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MAGNI Dynamics: A Vision-Based Kinematic and Dynamic Upper-Limb Model for Intelligent Robotic Rehabilitation

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Abstract : This paper presents a home-based robot-rehabilitation instrument, called ”MAGNI Dynamics”, that utilized a vision-based kinematic/dynamic module and an adaptive haptic feedback controller. The system is expected to provide personalized rehabilitation by adjusting its resistive and supportive behavior according to a fuzzy intelligence controller that acts as an inference system, which correlates the user’s performance to different stiffness factors. The vision module uses the Kinect’s skeletal tracking to monitor the user’s effort in an unobtrusive and safe way, by estimating the torque that affects the user’s arm. The system’s torque estimations are justified by capturing electromyographic data from primitive hand motions (Shoulder Abduction and Shoulder Forward Flexion). Moreover, we present and analyze how the Barrett WAM generates a force-field with a haptic controller to support or challenge the users. Experiments show that by shifting the proportional value, that corresponds to different stiffness factors of the haptic path, can potentially help the user to improve his/her motor skills. Finally, potential areas for future research are discussed, that address how a rehabilitation robotic framework may include multisensing data, to improve the user’s recovery process.

Keywords : human-robot interaction, kinect, kinematics, dynamics, haptic control, rehabilitation robotics, artificial intelligence
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