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A TECHNOLOGY DEMONSTRATION FOR ASTRONAUT EYE MONITORING: PRELIMINARY RESULTS FROM GROUND ANALOGS AND THE INTERNATIONAL SPACE STATION (ISS)

Abstract

Human missions to Mars may create medical monitoring and support challenges for Spaceflight Associated Neuro-ocular Syndrome (SANS), which affects nearly two thirds of astronauts on long duration missions, and can result in eye changes. To address these challenges, a technology demonstration was conducted using human-in-the-loop (HITL) testing within three isolated, confined, and extreme (ICE) environments: (1) a Mars ground analog during the 2021 Austrian Space Forum AMADEE Mission to the Negev Desert in Israel, (2) parabolic flights, and (3) during Increment 66/67 from 2021-2022 aboard the International Space Station (ISS). Retinal images from 8 ground analog and 2 spaceflight participants were collected using mobile devices (crew iPads / iPhones). Hardware ease of use was collected using the NASA Task Load Index (TLX). Time required to collect the images was recorded. All data was anonymized, encrypted, and securely downlinked. Preliminary results show that the retinal image collection task takes an average (standard deviation) of 10m04s (3m51s) seconds, with an average (standard deviation) mental demand of 66.6 (11.3) and effort demand of 61.6 (18.1) yielding the highest workload out of 100 point subscales. Images are now being used to train a machine learning model for feature detection using Tensorflow Lite for use as a mobile app. This experiment serves to advance the Technology Readiness Level (TRL) of this eye monitoring technology from 7 (system prototype demonstration in an operational environment) to 9 (final product is successfully operated in an actual mission). Altogether, the results of this technology demonstration show that (1) small, lightweight, mobile, non-invasive, non-contact, light-based retinal imaging devices can feasibly capture fundus video images from crew members in ICE environments throughout the time-course of a mission, and (2) machine learning models could feasibly aid crew members in SANS monitoring during future ISS missions and the Artemis program.