Machine Learning Techniques for Predicting Mobility Related Perception Errors in Astronauts

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Astronauts returning from prolonged periods in outer space often encounter balance disorders and challenges to perform normal mobility-related tasks such as walking, climbing stairs and perceiving distance to ambient objects or the floor. The primary reason for this is the recalibration of the sensorimotor system in microgravity environments, which leads to an altered perception of joint positions. To address this problem, we are developing a modular self-reconfigurable robot called the Modular Robotics Suit (MORS) that is fitted with position sensors and, once attached to the leg and/or arm joints of a person, could automatically detect position change of the joints during different tasks. In this work, we present our research on using machine learning (ML) techniques to analyze time-series mobility data collected from humans while performing simple mobility tasks such as flexing arms or legs. Our ML technique then automatically predicts if there were any space-time perception errors by the human while performing the mobility task. We present results comparing the efficiency and accuracy of different ML techniques including convolutional networks, self-ensembling networks and Support Vector Machines. Initial results on a small dataset have been promising, showing good prediction accuracy with reasonably small loss. We envisage that these ML techniques can be integrated on the hardware of MORS to autonomously detect joint position errors in real time for astronauts performing mobility tasks and used as a prescription for future methods for correcting balance disorders.