A DEVICE TO CONVERT BREATH INTO SPEECH

Ammar Chaudhry, Kanav Agarwal, Lingzhi Qiao, Raj Jain, Sanjana Ganguly, Sanjith Nambiar, Snehil Kumar, Yinzi Zhang

Abstract

The aim of this project is to create an Augmentative and Alternative Communication Device (AAC) which enables people with Neurological Developmental Disabilities (for example: LIS, ALS, Parkinson's Disease) and even speech disabilities like Muteness and Dysarthria, to converse naturally [1].

The device will use variations in a person's breath, representing letters, which when interpreted in the form of Morse code, will form sentences.

The first section of this report will look at the problem statement followed by the market research wherein the idea of existing possible ineffective solutions will be reiterated. Finally, the section of project development will look at the technical details and the concepts from the modules that will be used to implement this project.

1. Proposal

A: Problem Statement

According to a study conducted in the United States, about 1 in 50 people suffer from some form of paralysis resulting from spinal cord injuries [2]. China and India have over 11 million and 9 million people suffering from paralysis respectively [3]. Although not all paralyzed individuals suffer from speech impediments or muscular degeneration, there is a significant need for a non-muscle activated speech device. This device will enable them to communicate more organically, thus helping them live a better life.

B: Market Research and Business Case

The global speech generating devices market is projected to have a compound annual growth rate of 12.2% between 2017 and 2022, reaching a market value of 300 million USD [8].

C: Competitor Analysis

It is evident through the growth rate and market value that this is a growing area of interest, with existing solutions to the problem. However, we believe there is a need for a more affordable and accessible solution; which will differentiate this product from its existing competitors.

Some AAC devices in market include:

- Eye Tracker ~ £2500 (Causes fatigue and strain)[5]
- Brain Computer Interface (BCI) ~ £6000 (Still in its developmental phase)[6]
- Single Switch ~ £4600 (Slow speaking rate)[7]

These devices are slow, bulky and expensive. With proper implementation, the device can be made more financially and physically accessible, and will be able to support increased speaking rates.

The frontrunners in the supply of AAC devices are the following companies [9]:

1. Tobii Dynavox – World leader in eye tracking
2. Saltillo Corporation – Configurable communication devices

2. Project Development

A: Objectives

Through extensive planning and discussion, the following objectives of this project were defined as follows:

- Providing an alternative to muscle or eye movement induced communication.
- Providing a more cost effective AAC device.
- Configuring an increased speaking rate and convenience to the user.
- Prototyping and developing a robust, light-weight and portable low-power device.

Some ideas for additional features are:

- Providing an interface to display the commands entered through Morse code to viewers.
- Using external text to speech plugins integrated with a speaker module to give a 'voice' to the user.

B: Resources and Expertise

For the group project, we would be using of the following facilities and resources available to us –

- *Robotics Lab* – In order to come up with a robust and reliable structure for project, 3D printing facilities at the Robotics Lab will be of great use
- *Electronics Lab* – Since the Electronics Lab at the department is very well equipped, all the circuits and the prototypes will be built and tested in the lab

- *Advanced Hackspace* – The design and prototyping sub-group will use the resources of the Advanced Hackspace to come up with the best possible design.
- *Enterprise Labs* – To be used for brain storming and group meetings
- *Department of Bioengineering* - To gain knowledge on AAC devices

C: Technical Mapping

Circuit Analysis, Analogue Electronics and Control Engineering: Firstly, concepts of Circuit Analysis will be used extensively to connect sensors to each other. Furthermore, the integrated concepts of Circuit Analysis and Analogue Electronics, such as the ones explored in the Microelectronics Labs in Year 1 will be heavily used. For instance, op-amps will be used to amplify weak signals and other signal processing skills be useful.

Software Engineering: Concepts explored under the Microcontrollers experiment in Year 1 such as Arduino Board programming using C++ syntax will be used. To further tackle the intricacies of the problem, few concepts of machine learning intertwined with the Arduino programming.

D: Project Planning

The group of eight members have been allocated into roles as follows:

Project Manager: Sanjana
Module Sub-Group 1 - Circuit Design and Implementation: Sanjith, Raj, Yinzi, Ammar
Module Sub-Group 2 – Software Engineering: Kanav
Module Sub-Group 3 – Product Prototyping: Sanjana, Snehil, Linghzi
Secretary and Treasurer: Raj

The group uses WhatsApp for instant messages along with Google Drive for a file sharing system. Additionally, regular meetings will be taking place every week with each one lasting for an hour. For the purposes of decision making, the matrix method learnt in EDP in the first year will be employed. Finally, module sub-groups overlook each other's progress to ensure the progress is on track.

E: Timelines

The following timelines have been defined by the team:

- Beginning of Autumn Term; Weeks 2 – 6: Feasibility Study, Response, Research, Learn Skills
- Middle of Autumn Term; Week 7: Define Engineering Design Criteria and Product Design Specification
- End of Autumn Term: Preliminary Report
- Beginning of Spring Term: Stage 1 - Circuit Design and Implementation, Arduino Programming and Product Prototyping
- Middle of Spring Term: Implementation of PDS, ordering parts, and Stage 2 of Prototyping
- End of Spring Term: Final Stage – Testing, Poster Print, Demo, Poster Presentation and Final Report
- Beginning of Summer: Portfolio, Peer Assessment

3. References

1) https://www.cdc.gov/ncbddd/developmentaldisabilities/index.html
2) https://www.christopherreeve.org/living-with-paralysis/stats-about-paralysis
3) https://www.eyecomtec.com/3016-Statistics-about-Paralysis
4) http://www.nichcy.org/pubs/factshe/fs11txt.htm
5) http://www.aetna.com/cpb/medical/data/400_499/0437.html
6) https://en.wikipedia.org/wiki/Brain%E2%80%93computer_interface
7) https://www.healthcaredive.com/press-release/20180625-global-speech-generating-devices-market-projected-to-expand-at-a-value-cagr/
8) https://in.pinterest.com/iu5atc/aac-augumentative-communication-device-companies/?lp=true
9) https://www.christopherreeve.org/living-with-paralysis/stats-about-paralysis