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A novel Rotary Magnetorheological Fluid Damper for wearable rehabilitation robot

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This study explores the development of a new configuration and control method of rotary magnetorheological fluid damper (MR damper) for rehabilitation robot, especially for pathological tremor suppression. In order to get robot assisted therapy, the proposed novel MR damper aims for the design of compact size, light weight and enough output torque. Electromagnetic analytical methods and FEM numerical simulation are conducted for dimension and optimization of a serpentine magnetic path by employing an offset electromagnetic coil and an asymmetric rotor, by which a large radius and high area utilization rate of the magnetorheological fluid layer (thickness<1 mm) is enhanced. The output torque characteristic of the damper is evaluated.Control signals of the proposed damper is separated from tremor signals of upper limb with the WFLC algorithm. The experimental results prove the effectiveness of MR damper in pathological tremor suppression. Compared with an existed MR damper (axial length 90 mm) for pathological tremor suppression, our 58 mm shorter prototype MR damper can generate 2 times more torque and weigh 40% lighter. The proposed damper can provide more flexible output torques to accomplish suppression according to tremor frequency and amplitude obtained from sEMG pathological tremor signals.

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