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# Development and Evaluation of a Hip Exoskeleton for Lateral Resistance Walk Exercise

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***Abstract*—Lateral resistance walk exercise (LRWE) is a popular method for fitness and rehabilitation training. However, current methods such as lateral band walks (LBW) cannot actively control the resistance training intensity. In this work, we proposed a novel hip exoskeleton which can strengthen hip adductors by applying active resistance torque during lateral walking. The spatial linkage mechanism of the hip exoskeleton was designed and a prototype was fabricated. The dynamic model of transmission system coupling exoskeleton and human body was established. The Proportional-integral-differential (PID) control strategy based on fuzzy tuning was presented to control the resistance torque. Physical prototype experiments showed that the fuzzy tuning PID control strategy could significantly improve the torque tracking accuracy compared to the traditional PID control strategy. The muscle activities of No-exo, Exo-off, LBW, and Exo-on (10Nm, 15Nm, 20Nm) conditions were evaluated on ten healthy male subjects walking laterally at a speed of one step per second. The muscle activities of gluteus medius increased by 51.4%, 413.5%, 591.9%, 721.6% and 918.9% under Exo-off, LBW, and Exo-on (10Nm, 15Nm, 20Nm) conditions, respectively. The corresponding increments for tensor fasciae latae were 52.6%, 1136.8%, 1626.3%, 1994.7% and 2331.6%, respectively. The results demonstrate that the proposed hip exoskeleton can apply to LRWE and improve muscle activities of hip adductors. It will upgrade the exercise method of LRWE and has good potential in strengthening hip abductors.**

***Index Terms*—Lateral resistance walk exercise, hip exoskeleton, muscle activity, dynamic model, fuzzy tuning.**