DESIGN OF A SOFT EXOSUIT FOR THE LOWER BACK

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ABSTRACT

In recent decades, the incidence of low-back pain and musculoskeletal injuries in factory workers has increased, leading to increased sick leave and reduced quality of life. These workers often perform tasks such as forward leaning, twisting and repetitive lifting of heavy loads that are associated with the risk of back injuries [1]. Therefore, to reduce fatigue, low-back pain, and injuries, there is a need for physical interventions such as braces and wearable devices that are designed to support the lower back and spine.

In the context of workplace back support and fatigue relief, the need for ergonomics and effective assistance is critical for widespread adoption. Orthopedic braces are ergonomic, but do not reduce muscle fatigue or spinal loading. Passive exoskeletons and exosuits can also be ergonomic but lack task versatility and high support. Active back exoskeletons and exosuits provide appropriate assistance levels but currently lack ergonomics. Methods of application of assistive forces on the body for these devices include a contractile force parallel to the back extensor muscle, which could increase spinal compression loads, or normal forces on the torso that generate a sagittal moment about the lower back and sometimes hip. Therefore, there is a need for more ergonomic active devices that do not increase spinal compression.

This work presents a comparative study of contractile and moment generating exosuits. We implement contractile and bending actuation schemes using cable-driven and inflatable actuators in a wearable interface and perform static and dynamic characterisation. The actuators are sized and operated to ideally have similar performance outputs with minimal ergonomic footprint. The anchoring and actuation efficiency is estimated using a testbench. The anchor and actuation migration and effect on muscle activity is measured in tests on healthy subjects. We choose the most efficient and effective anchor and actuator for future embedding of sensors and intelligence with eventual use as a haptic and assistive support of the lower back and spine.

[1] Hoogendoorn, Wilhelmina E., et al. "Flexion and rotation of the trunk and lifting at work are risk factors for low back pain: results of a prospective cohort study." Spine 25.23 (2000): 3087-3092.