Design of Non-Invasive Hip Exoskeleton

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Abstract

NAU's Biomechatronics Lab focuses on developing wearable robotics (exoskeletons) to improve the mobility of people with walking impairment. New devices are tested by comparing the exo-assisted metabolic cost of walking with the unassisted metabolic demand. The hip exoskeleton will be used to test the optimal amount of joint torque assistance needed at the hip to decrease the metabolic cost of walking in children.

Requirements

C.Rs	Description
Lightweight Design	0.75 kg or less
Flexible for all sizes.	Sliding metal frames for adjustment
Reduced skin irritation	Fabric interface on the interior of the exoskeleton
Strong Device	Use of Carbon on the frames (high modulus of elasticity).
Non-invasive	No contact between the metal bars and the human skin
Comfort	Less than 20-40 seconds to on/off, and reduced irritation to skin
Simple system	Uses actuators on the hips to facilitate functionality

ER*	Target value	Tolerances	Description
Weight	7 lbs.	0.5lb	Weight of 4.5–9 lbs.
Strength	200 Gpa	5 Gpa	Material's Modulus of Elasticity
Force	100 N	10 N	Needed to actuate the device
Yield Strength	210 Gpa	3 Gpa	Choosing the proper materials
Shear Modulus	80 Gpa	5 Gpa	Calculate deformation
Young's Modulus	215 Gpa	2 Gpa	Measuring abilities of materials
Cost	$1150	$400	Cost effective
Torque	8 Nm	2 Nm	8 Nm out of the motor
Range of Motion	25-55	10 degrees	Hip joint from 150-390 degrees

Methods

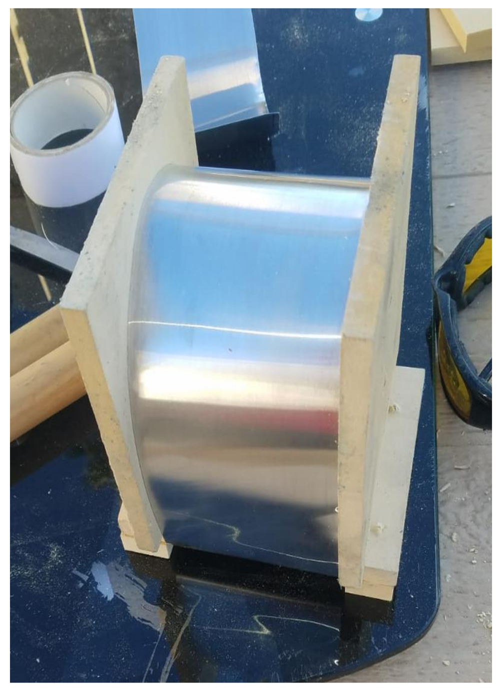

Figure 2: Thigh brace build

Figure 3: Thigh brace build

Figure 4: Thigh brace result

Same method applied when the team built the hip brace.

Results

The exoskeleton design comprises the following subsystems that include the pelvic design, the thigh design and the actuators. The actuators facilitate joint movement at the hips and the knees. The actuators receive signals from the sensors on the hip and knee joint to create a movement that minimizes the energy requirements for the user to move. The pelvic design is the main focus of the project. It comprises of various elements that include the torque sensors, the hip braces and the support frame. The sensors function in terms of acquisition and transfer of hip joint movement signals to the actuators to facilitate a proportional movement. The frames on the thighs and hip support the hips and thighs during movement to ensure safety and comfort of the user.

Conclusion

Exoskeletons are wearable devices that function in alongside the user's body parts. The design of an exoskeleton depends on various factors such as the purpose and the target body parts that requires support. The purpose of making this exoskeleton from the existing design is to ensure affordability, comfort and efficiency when functioning. Exoskeletons are used in different sectors such as healthcare, sports, military and rehabilitation facilities. They are used to assists individuals with hip and back issues to walk and maintain a stable posture. The devices comprises of a system with motors that collaborate with the signal produced by the body to provide adequate support to the hip joints of the user. The ultimate purpose of the design will be acting as an amplifier that augment, reinforce and restore movement of the user.

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