Paper ID: 72542
student

IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Interactive Presentations - IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (IP)

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TRACKING ASTRONAUT HEAD ORIENTATION USING REFLECTED SIGNAL FROM PASSIVE RFID SENSORS

Abstract

A current problem with the health monitoring electronics in space suits is the obtrusive nature of wired communication between the sensors and the central suit avionics system. This presents challenges during don/doff, causes irritation during extra vehicular activity, and restricts the number and type of biomedical measurements. This interactive presentation will discuss the development of a new system using ultra high frequency radio-frequency identification tags (RFID) along with data filtering and machine learning for tracking human head-neck kinematics. Astronauts work under tremendous stress under a low gravity environment, especially during EVA. The otolith-mediated delayed response of the vestibular system can lead to serious injuries. Head-neck injuries can be fatal and require serious attention for optimal performance by astronauts. Further, measuring head-neck kinematics could be important in gauging ergonomics, or detecting early onset of delayed vestibular response and guiding crew rehabilitation under low gravity. The head-tracking system was assembled using commercial off-the-shelf (COTS) parts consisting of two linearly polarized antennas, an RFID tag reader, and connection cables. Three COTS linear-polarized RFID tags were placed orthogonally behind the participant's head using a visor cap and a custom 3D-printed head piece. The reflected signal strength from each tag was recorded with vertical and horizontal polarized antennas while the participant varied the head pitch, yaw, and roll angles. Multiple parameter linear regression models were generated to correlate the head pitch, roll, and yaw angles to the reflected signal strength indicators. The models and the impact of Kalman filtering will be discussed along with the best standard error of estimates. The presentation will conclude with a discussion on the possible extension of the presented technology to other space applications.