

# **PRELIMINARY PROJECT PROPOSAL**

## **PROTOTYPE DEVELOPMENT OF A BRUSHING SYSTEM FOR PEOPLE WITH ARM DISABILITIES**

**Submitted to,  
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# INTRODUCTION

India has more than half a million amputees with tens of thousands added to the community every year. A majority of these amputations are a result of traumatic injuries sustained at work sites (like agriculture, construction, railway, military etc) or accidents. Such injuries may also render people in a quadriplegic state. Our study is focussed on people who have lost the functionalities of their upper extremities either due to amputation or paralysis. The lives of such people are pathetic as they have to rely on external support for performing their basic needs. We indent to help them be self-reliant in brushing their teeth. It is common now a days to see the use of prostheses by amputees to aid them in their daily lives.

A survey of upper limb amputees had been carried out at the Defence Services Artificial Limb Centre, Poona, India. Out of the 130 cases, only 30 people were bilateral amputees. The majority of the unilateral amputees (ULAs) did not use their prostheses for functional purposes. They wore it solely for cosmetic purposes. In contrast, among bilateral amputees (BLAs), the use of prostheses for functional purposes was very high, as their very existence depended on their functional gain following prosthetic fitting. [1]

The details of such surveys show that the prosthetic arms available in Indian market are functionally poor. A robotic arm is therefore irrelevant to most ULAs, who use protheses for cosmetic purposes. They are able to perform most of their activities using their capable hand and may use the prostheses for slight support only. On the other hand, full-fledged robotic prostheses are very useful for BLAs. But due to the limited utility offered by such devices, most of the BLAs ends up rejecting them. They end up using terminal devices instead, that offers specific functionalities. The most commonly used terminal devices are hooks, tweezers, tumbler holders etc.



*Figure.1 Terminal devices*



*Figure.2 Bilateral below elbow amputee, eating food with the help of a spoon device. Patient is wearing a tumbler holder on the other side. [1]*



*Figure 3 Bilateral below elbow amputee using rolling pin to make bread, with the help of hooks. [1]*

## ABOUT US

We are a group of five engineers, representing **Betamex** (start-up) and **R and D GECB** (student group), from Government Engineering College Barton Hill, Trivandrum. This project will be worked on as a joint venture between **Betamex** and **R and D GECB** under the guidance of **Dr. Anish K. John**.

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## SOLUTIONS

The survey mentioned in the introduction is outdated, but its findings are partially relevant even today. Most of the Indian made prostheses are cheap, but not functional. On the other hand, the imported products show better performance but is outside the buying power of a typical Indian user. A proper market survey is required to identify the exact needs and understand the general use cases of amputees in India. Inputs from such interviews will help us develop an affordable and useful product.

Considering the limited functionality of the indigenously available prosthetic arms, their irrelevance to ULAs and greater dependency on terminal devices by BLAs, we are suggesting 2 solutions which doesn't involve the use of prosthetics. Also, the application of these solutions is not constrained to handicapped people alone, but can be used by everyone.

1. A head mountable device that implements a mechanism to facilitate the brushing action.
2. A novel tooth brush design that provides a hands-free brushing experience.

In addition to these solutions, a prosthetic limb can also be realised to overcome the drawbacks of locally available artificial limbs. This prosthetic limb will not be developed as a terminal device, but as an arm capable of holding and using tools for brushing and other basic needs.

## Head mounted device

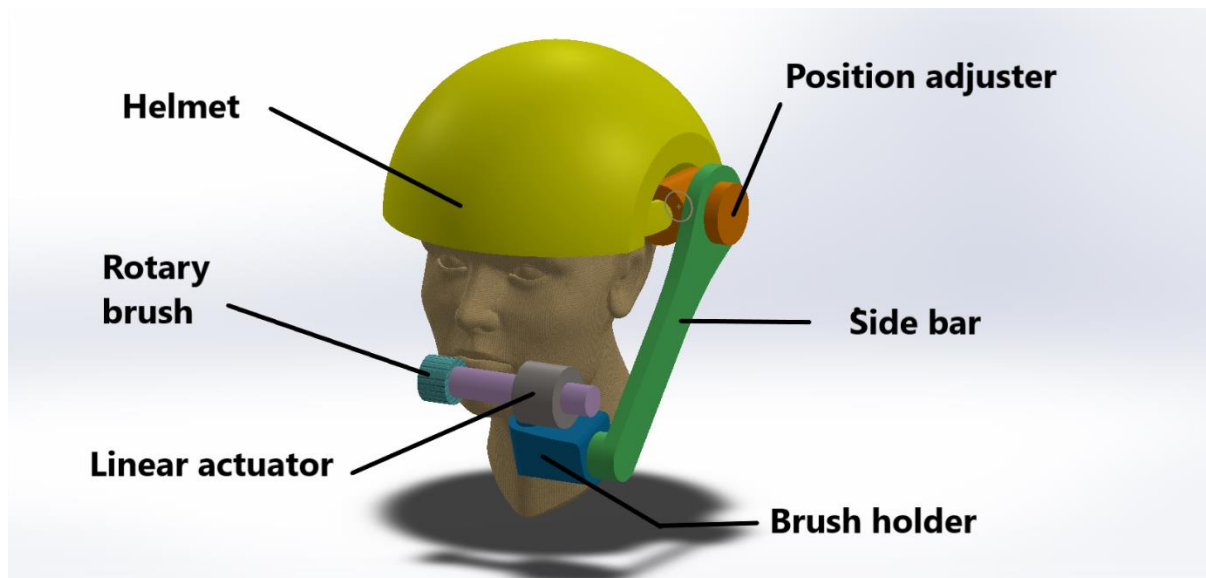


Figure.4 Model of the head mounted device

This device consists of a helmet like frame that sits on the user's head which supports and controls the rest of the parts. It makes use of a rotary brush to ease the brushing process. A simple mechanism involving 2 hinges facilitate the accurate positioning of the rotary brush with respect to the user's mouth. The side bar is extendable to fit all face sizes. The brush holder and linear actuator helps the mechanism to position the brush at different orientations inside the mouth. A flexible tubing connected to a small water container will be also provided so that the user can sip in water for rinsing their mouth (**note:** - this feature is not provided in the given models).

The rough working of the model can be viewed on this link [animation.mp4](#).

**Note:** - This is a rough model. The dimensions and fits are not accurate. All the parts shown are basic geometric representations and actual components may vary in appearance.

## Concept Tooth Brush

One of the best solutions to help a disabled person to brush is to redesign the tooth brush to suit his/her disability. After doing some market research we found some interesting products. The first one is the **Amabrush** claimed as the world's first automatic tooth brush. The Amabrush provides a hands-free brushing experience. The mouth piece is arranged with bristles which are vibrated electrically. Nozzles are provided on the mouth piece to supply tooth paste.



*Figure 5 Image of Amabrush*

Despite the easy-to-use flexible design, Amabrush failed in achieving its goal. Most users were unsatisfied by the cleaning provided. Watch this link for more details <https://youtu.be/iWxIXJ-VWOI>.

Another inspiring product is the **WaterPick's Cordless Water Flossers**. These devices make use of pressurised water jets to remove plaque from teeth.

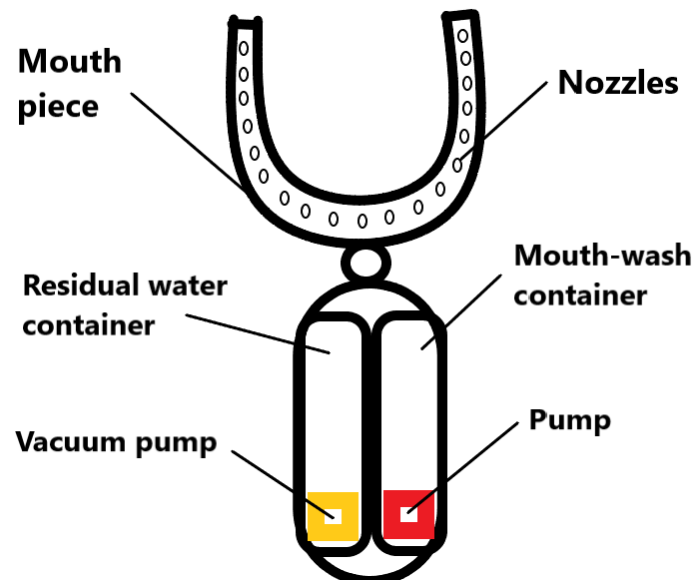


*Figure 6 WaterPicks cordless flosser*

Considering these two products, we plan to design a hybrid of both in achieving a new automatic tooth brush. Our design comprises of 2 containers, one for mouth wash and the other for collecting residual solution from the mouth. This tooth brush will have a mouth



piece similar to the Amabrush but without the bristles and vibrator. A pumping system as in the WaterPick's design will be used to spray jets of mouth wash on to the user's teeth, through carefully oriented nozzles. A vacuum pump will be used to suck out the residual solution parallelly. By combining these two systems, we hope to combine the efficient cleaning of the flosser and the hands-free experience of the Amabrush.



*Figure 7 Concept tooth brush rough sketch*

## Prosthetic Limb

This solution is aimed for amputees. Since amputations can occur at different levels, this solution is planned to be carried out as 3 stages: -

1. A prosthetic hand, for amputations near the wrist.



*Figure.8 prosthetic hand*

2. A prosthetic forearm, for amputations near the elbow.



*Figure.9 prosthetic hand and forearm*

3. A prosthetic arm, for shoulder level amputations.



*Figure 10 full length prosthetic arm*

All these prostheses will be designed and manufactured to be integrated with each other, thus resulting in a complete prosthetic limb. These prostheses will be complete on their own to be used by individuals with different levels of amputations.

## References

- [1] M. F. Brig. I.C. Narang, M. M. Lt. Col. B.P. Mathur, M. Lt. Col. Pal Singh and M. M. Mrs. V.S. Jape, "Clinical Survey of Upper Extremity Amputees in India," vol. 40, no. 1986, pp. 29 - 37.