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Wearable Jacket for Game-Based Post-Stroke Arm Rehabilitation

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Abstract : Stroke is the leading cause of adult disability worldwide. With recent advances in immediate post-stroke care, there is an increasing number of young stroke survivors, under the age of 65 years. While most stroke survivors will regain the ability to walk, they often experience long-term arm and hand motor impairments. Long term upper limb rehabilitation is needed to restore movement and function, and prevent deterioration from complications such as learned non-use and learned bad-use. We have developed a novel virtual coach, a wearable instrumented rehabilitation jacket, to motivate individuals to participate in long-term skill re-learning, that can be personalized to their impairment profile. The jacket can estimate the movements of an individual's arms using embedded off-the-shelf sensors (e.g., 9-DOF IMU for inertial measurements, flex-sensors for measuring angular orientation of fingers) and a Bluetooth Low Energy (BLE) powered microcontroller (e.g., RFduino) to non-intrusively extract data. The 9-DOF IMU sensors contain 3-axis accelerometer, 3-axis gyroscope, and 3-axis magnetometer to compute the quaternions, which are transmitted to a computer to compute the Euler angles and estimate the angular orientation of the arms. The data are used in a gaming environment to provide visual, and/or haptic feedback for goal-based, augmented-reality training to facilitate re-learning in a cost-effective, evidence-based manner. The full paper will elaborate the technical aspects of communication, interactive gaming environment, and physical aspects of electronics necessary to achieve our stated goal. Moreover, the paper will suggest methods to utilize the proposed system as a cheaper, portable, and versatile system vis-à-vis existing instrumentation to facilitate post-stroke personalized arm rehabilitation.

Keywords : feedback, gaming, Euler angles, rehabilitation, augmented reality
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