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3D BODY MAPPING FOR REAL-TIME MUSCLE VOLUME ASSESSMENT OF ASTRONAUTS DURING LDEM

Abstract

The main objective of our project is to develop a real-time, high resolution, 3D body mapping system to assess astronaut muscular health. The advancements of space travel in long duration exploration missions (LDEM) creates a growing need to understand and mitigate the adverse physiological effects that microgravity environments are known to induce. The HRPRD lists several risks associated with microgravity environments including impaired performance due to reduced muscle mass, strength and endurance. In-flight exercise has been shown to reduce the rate of muscle volume loss, yet astronauts still lose an average of 2.4% of their body mass every 100 days they are in space.

The need to monitor vigorous exercise routines are not limited to astronauts. Recently a wave of interactive exercise videogames have hit the market (e.g. Xbox Fitness). These programs track a user's movement by calculating joint bend angles from a generic skeletal representation, which is adequate for encouraging personal activity. However, they do not possess the spatial resolution necessary for automated muscle volume assessments. Traditionally these are completed by trained professionals using MRI or CT scans. Our system uses infrared depth sensors to take geometric measurements of the astronaut's body, which then can then be used to monitor the effectiveness of the astronaut's exercise routine.

To create high resolution 3D body maps, we have developed an algorithm that meshes Xbox Kinect depth sensor outputs to stored 3D models. This is completed by minimizing an objective function that calculates the difference between the 3D Kinect data and the model. These maps, comprised of over a million points, enable precise measurements of the user's features and pose from which changes in size are calculated using the extracted surface of the 3D map at multiple locations and times. Since the system performs real-time analysis, it is able to compensate for changes in size due to muscle loading. In order to accurately deduce muscle volume from feature size, we will conduct a series of validation tests comparing the calculated muscle volumes to those found using the GE iDXA.

Astronaut health is vital to the future success of long duration space flights. The constraints of outer space limit our ability to provide astronauts with the full benefits of modern health care. The completion of this project will not only enable non-intrusive, real-time assessment of astronaut muscular health, but will also create the foundation for more accurate analysis of dynamic performance.