Robotic Trans Radial Prosthetic MKIII

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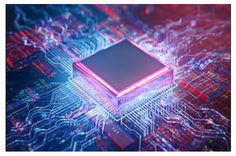
BACKGROUND

Prosthetic limbs have evolved much over the last century. Robotic prosthetics can be programmed to perform a wide range of functions. These types of medical devices attempt to restore more independence to amputees. Costs for these medical devices can range from $8,000 - $100,000. However, insurance companies often refuse to pay much of the cost, and this burden is left on the patient.



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User Independence:

A common problem among existing prosthetics is the requirement of a third party for many aspects of their use.

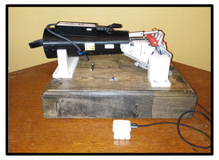


Figure 1: Prosthetic and Base Station

For example, if the user wants to equip their prosthetic; they will typically need help from another person due to the attachment mechanisms. This can prevent the user from utilizing their prosthetic. Not only is equipping the prosthetic a common struggle, but re-charging and swapping power sources is also an issue.

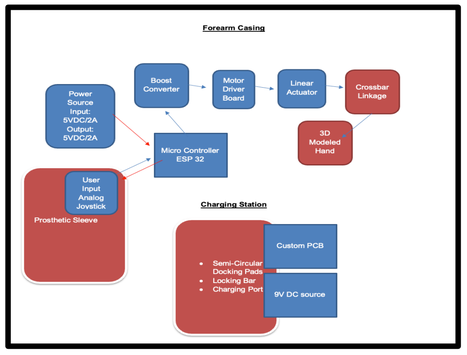
Prohibitive cost:

Prosthetics have historically been and are currently prohibitively expensive. As mentioned prior, these devices cost between 4 and 6 figures. Our solution, undercuts this figure by an order of magnitude (roughly $200/unit) increasing accessibility.

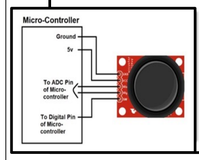
PROPOSED SOLUTION

Our proposed solution features two primary components, a prosthetic arm controlled via an analog joystick, and a base charging station. It utilizes several components (see system design) to create a seamless system aimed at conforming better to the user's daily needs. The prosthetic features an intuitive system for equipping and removing the device by utilizing a flexible 3D printed socket. The base charging station, as the name implies is responsible for keeping the battery charged when the user isn't wearing the device. It also has a grip bar so that the arm has something to brace against when the user no longer wants to wear the device. See the block diagram below (figure 2) for more information.

Figure 2: System Block Diagram



SYSTEM DESIGN



Analog Joystick

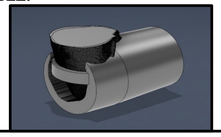
The system uses an analog joystick as its primary input. Its operation is simple, move it either up or down to open and close the hand, and click the button to lock the hand in place.

Rechargeable Battery Bank

The system is powered by a rechargeable battery bank. It features a 5000 mAh capacity capable of supplying 5 volts at 2 amps. With our base station, charge time is under 4 hours, and the battery can last over 24 hours.

Flexible Socket

The socket is inserted into the arm chassis and then worn by the user to give a custom fit. It is printed using TPU filament, allowing it to remain flexible.



Semi-Circular Holding Pad

The semi-circular holding pad is responsible for supporting the arm while in the base station. It helps to align the prosthetic with the charging cable. It is printed out of PLA filament.

Grip Bar

The grip bar is a critical component in the base station. It allows the user to lock the arm in place, so they have something to hold it while they remove or equip it. It is also printed out of PLA plastic.

Figure 3: Prosthetic

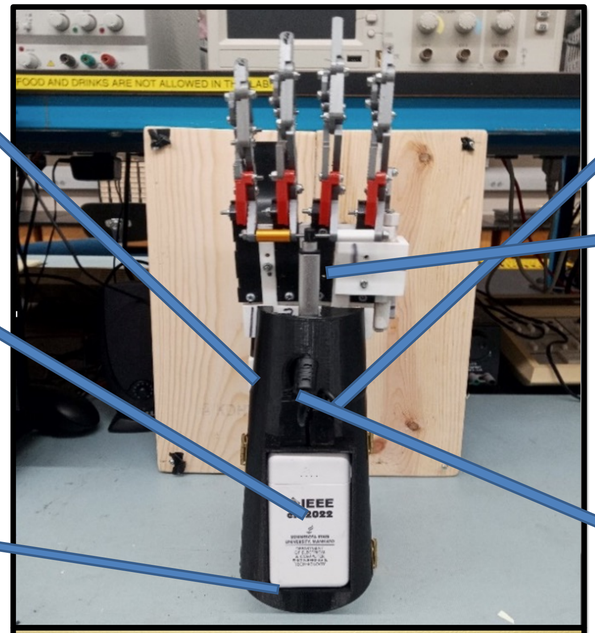
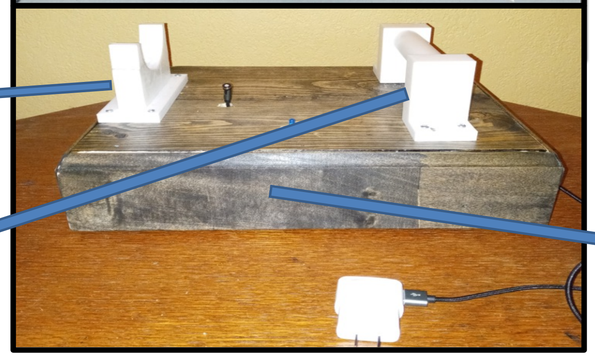
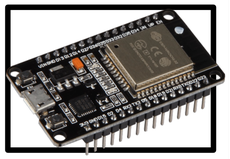


Figure 4: Base Charging Station



ESP32 microcontroller

The ESP32 is the "brains" behind the prosthetic's electronic system. It is responsible for taking input sent by the analog joystick and outputting the corresponding pulse-width modulated signal which is sent to the motor driver board. It also handles the lock function.



Linear actuator

The hand operation is controlled by a 12V 64N linear actuator, which receives signal from the motor driver board.

PLA Plastic Chassis

The prosthetic's chassis is created with Polylactic Acid (PLA) plastic. This filament is a nice balance between strength and weight. It is also easy to print with, cheap and more sustainable than other plastics.

Motor Driver Board

The motor driver board is responsible for converting PWM signals sent by the ESP32 into a voltage. This voltage is sent to the linear actuator and controls the extension of the hand.

Wooden Base Chassis

The base station chassis is constructed out of plywood and has the following dimensions: Length – 14.5 in, width – 11.75 in, height – 9.5 in. It has a hollow interior for electronic component housing. Inside is a custom PCB that handles charging logic. The PCB is powered through a hole in the side of the chassis, and power goes out through a cable aligned with the prosthetic.

Custom PCB

The custom PCB is housed inside of the base station and is responsible for charging control. When the prosthetic is within range and aligned properly, the circuit will start charging the battery and turn on a status LED. It is powered by a DC wall plug.

FUTURE IMPROVEMENTS

- Create a single PCB for prosthetic internal electronics.
- Implement an electromyography (EMG) sensor for more natural control.
- Redesign 3D models for more natural fit.
- Improve water resistance.
- Improve overall cosmetic appeal.

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