Team EE # 8 / ME # 29 Strength Assisting Orthotic

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Introduction

A strength assisting orthotic has a large market of use, and similar projects are being researched and developed around the world. A device like this has civilian, military and rehabilitation applications in its ability to assist lifting strength and stability. To make an orthotic that is useful, it is important that it will be lightweight and non-invasive to the natural movement of the user. Previous orthotics are bulky, heavy, and limit the user's movement.

Background

In order to develop the device, the load must be modeled. The greatest torque that will be applied to the arm will be when it is at 90 degrees, or perpendicular to the ground, where gravity will be the greatest. It is necessary for the motor to be able to handle the load at this point in order for the load to be lifted successfully by the device. We used the maximum length of the forearm to find the greatest torque applied at the point of actuation the elbow. Since the length of the arm has a adjusting forearm length and upper arm length 95% of earth's population will be able to use the strength assisting orthotic.

$$\tau_{load} = (mass)*(gravity)*\sin(\theta)*(Length_{Forearm})$$

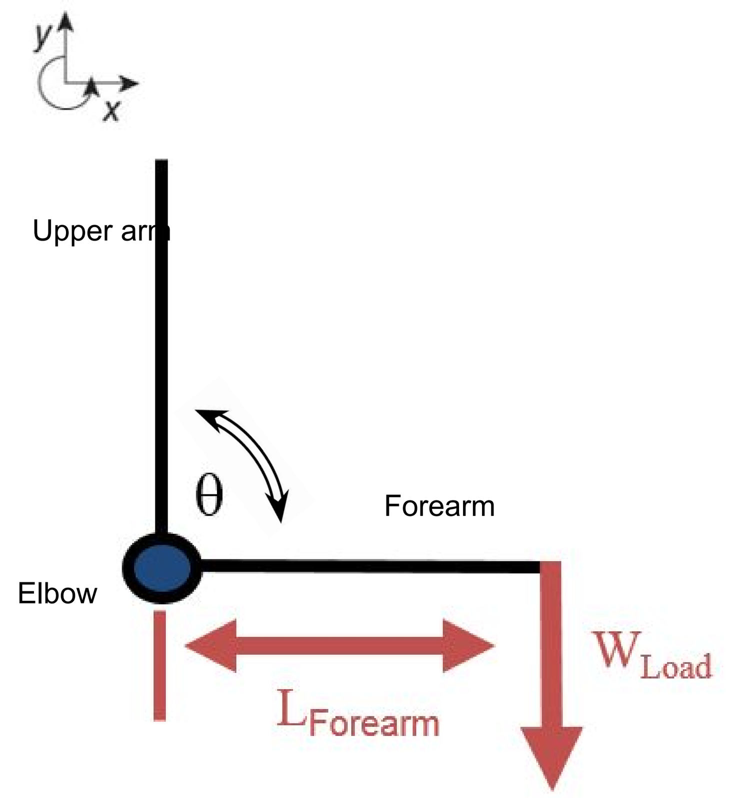

Figure 1. Modeling of the Load

This project is sponsored by the FAMU-FSU College of Engineering and by Dr. Devine, head of the business program at the FAMU-FSU College of Engineering.

Objectives and Constraints

- The goal of this project is to create a strength-assisting orthotic that increases the curl strength of the user by 10 pounds.
- Minimal objective is to lift a paper cup, for the arm to essentially lift its own weight.
- Primary objectives for this project are safety, low cost, and limited loss in mobility.
- Constraints are safety, weight, strength, lifespan, and versatility.

System Overview

- Safety is a key priority in this system.
- System has multiple redundant safety features, both mechanical and electrical.
- Electrical energy is being converted to mechanical energy to provide the necessary torque.
- The worm gear serves to reduce RPM to a safe speed and increase torque to lift the goal of 10 pounds.
- The 24V battery will be used for both the motor and the microcontroller with a voltage regulator to decrease voltage for the Arduino.

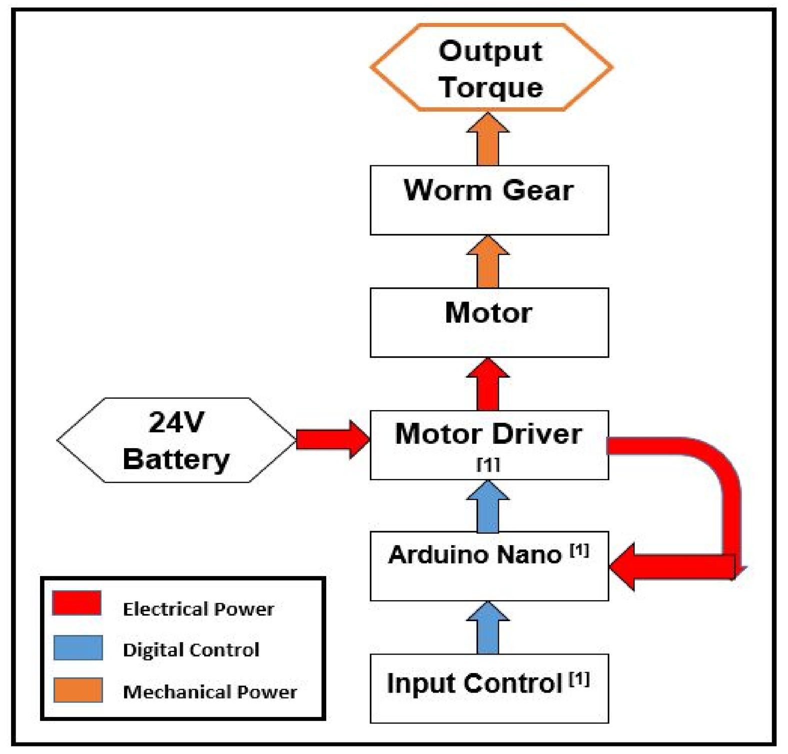

Figure 2: System Block Diagram

Frame

- The frame of the frame of the arm will consist of aluminum and steel.
- Length of the forearm: max of 53 cm and a min of 38 cm.
- Length of upper arm: max of 58 cm and a min of 40 cm.
- There is a 35 degree cut in the frame to stop the contracted arm and a 180 degree cut inside of the elbow to stop the arm at complete extension.
- Actuation will occur at the elbow with the use of a worm gear.
- A double u joint will be used to simulate a shoulder joint.

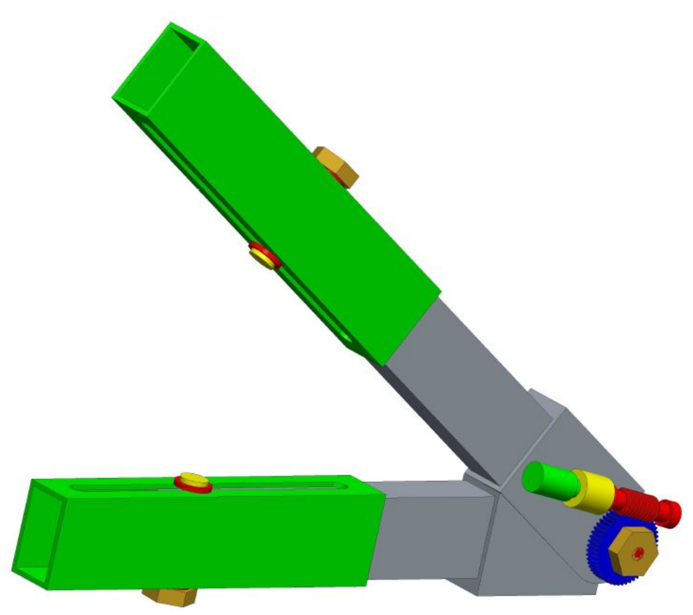

Figure 3: Frame at Minimum Angle

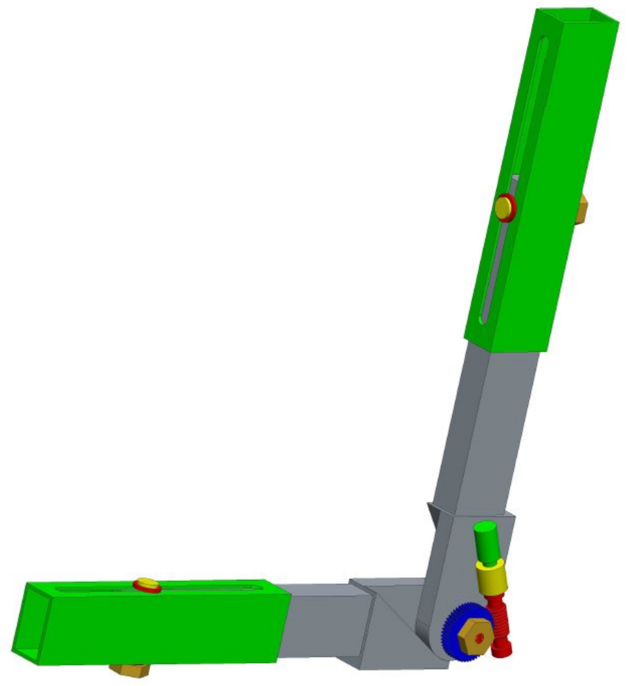

Figure 4. Frame at Maximum Torque

Electronics

- The Arduino Nano controller is chosen for its ease of use and expansive code libraries.
- The driver was bought pre-made, and implemented some convenient safety features out of the box.
- Pushbuttons were used to control the device and operated by a remote testing assistant, in order to increase safety during the tests.
- The control algorithms were designed to progressively increase and decrease power to the motor in order to reduce jerk.

Figure 5: SyRen 50A Regenerative Motor Driver

Figure 6: Arduino Nano

Safety Features

- In order to provide a reasonable amount of safety while performing R&D on this project, a number of safety features have been implemented.
- The arm hinge has been designed in such a way as to be physically unable to extend past the limits of the human arm.
- The motor driver has hardware limits built in to eliminate the possibility of power surges.
- The motor driver additionally has thermal protection for itself and undervoltage protection for the battery.
- The Arduino will control the motor driver and receive feedback from the human operator to shut off the motor at unsafe angles.
- If any one of these safeties trip, the arm will immediately cease movement and hold in place.

Prototype

- The prototype budget is $1,400.
- The pieces for the prototype arm were machined from aluminum.
- The arm is designed to telescope in two different locations, in order to provide optimal length for the maximum number of users.
- The worm gear in the elbow joint allows the motor to position the arm at any valid angle and remain in position without using additional power.

Conclusions and Future Work

Over the span of this year, the team has designed various arm frames and actuation methods. Both pneumatic and electromechanical methods were analyzed and evaluated, with the team deciding on an electromechanical system. A motor and driver were specced that met the requirements for the project, and an arm was constructed that allowed for the basic concept to be tested.

Future work will involve adding a better chassis and frame to support the arm, and more ergonomic control systems.

Contact Information

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