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Design and Control of a Knee Rehabilitation Device Using an MR-Fluid Brake

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Abstract : Most of the people who survive a stroke need rehabilitation tools to regain their mobility. The core function of these devices is a brake actuator. The goal of this study is to design and control a magnetorheological brake which can be used as a rehabilitation tool. In fact, the fluid used in this brake is called magnetorheological fluid or MR that properties can change by variation of the magnetic field. The braking properties can be set as control by using this feature of the fluid. In this research, different MR brake designs are first introduced in each design, and the dimensions of the brake have been determined based on the required torque for foot movement. To calculate the brake dimensions, it is assumed that the shear stress distribution in the fluid is uniform and the fluid is in its saturated state. After designing the rehabilitation brake, the mathematical model of the healthy movement of a healthy person is extracted. Due to the nonlinear nature of the system and its variability, various adaptive controllers, neural networks, and robust have been implemented to estimate the parameters and control the system. After calculating torque and control current, the best type of controller in terms of error and control current has been selected. Finally, this controller is implemented on the experimental data of the patient's movements, and the control current is calculated to achieve the desired torque and motion.

Keywords : rehabilitation, magnetorheological fluid, knee, brake, adaptive control, robust control, neural network control, torque control
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