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A Low-Cost Microprocessor-Controlled Stance-Control Knee Orthosis for Pediatric Mobility Impairments

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Jordan Witt and Levi Fertig

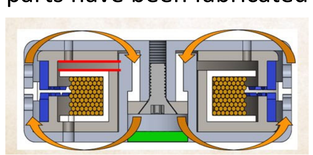
Our Partner

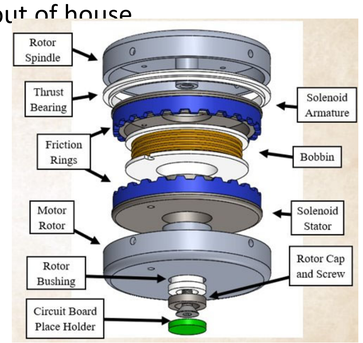
CURE Ethiopia is a children's hospital in Addis Ababa. We have partnered with them because they have an established gait lab where they use cameras to capture the patients gait cycle. They produce hundreds of orthotics every year. The initial target user of our stance control orthotic will be the children served at CURE Ethiopia between the ages of 8 and 11 with gait impairments resulting from spina bifida or cerebral palsy.

Mechanical Locking Mechanism

The locking mechanism will be located at the knee joint. Using a solenoid to lock and unlock a pair of friction rings, the orthotic can lock at any angle. The solenoid is activated by current controlled by the microprocessor. With a compact, nesting design, the locking mechanism can fit into a hockey puck-sized cylinder.

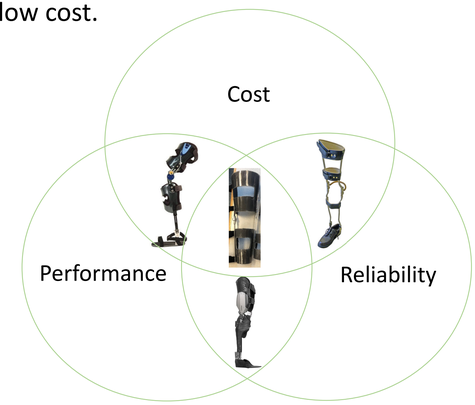
All the plastic components have been fabricated either on the lathe or with the use of the 3D printer. All the metal parts have been fabricated out of house.





Problem Statement

A gap exists in current orthosis technology for an inexpensive but reliable brace which provides stance support and free swing for healthy and safe walking. The team orthotic shown in the middle fills the void. On the left is a SCKAFO (Fillauer Swing Phase Lock 2). On the right is a locked KAFO. On the bottom is a hydraulic SCKAFO (C-Brace). In the middle is a SC-KO that has the performance and reliability required at a low cost.



Brace Fabrication

To thoroughly test the effectiveness of the locking mechanism and the control system, the team needs to be able to make orthoses that will fit future test subjects well to enable research and get meaningful results from the experiments. In addition to creating orthoses for team use, the team will write a detailed manual outlining a standardized method for creating an orthotic in-house with our custom locking and gait detection system.

Conclusion

The SC-KO team has successfully created functional prototypes of the mechanical locking mechanism and the gait detection system as well as two orthoses to test these systems. During the 22-23 school year, the team will be bringing all the elements together and performing device characterization experiments on able-bodied subjects.

Project goals

The SC-KO team aims to create a functional stance-control knee orthotic with an any-angle locking mechanism, controlled by a gait-detecting microprocessor system. The locking mechanism must be reliable for daily walking, and able to traverse uneven terrain and stairs. The final product must allow the user to move in a manner more consistent with a natural gait.

Gait Detection System

The gait detection system will be designed to work with the mechanical locking mechanism to control the when the lock will engage or disengage. This system not only requires the circuit and program, but also the housing to protect the system during use. This microprocessor system utilizes an accelerometer, gyroscope, a magnetic encoder, and an Adafruit Feather microprocessor. The team has been able to complete an initial program, electrical system, and 3D printed housing for this device.

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