Lightweight Walking Aid Ankle Exoskeleton Using Twisted String Actuator

Ji, Honggeun (School: Korea Science Academy of KAIST)
Shin, Chan (School: Korea Science Academy of KAIST)

Walking, constituting a significant portion of human energy expenditure, has spurred research into ankle exoskeletons aimed at mitigating energy consumption. Various exoskeleton designs have been explored, with a focus on the active type that converts electrical energy into assisting forces. However, challenges include the heaviness imposed by control systems and the limitation in achieving a flexible and biomechanical design. To overcome these challenges, the Twisted String Actuator (TSA), known for its flexibility, lightweight was employed as the driving mechanism. Based on the walking patterns and body dimensions of individuals aged 20 to 24, the exoskeleton is designed. Total mass was 410g and it was worn without ill-fitting. The TSA was attached to the back of the calf to apply support torque to the heel and controlled by tethered connection implementing PD control. Total length control algorithm is developed using governing equation. The actuator's governing equation was validated with TSA module mounted to CNC(Computer Numerical Control) machine and max force of 76.5N is recorded. This study has developed lightweight ankle exoskeleton using TSA. Total mass of the exoskeleton was 410g and max applicable force of 76.5N is resulted. Future work includes the development of force assistance algorithms, force assistance testing, and performance evaluation through sEMG(Surface Electromyography) or metabolic rate measurements.

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