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PROTOTYPING WEARABLE SENSOR GARMENT FOR UNDERSTANDING PROPRIOCEPTIVE CHANGES IN MICROGRAVITY

Abstract

In a microgravity environment, the human body does not experience vestibular cues that indicate orientation in a 1-g environment. The constant gravitational cue on Earth informs the neurovestibular and proprioceptive systems, which are system within the human body that control both interactions with the external environment and movement. Posture and limb movements heavily rely on gravitational cues, and aspects of movement have been shown to adapt over the course of a long-duration stay on the ISS. This study investigates proprioceptive adaptation in short-duration exposure to microgravity over the duration of a parabolic flight through a quantitative comparison of joint kinematics.

To gather data, a wearable sensor system garment has been designed and prototyped. The garment is equipped with twelve 6-degrees-of-freedom accelerometers on each limb joint that gather angular acceleration and rotational motion data. Demonstration of this initial prototype took place in ground-based human participant experiments involving locomotion tasks, and in a parabolic research flight experiment. A fluidity score can then be assigned to each ground experiment and each parabola of the flight based on the sensor data.

This wearable sensor system is an enabling technology to assess the proprioceptive adaptation to microgravity in short-duration exposures. Contributions to the body of knowledge regarding physical adaptations to microgravity are scientifically important and have applications in many human spaceflight fields, such as spacesuit and habitat design. With the rise of commercial suborbital flights, information about the short-term performance of the proprioceptive system are crucial for the ergonomic design of commercial capsules. This study also isolates microgravity as a confounding factor of the space environment for proprioceptive changes and adaptations.

This paper covers the design and prototyping process in detail, and includes an assessment of the preliminary performance of the system in human participant experiments.