Lerner Exoskeleton Actuators

Torki Alhaqan,Fawaz Almubarak,Barjes Alenezi,Humood Aljabri, Mohammad Alali

Department of Mechanical Engineering, Northern Arizona University, Flagstaff, AZ 86011

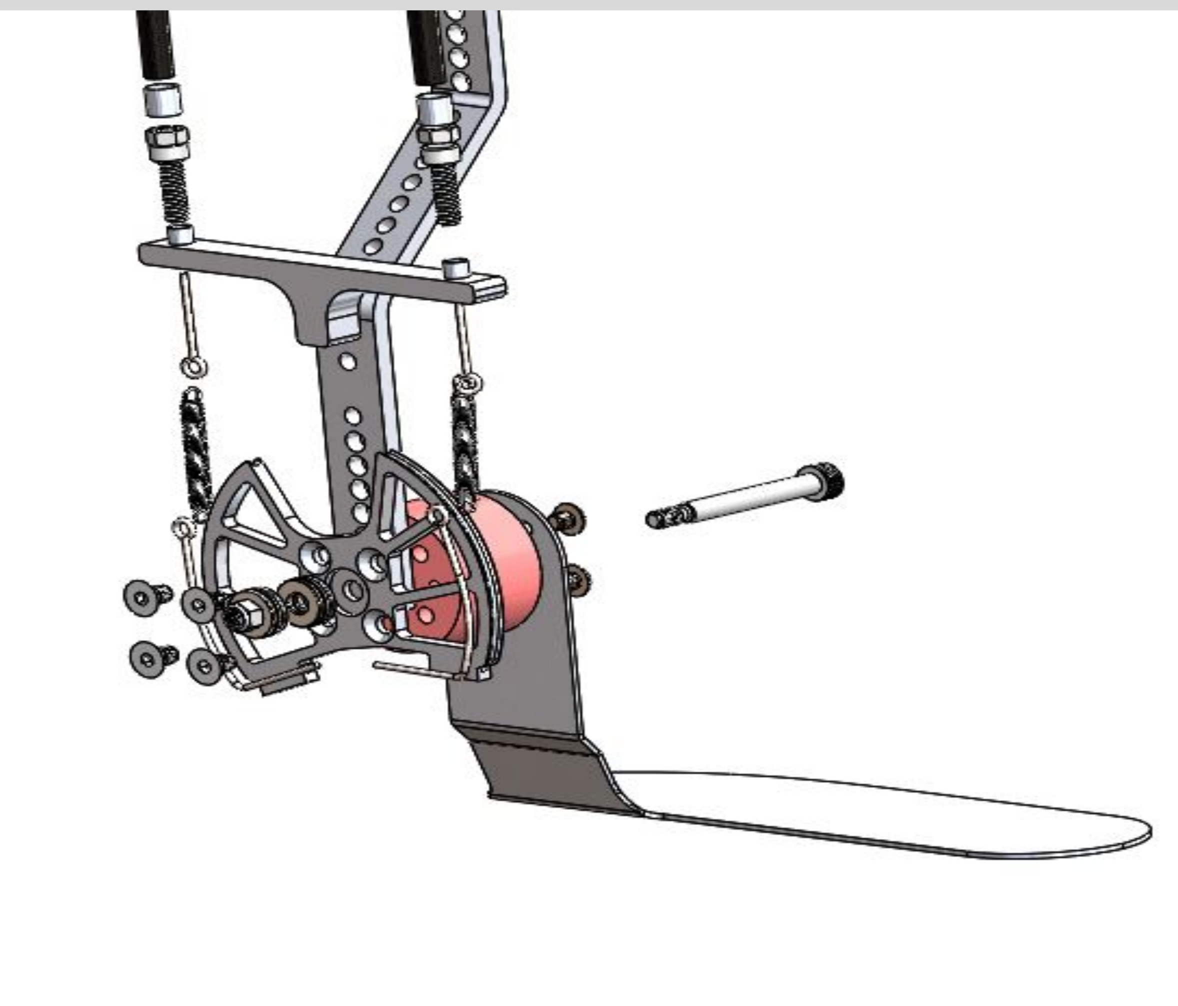
NAU NORTHERN ARIZONA UNIVERSITY
Office of Undergraduate Research and Creative Activity

Abstract

Purpose:
The reason that our team is doing this project is to help children with Cerebral palsy which is disease that affects a child's from moving and it is caused by brain damage .
Method:
The purpose of this project is to design a series elastic actuation system for a robotic lower-extremity exoskeleton. The system will be actuated by a high-performance DC motor. Series elasticity will be implemented in the form of linear or rotation springs. In addition to the design and manufacturing of the system, the capstone team will be asked to provide an analytical characterization of system performance, validated through experimentation.

Project Requirement

- Provide 0-7Nm of torque for the motor
- Provide 0-21Nm of torque for the lower pulley
- Specify the perfect location for the spring
- Must not contact the ankle
- Make the design as simple as possible

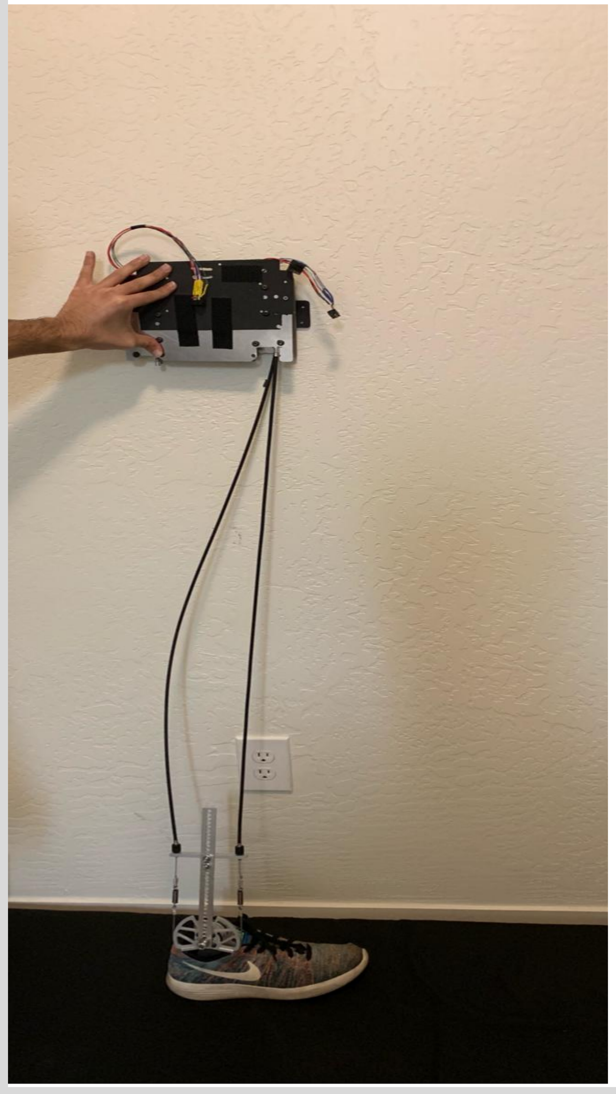


Background

The team looks into making improvements on the existing exoskeleton such that it could work better and more efficiently. The robotic exoskeletons are normally used by healthcare industries in order to assist people with neuromuscular disorders to be able to walk better than how they walk without the devices. The device has a system with motors that collaborate with the transmissions produced and give enough support to the ankle joints of the user [1]. Another aim of this project is to design a series elastic actuator that can assist the patient to have a more clinical gate and improve the walking movement. First, a new design of the exoskeleton is to be put in place. The previous form was not comfortable and came along with various difficulties. The new one is meant to set the record by enabling a stiff point of mounting on the user's organ, to be able to adjust to different sizes and ages of users, to be able to be easily put on and off, to be comfortable to the user as well as to be way lighter than the previous. Secondly, after making a design using springs in different ways that can help the patient not slip and walk more comfortable, then the project would have been successfully completed.

Testing, Design Approach and Result

- Concept generation and selection.
- CAD modeling for the chosen design.
- Machined parts: Leg bar, T-bar, Motor Support Bracket, Motor Block.
- Order the necessary parts
- Assemble the design.



Analytical Analysis Overview

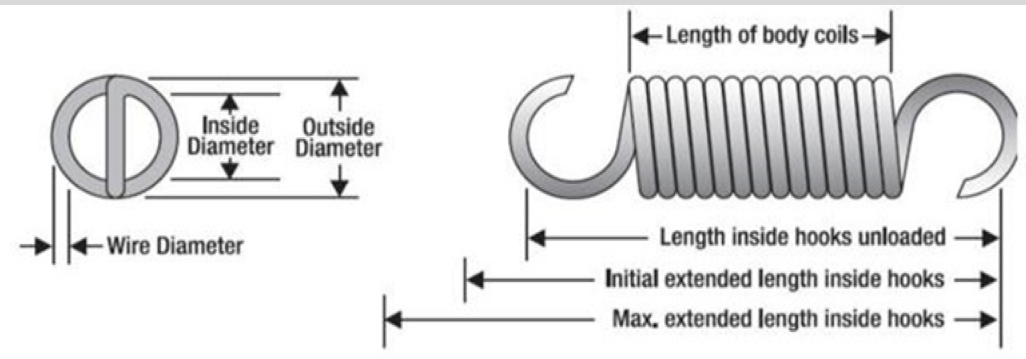
- Torque produced on the pulley 20.6Nm
- Torque Produced on the motor 6.97Nm
- Strength of the Spring F=635.35N
- Maximum force of the Bowden cable is F=588N
- Spring force constant(K)

$$k = \frac{Gd^4}{8D^3 n_a}$$

- Torque equation
- Where r is pulley radius and F is force produced on cable
  T=r x F
- Spring Index

$$C = \frac{D}{d}$$

C=4.8



Part Number: 80429

Initial Tension (lb)	2.00
Suggested Max Load (lb)	23.000
Length (in)	1.38
Loop Style	Full Loop
O. D. (in)	0.300
Rate (lb/in)	52.00
Suggested Max Deflection (in)	0.400
Wire Dia (in)	0.055
Length 2	1.38
Standard Finish	None - N

Acknowledgements

- Dr. Zachary Lerner
- NAU

NORTHERN ARIZONA UNIVERSITY

References

[1] S. Hasegawa, M. Konyo, K. Kyung, T. Nojima and H. Kajimoto, *Haptic Interaction: Perception, devices and applications*. 2015.
[2] "Catalog," *Century Spring*. [Online]. Available: https://www.centuryspring.com/catalog/?page=product&cid=extension-regular&id=80429CS&cdskeys=80429. [Accessed: 05-Apr-2019].