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An Inflatable and Foldable Knee Exosuit Based on Intelligent Management of Biomechanical Energy

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Abstract : Wearable robotics is a potential solution in aiding gait rehabilitation of lower limbs dyskinesia patients, such as knee osteoarthritis or stroke afflicted patients. Many wearable robots have been developed in the form of rigid exoskeletons, but their bulk devices, high cost and control complexity hinder their popularity in the field of gait rehabilitation. Thus, the development of a portable, compliant and low-cost wearable robot for gait rehabilitation is necessary. Inspired by Chinese traditional folding fans and balloon inflators, the authors present an inflatable, foldable and variable stiffness knee exosuit (IFVSKE) in this paper. The pneumatic actuator of IFVSKE was fabricated in the shape of folding fans by using thermoplastic polyurethane (TPU) fabric materials. The geometric and mechanical properties of IFVSKE were characterized with experimental methods. To assist the knee joint smartly, an intelligent control profile for IFVSKE was proposed based on the concept of full-cycle energy management of the biomechanical energy during human movement. The biomechanical energy of knee joints in a walking gait cycle of patients could be collected and released to assist the joint motion just by adjusting the inner pressure of IFVSKE. Finally, a healthy subject was involved to walk with and without the IFVSKE to evaluate the assisting effects.

Keywords : biomechanical energy management, knee exosuit, gait rehabilitation, wearable robotics
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