Creating Customizable Above-Elbow 3D-Printed Low-Cost Prosthetics for Refugees of the Civil War in Myanmar

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PROBLEM DESCRIPTION

Myanmar's ongoing civil war, has displaced an **estimated 1.5 million refugees to Thailand** in search of medical aid over the past 2 years [1]. Without official immigration status, many refugees are unable to access healthcare.

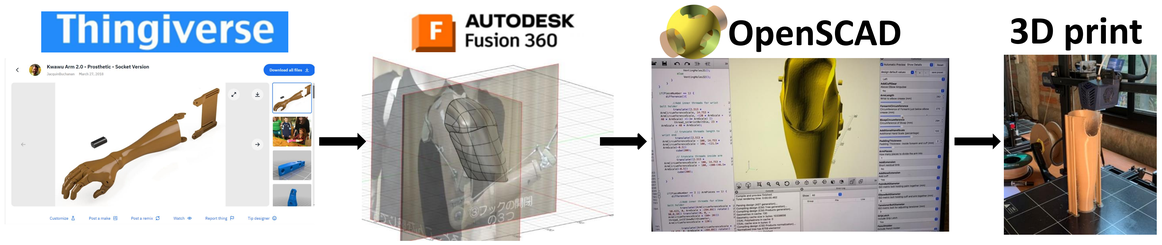
Burma Children Medical Fund (BCMF) is a nonprofit based in Mae Sot, Thailand (fig.1) that focuses on funding medical treatment and support services for these refugees, including providing accessible prosthetics for those who have experienced limb loss. Currently, BCMF offers only below-elbow prosthetics, limiting accessibility for amputees. The staff at BCMF have **limited Computer Aided Design (CAD) experience** so they cannot design different prosthetics to provide prosthetics to above-elbow amputees.

Queen's Biomedical Innovation Team (QBiT) at Queen's University is a student-led biomedical engineering design team that has started a prosthetic project to support them.

Fig. 1: Mae Sot, Tak, Thailand.

The objective of this project is to design a low-cost, 3D-printed, body-powered, above-elbow prosthetic similar to the existing below-elbow prosthetics currently used by BCMF.

METHODS



BCMF uses the below-elbow Kwawu Arm 2.0 [2] found on open-sourced on Thingiverse. Above is BCMFs workflow, QBiT has created the new prosthetic design while maintaining BCMF's workflow.

QBiT has designed a shoulder piece to extend the below-elbow prosthetic to fit above-elbow amputees (fig.2). We have created an OpenSCAD [4] user interface for staff at BCMF. OpenSCAD scales the model by length and circumference to fit the prosthetic the recipient's unique measurements. Our harness design is created from a polyester strap so the patient can control the prosthetic by adjusting their shoulder to operate the hand attachment (fig.2).

Fig. 2: CAD assembly of the shoulder, forearm and gripper hand prosthetic.

Fig. 3: A.R.M. Pieces include the arm, forearm, gripper hand, wrist bolt.

Future work includes:
Continuing to fill the gap between open-sourced models and patient-specific needs to refine the 3D-printing workflow by creating customizable, generalized designs.

RESULTS

Since 2019, BCMF has provided about 100 3D-printed prosthetics with about a dozen refugees on the waitlist for the new above-elbow prosthetic. This durable design is made for Burmese climates and living conditions. The control wires connecting the harness to the dynamic prosthetic are routed internally, minimizing the risk of snagging. The final design restores partial range of motion to the patient through the use of the body-powered prosthetic.

Fig. 4: CAD assembly of the shoulder, forearm and gripper hand prosthetic.

CONCLUSION

We have added a comprehensive manual, complete with detailed images, and a tutorial video outlining the steps for setting up the harness to fit the patient's measurements.

The arm is undergoing an iterative testing process for durability and comfort with constant communication between the BCMF and QBiT. Patient feedback from BCMF ensures the prosthetics cater to the needs of each recipient. The prosthetic will incorporate interchangeable end-effectors to adapt to the patients' daily activities.

This collaboration demonstrates the potential for future partnerships between educational institutions and NGOs to address health care access disparities and empowers BCMF to expand their reach and improve access to low-cost, body-powered prosthetic solutions for a growing number of patients in need.

References

1. UN. *Overview of Myanmar nationals in Thailand*. IOM UN migration. https://thailand.iom.int/resources/overview-myanmar-nationals-thailand-april-2024
2. *Burma Children Medical Fund - Mae Sot, Thailand*. BCMF | Burma Children Medical Fund - Mae Sot, Thailand - Operating to give people a future. (n.d.). https://burmachildren.com/
3. Buchanan, J. (2018, March 27). *Kwawu Arm 2.0 - Prosthetic - socket version*. Thingiverse. https://www.thingiverse.com/thing:2841281
4. *OpenSCAD*. The Programmers Solid 3D CAD Modeller. (n.d.). https://openscad.org/