

Powerflex Arm - A Powered Upper Limb Orthotic

Operation Manual



Group # ECE 8 / ME 29

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Introduction

This project looks at enhancing human strength to increase productivity of healthy people and increase mobility and usability in rehabilitation of injured people. People need assistance with moving their arms under load if the load is too large. Current orthotics are bulky and weigh down the user. The primary objective of this project is to come up with a strength-assisting orthotic that is ergonomic and inexpensive. This orthotic will be designed to be ergonomic and enable the user to retain a natural level of mobility. It should be light, strong, and long lasting. This device will be user friendly, easy to modify, safe, and dependable under a wide range of use cases. The power arm is a device that fits over the arms of the user and uses electromechanical actuators to augment their strength. It either contains a strong exoskeleton to help bear loads or it uses straps to attach to the user's body and increases the torque generated by the user's skeleton. The microcontroller being used will be the Arduino Nano, as it is well equipped to drive motors. Assembly of the product is not required from the user, though the user does have to put on the backpack and arm frame for use. It can be done by a single person quickly and easily. The current control scheme just uses two push buttons as input, one for to lift and one to drive the frame downward. Any malfunctions with the product can be checked with the troubleshooting guide for correction by determining the source of the malfunction. To avoid malfunctions regular maintenance is highly recommended. Maintenance includes, but is not limited to, lubricating moving parts, using the correct charger to regulate the battery charging, and ensuring all bolts are tight and secure. Replacement of most parts only requires the removal of a few bolts, and the electrical parts can be found online from numerous sources. This product has been designed for long term usability, and with proper maintenance and upkeep will continue to run at a high performance.

Functional Analysis

The strength assisting orthotic arm is comprised of numerous components. It is designed to be modular with easily replaceable parts. These parts make up both the mechanical systems and electrical systems.

Setup

Plug in the battery to a wall outlet and make sure that it is fully charged. This device is ready out of the box with very minimal setup required. To use this device, please acquire permission from the safety committee to do so, as currently this device is not cleared for human use. To wear this powered orthotic, first put on the backpack and secure the hip belt and two backpack straps. Next, secure your arm with the straps on the orthotic. Before powering up the arm, adjust the arm length to fit your arm. Make sure not to undo bolts in sliding bar mechanism or the arm could become undone.

Components

Our design is composed of several components: a backpack that houses the battery and electronics, a frame that attaches to the arm and actuates about the elbow by the use of a worm gear and a motor, and a control system that will be used by the user.

Mechanical Systems

The frame of the arm will serve to protect the user as well as enhance lifting capabilities and movement. The arm is designed with the bicep curl motion in mind, as this is a function prototype in which following iterations will provide more degrees of freedom to the user as well as strength and endurance through the user supplying less force to lift a heavy object. To use the arm, the user must strap his/her arm securely in the provided straps and wear the backpack as well. The motor will actuate the orthotic at the elbow and provide torque to ease the lifting strain of the user.

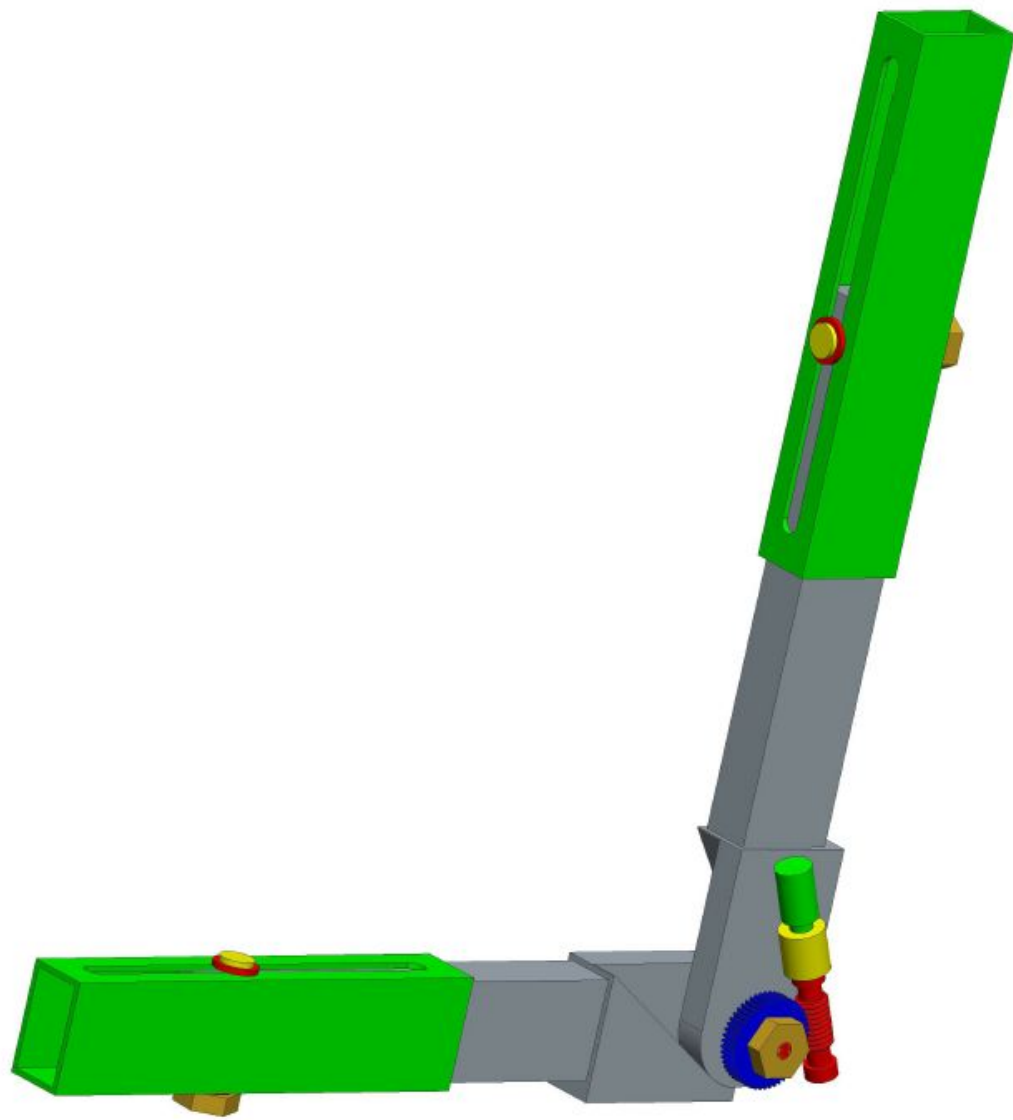


Figure 1: Arm Frame at 90°

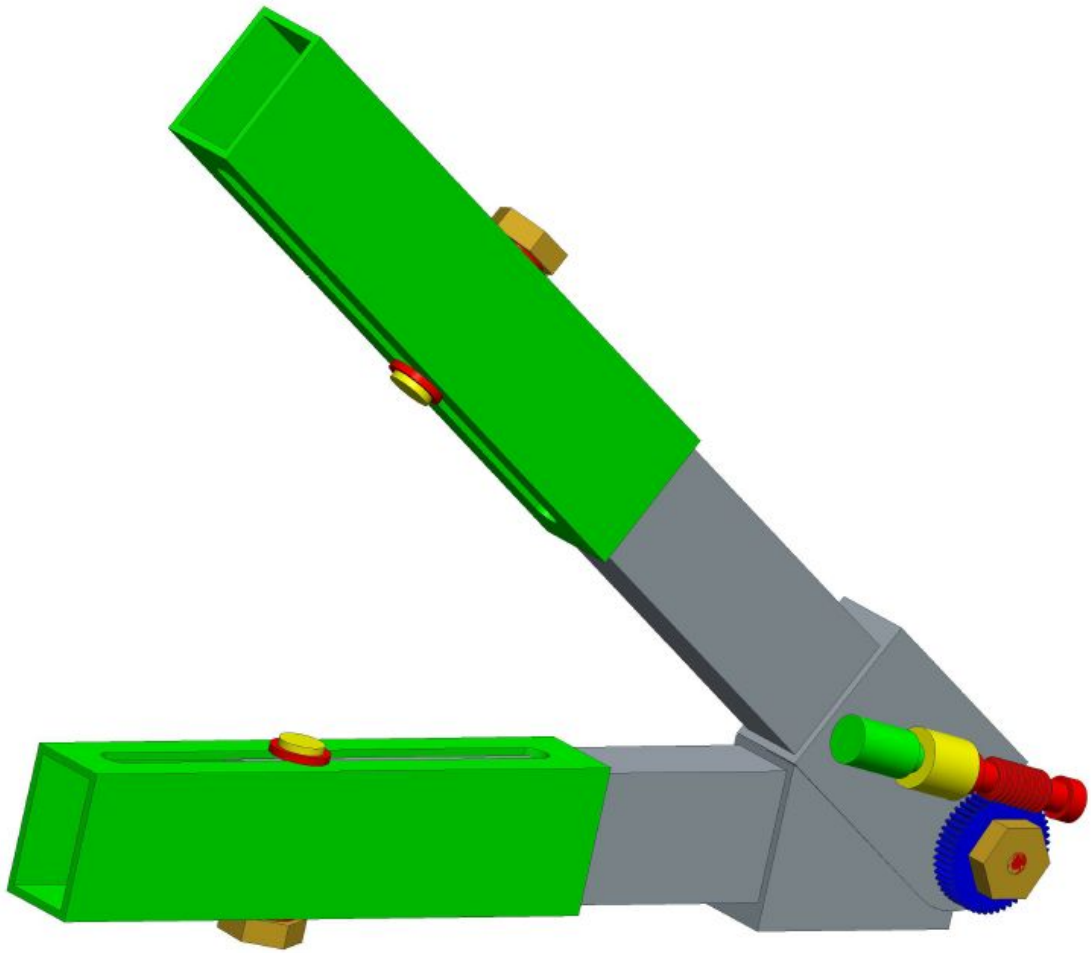


Figure 2: Arm Frame at 35°

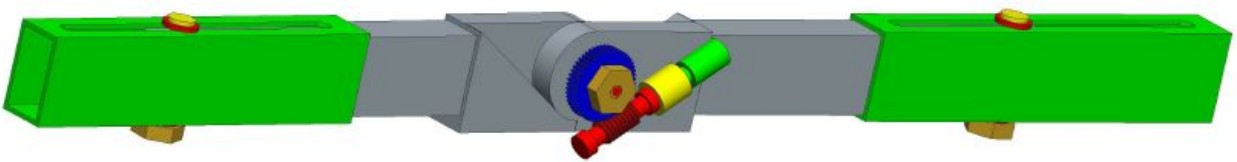


Figure 3: Arm Frame at 180°

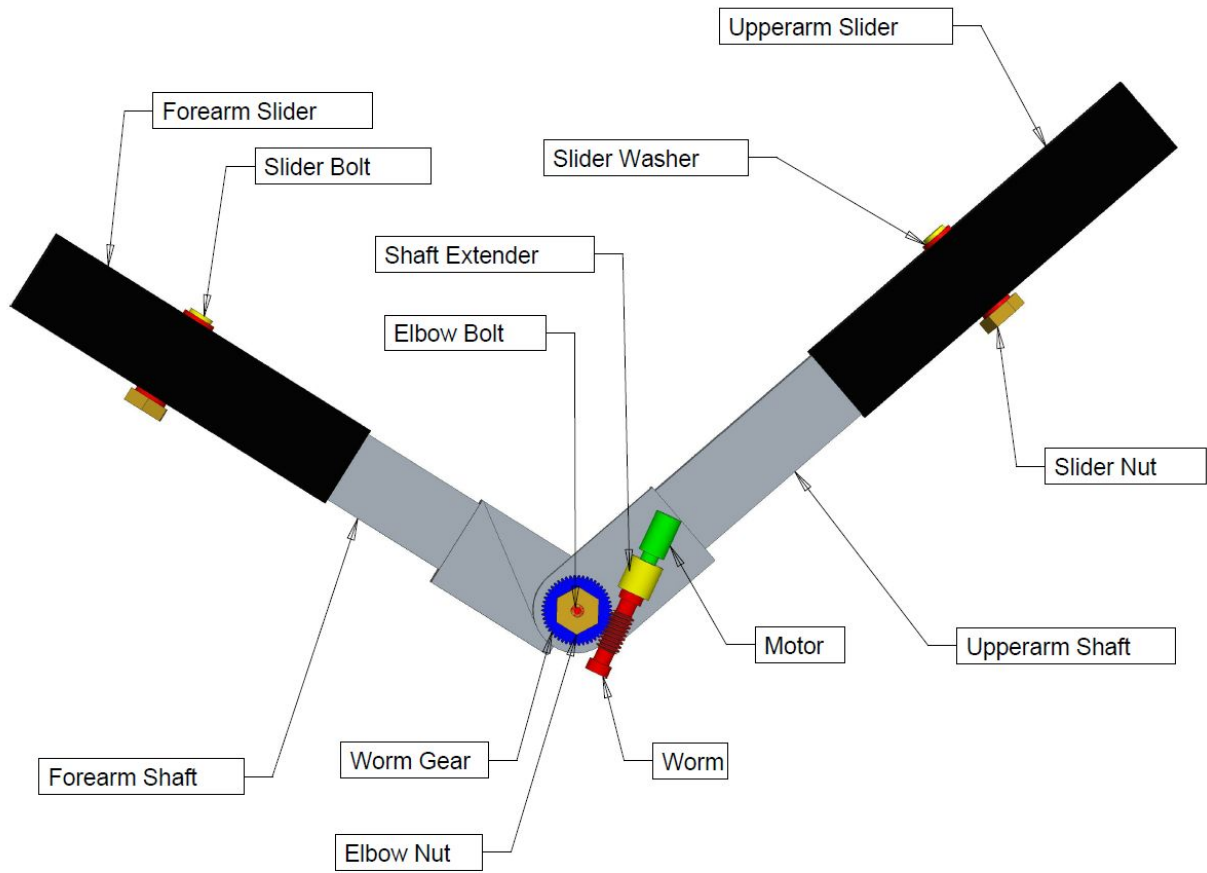


Figure 4: Arm Frame with labels



Figure 5: AmpFlow E30-150 Brushed DC Motor

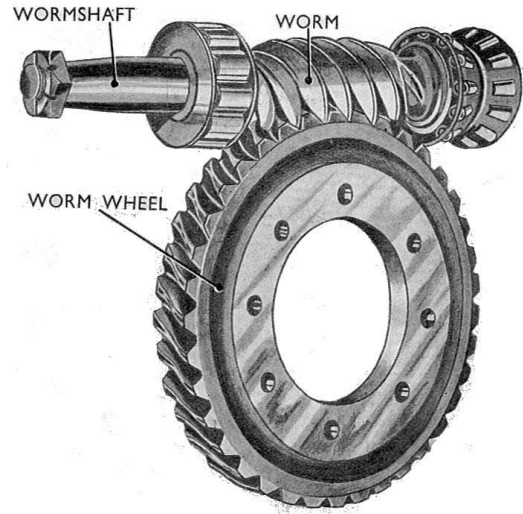


Figure 6: Worm Gear, Worm, Shaft



Figure 7: Backpack

Electrical Systems

An Arduino Nano will control the motor based off of user input.

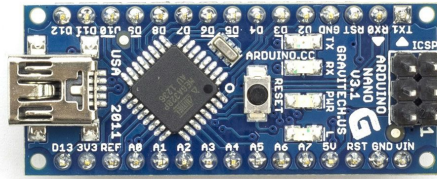


Figure 8: Arduino Nano



Figure 9: LiPo Battery (4000mAh, 24V)

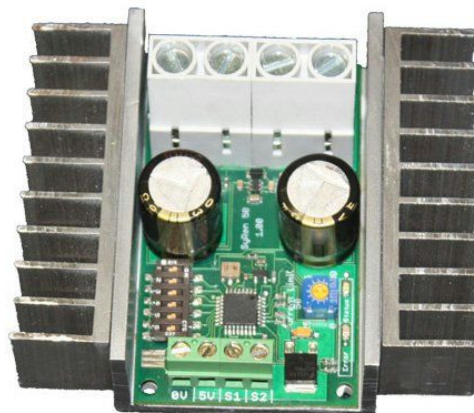


Figure 10: Syren 50 Motor Driver

Control Diagram

As seen in Figure 11, The battery provides power to the motor driver. The Arduino Nano takes in a signal from the input control pushbuttons and sends a signal to the motor driver. The motor driver feeds back into the Arduino, as well as sends a signal to the

motor. The motor turns the worm gear which provides the output torque. In Figure 11, [1] indicates the presence of a safety mechanism.

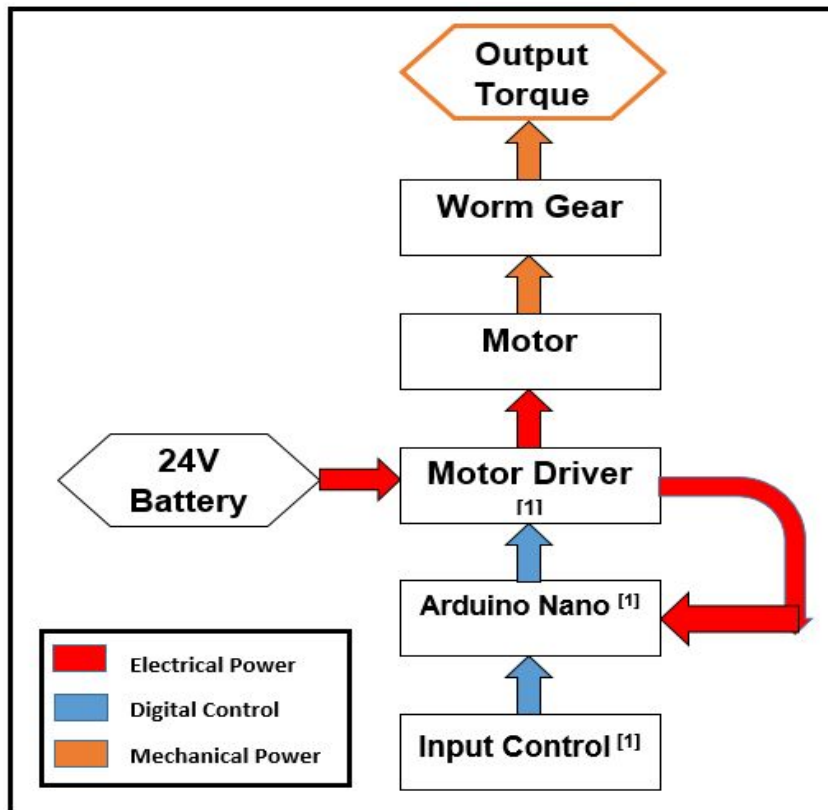


Figure 11: Upper Level System Design

Operational Instructions

To wear this powered orthotic, first put on the backpack and secure the hip belt and two backpack straps. Next, secure your arm with the straps on the orthotic. Before powering up the arm, check to make sure all straps are tight and secure. When ready, power up the device and use push button one to lift with the arm and push button two to extend the arm. Congratulations! You now know how to operate our powered orthotic. As with all products, please use safely and correctly to reduce the possibility for injury.

SAFETY - *Please read carefully*

- If the frame of the orthotic has any irregularities or damage do not use.
- If the battery is overheating, replace immediately or run the risk of a Li-Po being damaged and exploding.
- The frame is not designed to go out of the natural range of 180 degrees fully extended to 35 degrees fully contracted, if used or trying to use outside this range we are not liable for any injury that may occur.
- If any injury does occur, contact help immediately and go to a hospital.

Troubleshooting and Regular Maintenance

Although this orthotic device is designed for long term use, there is always a chance that malfunctions may occur over time. Take these steps in case of malfunction and for normal maintenance.

Ensure that the arm frame is still free of cracks and fractures.

If the arm is not functioning, make sure the battery is charged and none of the wire connections are loose.

Every three months

- Lubricate the frame at the elbow joint. To do this remove the bolt from the worm gear, separate the orthotic at the elbow, and apply grease liberally.

Every six months

- Inspect frame for corrosion.
- Inspect bolts and nuts to make sure they have not rusted or deformed.
- Check straps on backpack to ensure there aren't any tears or rips in the fabric.

Any signs the the arm is failing or has fatigue all use of the arm needs to stop and must be reported to the manufacturer immediately, or take it to a certified powered orthotic maintenance shop.

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Spare Parts

The powered orthotic device was designed to have easily replaceable parts in order to be as user friendly as possible. These spare parts listed are these such parts. For any other parts that need to be replaced, contact the manufacturer.

- Battery: 4000 mAh LiPo, 24V
- Nuts: 5/16"
- Washers: 1/4"
- Bolts: 5/16"x 3/4"
- Lubrication: Standard Lithium Grease

References & Appendices

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