Single-motor actuated semi-rigid hip exoskeleton design capable of assisting flexion and extension while walking

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Abstract- The design presented is aimed to reduce the cost of walking by actuating the hip during walking. The most common exosuit design is to keep the motors centered at the hip and use a cable drive to actuate distal points on the leg but they still need to motors for bidirectional actuation. Here we present the design of a soft exosuit with one actuator and two electroadhesive clutches per leg for bimodal articulation. The preliminary results, characterized from the exoskeleton by actuating the force manually during walking, show that the design efficiently transfers force and is comfortable to the user. The results suggest that the design holds the potential to transfer up to 100N of assisting force from a single motor to each leg during the flexion and extension phases.

Keywords: hip exoskeleton, human-robot interaction, soft robotics, assistive

I. INTRODUCTION

The key factor for using lower body exoskeletons is to reduce the metabolic cost of the individual while walking or running [2] In order to accomplish that, a sufficient amount of force and support must be supplied to the individual at key spots at the accurate timing in the gait cycle. Most exoskeletons are commonly designed with rigid mechanical components which allow the necessary torque to be delivered but reduce the flexibility of the subject and add a significant amount of weight on the user [1]. Soft exoskeletons are an alternative that allow the user to maintain a high flexibility while being capable of delivering the necessary amount of force to assist. These exosuits are generally made of fabric which utilizes skeletal structure to support compressive forces and boast a lower weight than their counter parts. While these types of systems are lighter and do not inhibit the natural human movement of walking, they do not provide the support necessary to handle unwanted high compression forces transmitted to the individual. The compromise of this semi-rigid design will allow for the support necessary to handle compressive forces while allowing flexibility and natural walking dynamics.

II. METHOD

The exoskeleton will utilize electro adhesive clutches to articulate each phase while walking. Four clutches are used in the design to differentiate flexion and extension assistance on each leg. An off board motor is used to supply the torque to the system through a Bowden cable. As the subject walks, an encoder digitizes the angle of the legs which signals the control system to activate the clutches when needed. The clutches are capable of transferring up to 100N of force when activated and allow for motion to bypass them when deactivated [3]. The control system analyzes the encoder signal and determines the correct timing to activate each clutch while running the motor to maintain four torque spikes per gait cycle.

III. DISCUSSION

Our presentation will introduce the ongoing effort including the physical prototype. We will discuss in further detail how the device is actuated and how the control system functions.

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