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VR-CARDIORESP: FEASIBILITY OF STRESS BIOMETRICS ESTIMATION IN MICROGRAVITY ENVIRONMENT BY INERTIAL SENSORS EMBEDDED IN A VIRTUAL REALITY HEADSET

Abstract

During space missions, astronauts experience sensory monotony, spatial confinement and social isolation, possibly compromising psycho-social equilibrium, generating psychological disturbances, fatigue, stress, sleep disorders and reduced social cohesion. Future long duration space exploration missions will inevitably increase this risk, posing the need for regular in-flight monitoring and the implementation of effective countermeasures. Virtual reality (VR) appears as a promising solution for reducing the stress derived from the huge workload, prolonged permanence in an isolated, confined and hazardous environment and distance from Earth. In recent studies, we exploited the principles of ballistocardiography (i.e., measurement of body micro-movements in response to blood flow through the vessels at each heartbeat) to demonstrate the possibility to monitor the cardio-respiratory activity of subjects using the inertial sensors embedded in a VR headset. In the context of Human Physiology and Technology Demonstration, the VR-CardioResp investigation (sponsored by the Italian Space Agency with the support of the European Space Agency) aims to evaluate the feasibility to measure heart rate and respiratory rate also in microgravity on the International Space Station (ISS) using the on-board VR system (Perspective, CNES). The study will include the voluntary participation of one astronaut to one pre-flight acquisition and three in-flight acquisitions (one in the first month, one halfway through the mission, and one in the last month of the mission). Specifically, three VR scenarios will be displayed, eliciting three different emotional states: neutral, relax, stress. During each session, data acquired from the headset-embedded tri-axial accelerometer and gyroscope will be recorded, together with ECG as gold standard. This study, if proved successful, will pave the way to obtain opportunistic measurements of stress-related biomarkers while using the on-board VR headset for training, leisure or science experiments. This potential technology could increase the opportunities for monitoring crew's physical condition without the need of additional sensors, having as fields of possible interest the performance evaluation, training, or exercise sessions. In addition, obtaining this biofeedback directly from the VR headset, would allow the design of VR scenarios able to autonomously modify given the measured astronaut's stress level, thus leading to the optimization of the expected outcome. As the adoption of VR in the healthcare sector is also rapidly increasing, the exploitation of VR headset-integrated sensors to monitor heart rate and respiration parameters would promote the development of innovative methodological perspectives in the use of VR scenarios, capable of self-adapting according to the patient's reactions, also in Earth-based medicine.