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3D Printing Low-Cost Prosthetic Arms for the Developing World

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PROBLEM STATEMENT

Sufferers of upper limb loss in the Dominican Republic need cheap but effective prosthetic arms. Providing these prostheses will allow them to re-establish a better quality of life, by making it possible to work and accomplish other day-to-day tasks again. Users require an arm that is both strong and durable to withstand the rigors of manual labor and environmental strain, while appearing aesthetically pleasing, for a low cost of about $100.

MATERIALS & METHODS

We decided to explore the independent feasibility of:

- **Servo motor based finger actuation**

The cost of servo motors is low, so the potential of creating a cost effective solution which allows for individual actuation of fingers is great.

- **Signals from muscles for servo activation**

Cost of constructing and weather-proofing sensor circuits is low, and will allow for more effective actuation of grip.

- **Modularity of hand, wrist, and forearm**

The cost of servicing will be greatly reduced if smaller, modular parts are used.

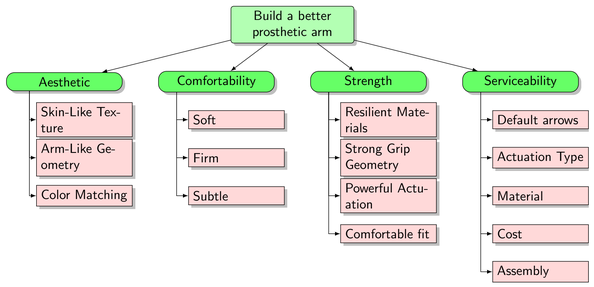
We explore the use of several filament materials, namely ABS, PLA, and a carbon fiber infused ABS
We use a modified EEG circuit for signal detection due to the availability of resources and the lower cost of the circuit components.

REFERENCES

[1] Gyrobot. Flexy-hand 2 by gyrobot.

[2] Yogendra Narain Singh, Sanjay Kumar Singh, and Amit Kumar Ray. Bioelectrical signals as emerging biometrics: Issues and challenges. *ISRN Signal Processing*, 2012:1–13, 2012.

INTRODUCTION



We have outlined what evidence has shown to be the most important considerations when designing and implementing prosthetics; though cost is a fundamental constraint in this project, we have placed it as a sub branch in this tree, as it is an important part of serviceability.

To obtain good aesthetic quality:

- high-resolution 3D printing
- arm-like geometry is obtained through the starting arm model [1]
- highly adhesive paint or various plastic colors

To achieve comfortability:

- properly weighted
- cushioned but firm attachment to amputation sight
- good aesthetics (socially comfortable)

To achieve strength:

- high-strength plastic
- good in-fill on fingers
- high-torque servo motors

To optimize serviceability:

- highly-accessible components
- easily printed materials
- modularity for individual components

RESULTS

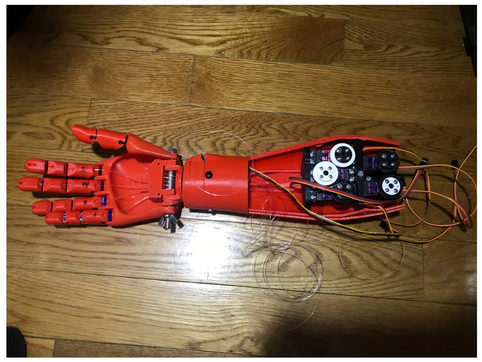


Figure 1: A hand and forarm assembly with servos and "tendons"

Our efforts thus far have resulted in the successful implementation of bi-directional servos (actuating both contraction and extension), a circuit which successfully detects electrical signals using conventional EEG technology, adapted for this purpose. Work still must be done to put everything together.
The resulting grip strength of the arm is superb, and the durability of the components (tendons, servos, plastic joints) has proven to be durable enough for manual labor
Figure 3 shows the current prototype for our muscle twitch detection. This circuit is based on an EEG due to availability of resources, but an EMG would be preferred and implemented without cascading changes.

Figure 2: A hand and forearm assembly gripping a drill

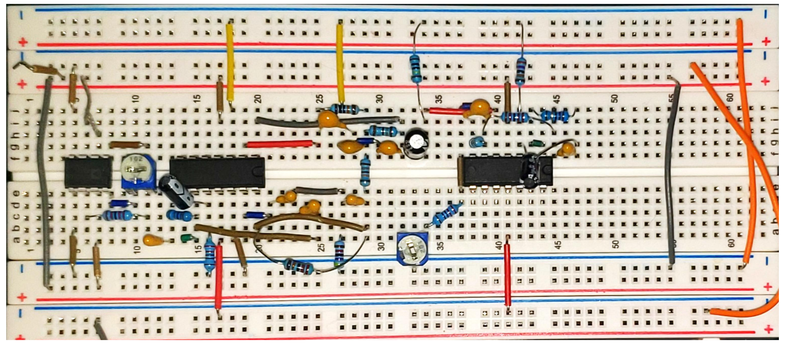


Figure 3: The prototypical EEG circuit, modified as a pseudo-EMG

CONCLUSION

- The current prototype has excellent grip strength and durability
- The actuation technology needs to be developed further, but promises to be effective and low-cost.