Paper ID: 7142
student

SPACE LIFE SCIENCES SYMPOSIUM (A1)
Medical Care for Humans in Space (3)

Author: Mr. Hui YAN
Tsinghua University, China, lygyanh@gmail.com

Dr. Chunhua Hu
China, huchunhua@tsinghua.edu.cn
Dr. Luming Li
Tsinghua University, China, lilm@tsinghua.edu.cn

ASTRONAUT BODY MASS MEASUREMENT DEVICE CALIBRATED WITH MINIATURE LOAD CELL

Abstract

The stability of body mass is an important factor for astronaut's health. So the device for mass measurement is necessary for long-term manned space mission. Current measurement methods in micro-gravity environment mainly fall into two categories. One is Newton's Second Law or momentum theorem, and the other is natural frequency of oscillation. Both need the astronaut to move in a specified manner. As a non-rigid object, human body vibrates unwantedly during motion, causing a remarkable measurement error. Key to reduce the error is to produce an uniform and steady acceleration field, or, a constant linear acceleration. The paper presents a device employing the constant linear acceleration method. A spring-cam produces a controlled constant pulling force, pulling the human body to accelerate linearly. An optical encoder is used to detect displacement and acceleration is calculated by displacement versus time trajectory. Body mass is then calculated by m=F/a. The device was tested on ground on an air floating platform. The platform, which has low horizontal friction and supports human body against gravity, can simulate the microgravity environment. Testing subjects include rigid weights 50-80kg and human 50-70kg. The device achieved satisfactory accuracy and repeatability for both subjects. A miniature high accuracy load cell is employed for calibration in space. Conventional calibration procedure is to measure a series of subjects with different mass, and calculate the best fitting parameters. It is complicated and inconvenient and too massive for space use. We managed to make the device work steadily enough and the only major changing parameter was the pulling force caused by the change of spring stiffness and length over time. Connected inline with the pulling lanyard, the load cell measures the pulling force and calibrates the parameter for mass calculation. A vibration test, which simulates the most severe condition during launch, was carried out to test the calibration method. The pulling force changed about 3% after vibration. The load cell calibrated the calculation parameter accurately and the device kept the same measurement accuracy as before vibration for rigid weights from 50 to 80kg. Two load cells were tested for durability, one intensively used for months (including several vibration tests) and the other stored for almost 1 year. Both samples showed no significant change in performance, proving the effectiveness and reliability of this novel calibration method which is much lighter and easier to use in space.