33rd IAA SYMPOSIUM ON SPACE AND SOCIETY (E5)
Simulating Space Habitation: Habitats, Design and Simulation Missions (6)

Author: Dr. Kaja Antlej
Deakin University, Australia, kaja.antlej@deakin.edu.au

Dr. Annahita Nezami
City University of London, United Kingdom, annahitanezami@gmail.com
Ms. Kaori Becerril
Dereum Labs S.A. de C.V., Mexico, kaori.becerril@dereum.mx
Dr. Bahareh Nakisa
Deakin University, Australia, bahar.nakisa@deakin.edu.au

INTEGRATING DUAL-PURPOSED MEANINGFUL EXTENDED REALITY (XR) EXPERIENCES INTO A DAILY EXERCISE ROUTINE IN ISOLATED, CONFINED, AND EXTREME (ICE) ENVIRONMENTS: ENGINEERING DESIGN STUDENT CONCEPTS FOR IMPROVING CREW MOTIVATION AND PROPRIOCEPTION

Abstract

As astronauts journey further away from Earth risks associated with radiation and exposure to altered gravity increase. Bone and muscle atrophy in microgravity continue to be a significant challenge for long-duration space missions. As a countermeasure, astronauts on the International Space Station (ISS) spend approximately 2.5 hours per day exercising. However, the current equipment is relatively heavy, bulky, can produce vibrations that interfere with other research instruments, and require continuous maintenance and repair. Furthermore, astronauts report that the exercises are repetitive and monotonous, which leads to dwindling motivation to make daily use of the equipment. As we expand into the solar system to explore, work, and live, it is imperative to research and design multifunctional well-being solutions to reduce multiple health risks and help crew members adjust and acclimatise to their new environment.

The proposed study combines an engineering, meaningful (heritage), and affective-computing well-being informed approach to studying the benefits of integrating an Extended Reality (XR) environment into astronauts' daily exercise routine in order to help offset environmental challenges (microgravity) and psychosocial stressors (isolation and lack of motivation). Additionally, wearable biosensors that measure emotional states can be integrated and used by individual crew members or ground control to mitigate risk further and promote health.

Phase one of the study involves a walk through the Double-Diamond product design process (Design Council, 2005) used by the international Masters of Engineering and Undergraduate Engineering students in 2021 and 2022 who worked on a design challenge titled 'Gamified exercise equipment for people living and working in Space' at an Australian university. A panel of experts mentored the students (including mechanical engineering and mechatronics) and reviewed their designs. Following this initial concept generation stage, one of the finalist designs will be coupled with a meaningful XR heritage experience to create a prototype for testing in a microgravity environment.

There are multiple benefits of the proposed prototype, such as increased physical activity and exercise motivation, reduced emotional and cognitive stress, and selective sensory stimulation that can enhance sensory and physical experiences.

The study will consider implications of dual-purpose (psychosocial and physical health) XR applications for the Low Earth Orbit (LEO) missions and planned Moon and deep space missions.