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FRAMEWORK FOR ONLINE MENTAL WORKLOAD MODELING IN HUMAN ROBOT TEAMS

Abstract

Poor Human Robot (HR) teaming risks dangerous scenarios and mission failure. Inadequate mental workload (MW) models often cause HR team disconnects due to limited information and designer bias. The NASA Human Research Roadmap calls for improvements in HR performance through various gaps. Previous studies collected limited data in low-risk environments with MW model creation as a post-process. Task specific online multimodal data collection could improve MW model estimations by reducing design bias. Coactive design, a leading teaming framework for manned missions focused on interdependent collaboration with an emphasis on smooth autonomous HR control transitions, could drastically improve mission outcomes with the help of refined MW models. Here, we describe a Virtual Reality (VR) experiment design, capable of online assessment of MW, and the resultant dataset.

Our VR environment modulates MW by altering simulation difficulty while collecting time synchronized objective performance and physiological measures online. The user navigates to specific locations on the lunar surface by operating the Apollo rover. The VR environment and 6-axis motion platform help produce an immersive experience to facilitate more realistic physiological responses. While navigating, the user must respond to various rover alerts, chosen in relationship to the Multi-Attribute Task Battery II (MATB-II). Alert frequency and sensitivity modulates user performance and MW level. Upon reaching an objective, the user completes a NASA Task Load Index (TLX) survey. Afterward, the system generates a new objective point and alters the simulation difficulty. The user completes four separate runs during a one-hour test.

Our experiment produces a framework to reduce bias by developing MW models focused on objective multimodal signals. We anticipate a dataset of time-synced results with biosignal features derived from cardiac, skin, respiratory, and ocular measurements, in-game objective performance measures, and between run TLX survey results (n36) collected within a Robot Operating System (ROS) framework. Data collection is currently ongoing. MW (i.e., over and under-loaded MW) will be validated against TLX results via repeated measures ANOVA.

Human space exploration success is at risk when there is mediocre HR teaming. Less biased MW models can assist HR teams by mitigating decrements in operational performance and evaluating the mental demands of high risk missions. By using synchronized physiological and performance data from immersive, dangerous simulations, online models better reflect how human cognition reacts to different

levels of tasks. Our framework opens pathways for developing HR teams that mutually adapt to mitigate stressors, impacting cognitive health and mission success.