Royal Academy of Engineering

Developing low-cost hand prostheses for patients in need

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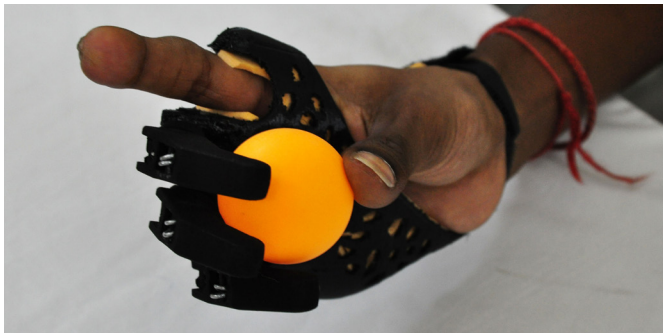

1 Access Prosthetics (2017). 15 Limb Loss Statistics that May Surprise You https://accessprosthetics.com/15-limb-loss-statistics-may-surprise/

2 WHO (2005). Guidelines for Training Personnel in Developing Countries for Prosthetics and Orthotics Services https://www.who.int/medical_devices/publications/guide_prosthe_ortho_train/en/

3 Alturkistani R, A K, Devasahayam S, Thomas R, Colombini EL, Cifuentes CA, Homer-Vanniasinkam S, Wurdemann H, Moazen M. 2020. Affordable passive 3D-printed prosthesis for persons with partial hand amputation. Prosthetics & Orthotics International, 44:92-98. https://doi.org/10.1177/0309364620905220

Project

Development of an affordable hand prosthesis

Awardee

Mehran Moazen,
University College London

Collaborators

- Helge Wurdemann, University College London
- Shervanthi Homer-Vanniasinkam, University College London
- Esther Luna Colombini, University of Campinas
- Carlos Cifuentes, Colombian School of Engineering Julio Garavito
- Raji Thomas, Christian Medical College
- Kavin Alagesan, Christian Medical College
- Suresh Devasahayam, Christian Medical College

Challenge

The loss of all or part of a limb is a traumatic and life changing event. Globally, there are over one million limb amputations every year[1]. The World Health Organization estimates that 30 million people need a prosthetic or orthotic device[2]. Significant advances in technology in recent decades mean that there are solutions that can assist amputees in their daily life. However, many of these technologies are unavailable to people from disadvantaged backgrounds or low- and middle-income countries, where hospitals may not have the tools or expertise to provide prosthetics and patients often lack the means to afford treatment and rehabilitation. This is especially true for partial hand amputees, whose amputations are more unique and complex than other body parts so there is far less expertise in this form of rehabilitation.

Project solution

To help address this problem, three teams of engineers from Colombia, Brazil, and the UK worked with clinicians at the Christian Medical College (CMC) in India to design and create low-cost upper limb prostheses that can be offered to patients in need. The teams designed and manufactured 3D-printed patient-specific prosthetic hands using moulds and information about the patients from the clinicians at the hospital[3]. The team also hosted a student

competition in all three countries to design non-3D-printed hands, as an alternative to 3D-printing, using recyclable materials and easily accessible manufacturing procedures.

Interdisciplinary collaboration

Partial-hand amputations can differ widely and must be reviewed and treated on a case-by-case basis. With teams in four separate countries around the world, close collaboration between clinicians and engineering teams was crucial in delivering functional prostheses. Images and 3D moulds of patients' hands were shared among the team to develop 3D printed and non-3D printed designs. During two capacity- building trips to India, researchers and students from the UK, Columbia and Brazil met with patients to test the prosthetics and further refine them based on their feedback.

Impact

At the end of this project, three 3D-printed hand prostheses and three non-3D-printed ones were tested on the patients, using the GRASP Taxonomy test to examine the functionality of the prosthetic devices. The 3D-printed prostheses outperformed the non-3D-printed ones and the researchers received positive anecdotal feedback. The team trained local clinicians and researchers in India in the research methods and prosthetic design process, as well as students in their respective countries. A further 60 students from the UK, Colombia, and Brazil participated in the student competition and were taught non-3D-printed prosthetic design and manufacturing, building their engineering capacity and research skills. The team identified ways to further improve the functionality of the 3D-printed devices and have continued working in this area through student projects[4]. Finally, the team identified that one of the key challenges for the CMC was access to manufacturing facilities to create the prostheses. The team is currently working on providing the hospital with access to 3D printers to enable them to create their own designs and support their patients.

Future plans

Following positive initial results, the team is working to establish continuity for the project and attract further funding to expand its reach, aiming to help more patients get the care they need. Scaling up this project could give local hospitals a sustainable means of providing accessible and functional prostheses to their patients.

"The driving force behind this project was our motivation to have a tangible impact on the people in need. I've worked on many projects over the course of my career, but to me, this project has been one of the most positive ones. Even though we all come from a diverse range of backgrounds and expertise, we were united by this common goal to make real impact to the communities of India."

Mehran Moazen, University College London

Sustainable development goals

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Prostheses

Funding

The 12-month project was rewarded £20,000 from the Frontiers of Engineering for Development programme in 2017.

Three 3D-printed hand prosthesis and three non-3D-printed ones developed and tested

60 students from the UK, Colombia and Brazil participated in student competition to design a non-3D-printed prosthetic

For more information, including eligibility, please visit **raeng.org.uk/frontiers** and follow **@RAEngGlobal**

Royal Academy of Engineering
Prince Philip House, 3 Carlton House Terrace, London SW1Y 5DG