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Project Title:	Mixed Reality (MR) Care-Delivery Guidance System to Support Medical Event Management on Long Duration Exploration Missions		
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Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	TRISH--TRISH		
Joint Agency Name:		**TechPort:**	No
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Space Biology Element:	None		
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Comments:			
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Task Description:

Unanticipated medical events may potentially affect crew health, impact in-flight capacity, and compromise success of long-duration exploration missions. Like technical problem solving, medical events require crew members to rapidly coordinate in order to diagnose and manage situations that may be outside their primary technical expertise. Missions, such as those to Mars, will take upwards of three years and lack real-time communications with experts on the ground. As a result, we need to provide crew with tools and technology that can help them provide medical care autonomously. Effective spaceflight medical training must be combined with in-flight support tools to ensure crew competence in management of medical events and caring for sick astronauts. Collectively called Augmented Clinical Tools (ACT), these include technologies and applications to assist medical decision-making and action. Mixed Reality (MR) -- the ability to place virtual and photo-realistic items into the field of view using holograms -- provides an immersive, realistic user experience that has also proven feasible for training and guidance during technical non-routine tasks.

We propose to utilize existing technology to develop MR software that provides realistic training scenarios for astronauts, and combine medical education with real-time clinical support for some probable medical events in deep space. This includes a “SMART checklist” which guides astronauts through managing medical events in real-time. MR allows us to create lifelike space environments for astronauts to practice their skills. We will involve a wide range of stakeholders in software development and testing for usability, engagement, and performance. The project will take two years to complete and we will provide innovative products and guidance that can be incorporated into astronaut training to ensure that they have the knowledge, skills, and support to manage the expected and unexpected challenges on successful deep space missions.

Rationale for HRP Directed Research:

Research Impact/Earth Benefits:

Impact for Space
This project will foster effective in-flight medical training for both on-demand and continued medical education.

This project will provide clinical decision support tools for astronauts managing in-flight medical emergencies under varied levels of autonomy.

The deliverables from this project have the potential to mitigate the risks related to Adverse Health Outcomes & Decrements in Performance due to inflight Medical Conditions during long-duration exploration missions (LDEM).

Impact for Earth

Similar to LDEM, many terrestrial settings require medical education and clinical guidance tools for autonomous training and clinical care. The deliverables from this project can be used to support healthcare professionals who work in austere environments. Even in resourceful environments, like hospitals, medical trainees practice medicine under varied levels of autonomy through their clinical training. The project's deliverables can also be used in this environment to support medical trainees during clinical training (e.g., medical residency) when they do not have immediate access to their supervisors (e.g., during shifts when attending is on call).

Task Progress:

Unanticipated medical events may potentially affect crew health; impact in-flight capacity, and compromise the success of long-duration exploration missions (LDEM). Like technical problem solving, medical events require crew members to rapidly coordinate in order to diagnose and manage situations that may be outside their primary technical expertise. Missions, such as those to Mars, will take upwards of three years and lack real-time communications with experts on the ground. As a result, we need to provide the crew with tools and technology that can help them provide medical care autonomously.
Effective spaceflight medical training must be combined with in-flight support tools to ensure crew competence in the management of medical events and caring for sick astronauts. Collectively called Augmented Clinical Tools (ACT), these include technologies and applications to assist medical decision-making and action. Extended Reality (XR) - the ability to place virtual and photo-realistic items into the field of view using holograms - provides an immersive, realistic user experience that has also proven feasible for training and guidance during technical non-routine tasks.

We propose to utilize existing technology to develop XR software that provides realistic training scenarios for astronauts and combines medical education with real-time clinical support for some probable medical events in deep space. This includes a SMART checklist which guides astronauts through managing medical events in real-time. XR allows us to create lifelike space environments for astronauts to practice their skills. We will involve a wide range of stakeholders in software development and testing for usability, engagement, and performance. The project will take two years to complete and we will provide innovative products and guidance that can be incorporated into astronaut training to ensure that they have the knowledge, skills, and support to manage the expected and unexpected challenges on successful deep space missions.

In the first year of this project, we completed a total of 5 monthly videoconferences with a multidisciplinary expert panel composed of 45 panelists. During the meetings and through surveys between meetings, we applied a Delphi method to get consensus on functionalities that are essential for both XR medical education and clinical guidance during LDEM. The expert panel has also provided recommendations on specific medical events that would be suitable for an XR platform in addition to relevant clinical competencies and instructional design considerations for simulation scenarios and ACT development. Based on these findings, we listed a total of 89 distinct XR functionalities, from which 13 were removed based on the level of essentiality assessed by experts after 4 rounds of the Delphi Method. Based on the expert panel rating, we have also selected Tension Pneumothorax and Smoke Inhalation as the medical events that will be featured in the XR scenarios. Preliminary data from the expert panel on emergency medicine XR scenarios was submitted and accepted for poster presentation at the 2021 Society for Academic Emergency Medicine (SAEM) Annual Conference.

In the second year of this project, we will develop two simulated scenarios for three different modalities: screen-based virtual reality (VR), immersive VR, and augmented reality (AR). After development, we will run an experiment by recruiting astronaut-like participants and randomizing them in one of these modalities. A series of learning outcomes and engagement metrics, including learners' physiological signals, will be captured and analyzed.

Bibliography Type:	Description: (Last Updated: 04/25/2024)