Active 3D Printed Prosthetic Arm

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Abstract

Hands are essential to daily life. Whether it is interacting with others or with one's environment, people rely on their hands for functionality, feedback, and control. For amputees, using prostheses can cost thousands of dollars. This financial burden is higher for child amputees because they need replacements as they grow. This project aimed to create an affordable active prosthetic device for children with upper limb amputations. This solution uses 3D printing technology to leverage both mechanical and electrical engineering. This device provides haptic feedback and control to its user at an affordable price. Using the client's toes, they can control the device with precision. The child that receives the arm will have a prosthetic that allows for greater control, functionality, and feedback for a low cost. The active prosthesis will also be released as open source for people to use around the world.

Background

This device provides below the elbow amputees with an active prosthetic arm that is affordable, functional, and controllable.

Low cost prosthetics are available through Enable. Enable is worldwide group that provides open source mechanical prosthetics for people in need. However, the devices are limited. This project expands on their goal to share prosthetic design around the world.

Actuation

Pressure input is mapped to motor output. This allows motion control of fingers and adjustability of grip, remotely controlled by the toes.
Steps 1-4 show the actuation process.

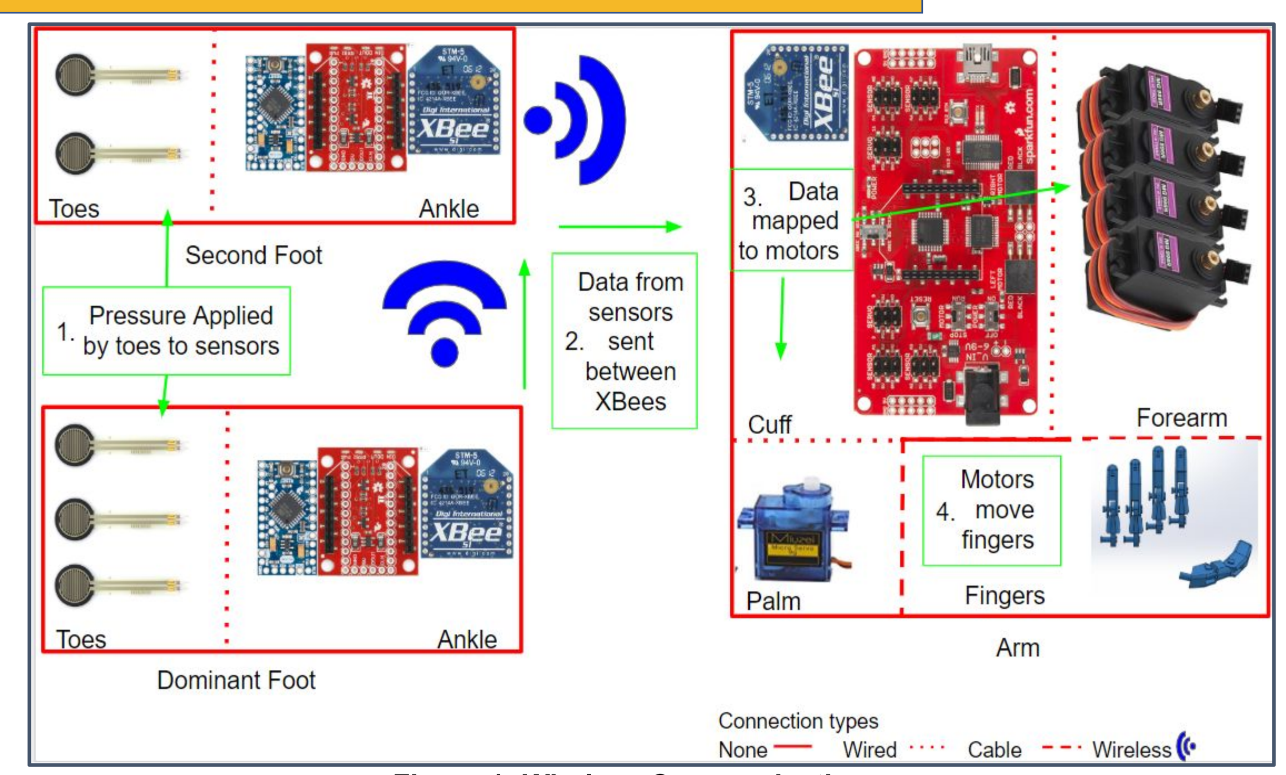
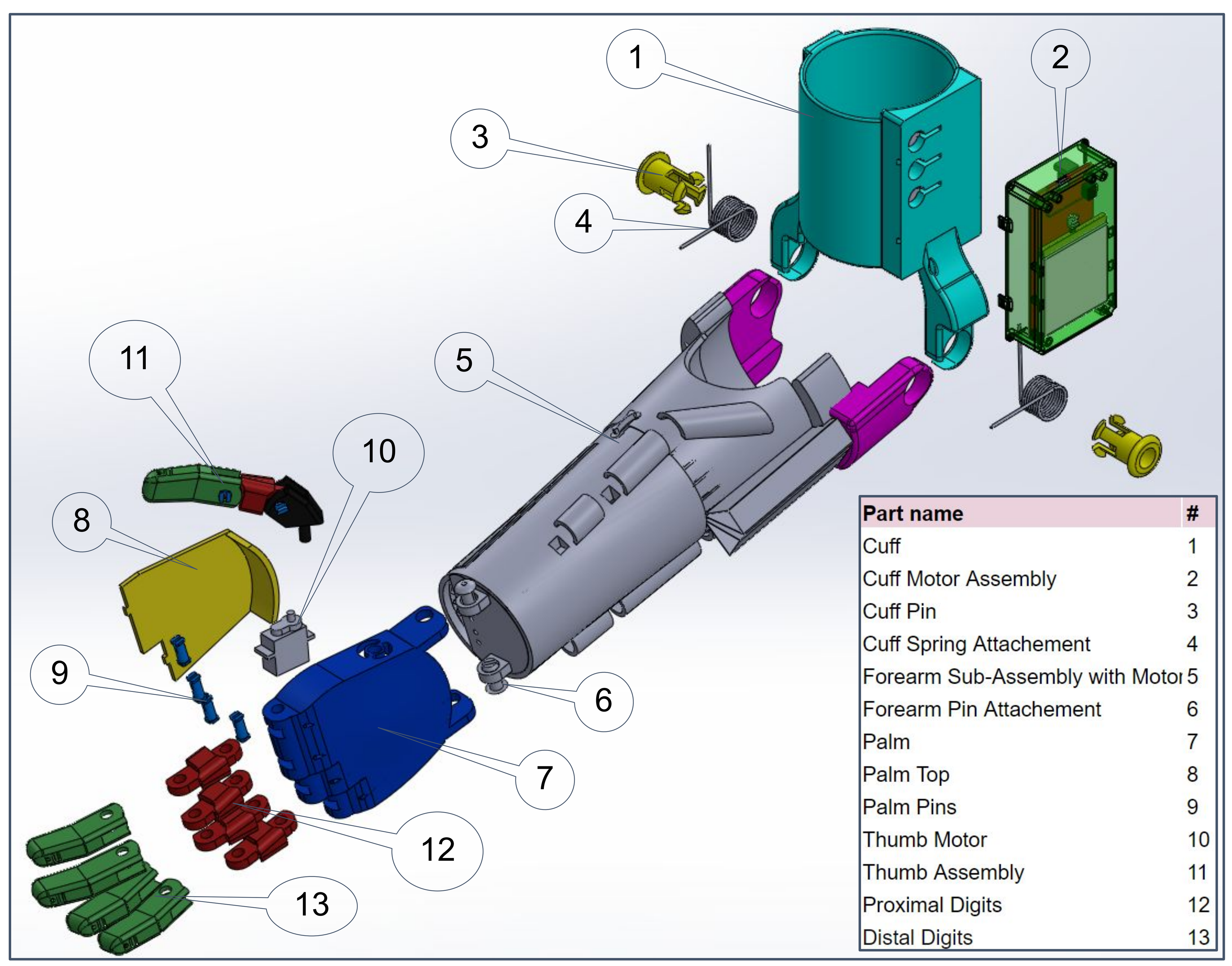


Figure 1: Wireless Communication

Final Assembly

The Prosthetic Arm is customizable, manageable, wire protected, and actuated via the electronics and CAD assemblies.

- The cuff, palm, and forearm subassemblies contain electronics and motors that control arm movement
- Wires are contained for user safety
- Spring aids with actuation and movement
- Total device weighs 2 lbs and is lighter than the average human forearm of 2.5 lbs
- 3D printed parts are easily scalable and replaceable
- The arm is more expensive than other Enable prosthetics because of its advancements. It is more affordable than most devices on the market



Part name	#
Cuff	1
Cuff Motor Assembly	2
Cuff Pin	3
Cuff Spring Attachement	4
Forearm Sub-Assembly with Motor	5
Forearm Pin Attachement	6
Palm	7
Palm Top	8
Palm Pins	9
Thumb Motor	10
Thumb Assembly	11
Proximal Digits	12
Distal Digits	13

Figure 2: Final Assembly Exploded View

Testing and Results

Tests were conducted to prove that the prosthetic meets engineering requirements.

Table 1: Testing Procedures

Engineering Requirement	Testing Procedure
Scalable Size (6-18 in)	Scale in SolidWorks
Weight (~ 3 lbs)	Weigh using fishing scale
Budget ($500)	Tally Receipts
Force to Actuate (< 5 lbs)	Measure from force sensors (1 lbf)
Force of Grip (2 lbs)	Measure from motors (9.5 in*lbs)
Number of Parts (< 100)	Tally Parts
Durability (< 10 lbs)	Withstands extreme forces

Figure 3: Durability Test Results

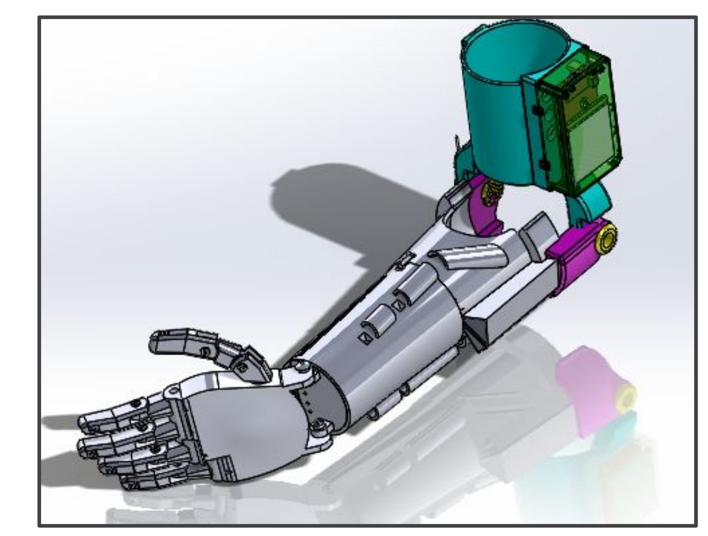


Figure 4: Final Assembly

Table 2: Testing Results

Engineering Requirement	Testing Results
Scalable Size	10.5-18 (in)
Weight (~3 lbs)	2 (lbs)
Budget ($500)	~$400
Force to Actuate	1 lbf
Force of Grip	+9.5 in*lbs
Number of Parts	98
Durability	Minor attachment fractures

References

"Enabling The Future," [Online]. Available: http://enablingthefuture.org/. [Accessed: 10-Oct-2018].

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