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COUNTERACTING EFFECTS OF LONG DURATION SPACEFLIGHT

Abstract

Deterioration of the human body's skeletal and muscular systems occurs rapidly upon entry into microgravity. Current methods of slowing these losses use expensive and bulky machinery in specific configurations to approximate similar terrestrial-based exercises. While they do decrease atrophy, they are insufficient in providing a wide range of exercises, are dull and repetitive, and too large for long-duration exploratory missions. To this end, a need exists to develop an inexpensive and lightweight system with a small footprint working in conjunction with a Virtual Reality (VR) environment to create an analogous experience to weightlifting under a 1G load. Such a system would not only allow any number of customizable exercises to be made available, but also allow those exercises to take place in any environment and take on any form. To accomplish this, a modular, 3D printable upper-body exoskeleton was designed alongside custom virtual environments. The software algorithm was also created to characterize the load at each mechanical joint as it relates to its human correlative using the current position of the user, the predicted motion, and the weight interacted with. The exoskeleton provides 14 degrees of freedom each with a passive load given through resistive braking. Muscle recruitment, respiration, and heart rate were compared for the performance of arm, chest, and shoulder exercises. Subjects performed the exoskeleton-enabled exercises while utilizing one of two virtual environments: a typical gym setting and a gamified gym setting. The results of this study are presented and discussed below in relation to both the muscular benefits and any potential psychological benefits seen by utilizing a VR environment. The data gathered from each user is used to further optimize and refine the design and control algorithm. The success of mitigating muscular degeneration and encouraging a desire to exercise will serve to create a better system overall, improving conditions for every type of manned space flight, specifically long-duration missions.