will be presented to model an open loop system integrated with a countermeasure feedback component for human health monitoring in space.