# HOPE Devices: Tone of Voice in Augmentative and Alternative Communication


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## Abstract

The Amyotrophic Lateral Sclerosis (ALS) community requires new technology to aid in expressing emotion with speech generating devices (SGDs). The project aims to create a new access method, to make it easier for users to input their desired emotion and implement emotion into synthesized speech. Current systems do not allow users to input emotion, nor do their systems integrate emotion into synthesized speech. Emotion is thought to be expressed by modulating pitch, accents, frequency, rate, and intensity. The goal for our team is to generate original solutions to offer expressive control over the tone of speech produced by their SGD. Our team has identified specific settings that allow sentences to be differentiated in the emotion they convey. Our current program can integrate normal, happy, and sad into synthesized speech. We have also created sensors that allow the user to indicate the emotion they would like to convey.

### *Significance*

Many people with ALS have verbalized through speech generation devices the desire to express emotion to their friends and loved ones. They want to talk in a loving voice to their wives, to express sadness when they are troubled, and to show enthusiasm when motivating others. While medicine and research are actively seeking the cures for ALS, technology has supported this population to remain integrated into society and continue to communicate. Emotion in SGDs is the next step to empower the ALS community to be heard with expression.

## Problem Statement

The ALS community, which is the targeted customer population, requires new technology to aid in expressing emotion with SGDs. There is a need to develop ways for ALS users to easily integrate emotion into the existing software of their SGDs and use simple input methods to determine the emotion they want to convey. The access methods produced for the project should be compatible with emerging speech generation software, and should address the integration issue.

## Methods

Thorough research of current literature was completed in order to gain an understanding of ALS. We specifically sought to identify ways in which it affects people and the extent of their mobility over time. The team was fortunate to work with Godfrey Nazareth, a biomedical engineer diagnosed with ALS. During the last semester many meetings were conducted to evaluate our designs with Godfrey. As a team we also reached out to the ALS community. A forum was created in order to ask people affected by ALS what emotions they would want to have and what ways would they prefer to input these emotions through their SGD.

## Solutions Considered

There are multiple solutions and perspectives to solving the problem of emotional input in speech generation devices. The following ideas shows how Arduino (a free platform with easy-to-use and low-cost hardware) and off-the-shelf sensors make it possible for users to select and input emotions in an easy manner. The team modified the existing open-source software, Optikey, to demonstrate the use of sensors through a text-to-speech generation program.

### *Concept Designs*

1) <u>MyoWare Muscle Sensor</u>

The muscle sensor, depicted in figure 1, is a wearable sensor which is placed on any muscle group on the individual. For example, the user can wear the sensor on their wrist, forehead, calf, or any part that still has muscle control. While using the selected muscle group, the user would then select an emotion by flexing/twitching the desired muscle to click through an "emotion menu". Once an emotion is selected it is sent to their SGD.

*Figure 1 - MyoWare Muscle Sensor*

*Figure 2 - SoftPot Membrane Potentiometer*

2) <u>SoftPot Membrane Potentiometer</u>

The SoftPot membrane, refer to figure 2 is a strip that can be attached to the user's device or armrest. This way we give the user the ability to select an emotion by pressing their finger at specific points  the SoftPot to gain access to a range of emotions.

3) <u>Infrared Sensor (Proximity sensor)</u>

The infrared sensor is going to be used as a proximity sensor, refer to figures 3 for an illustration of the sensors. This would mean that the user would have wear an infrared emitting led wristband/armband. Then by moving closer or further away from the receiver the user would be able to select an emotion of their choosing.

*Figure 3 - Infrared Sensor, Transmitter, and Receiver*

*Figure 4 - Galvanic Skin Response (GSR) Sensor*

4) <u>Galvanic Skin Response (GSR) Sensor</u>

The GSR sensor measures sweat and depending on how much the user sweats from the normal benchmark an emotion could have been selected on behalf of the user. The sensor(s) would be wrapped around the user's fingers. Refer to figure 4 for an example of the sensor. Using this sensor(s) would have been very difficult because not all users sweat under the same conditions.

5) <u>Pulse Sensor</u>

The pulse sensor measures the user's heart rate. Using this information, we had hoped it would've been possible to detect increases or decreases in the user's heart rate. If the user's heart rate was not his resting heart rate, we thought it could've been possible to tell what emotion the user was feeling and suggest an emotion on behalf of the user. Refer to figure 5 for an example of the pulse sensor.

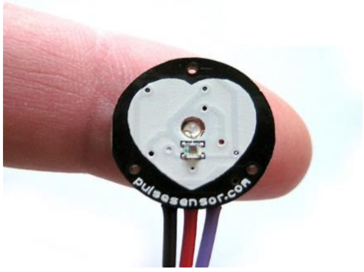


*Figure 5 - Pulse Sensor*

Figure 6 - Emotiv Neuro Headset

6) Emotiv Neuro Headset

This headset interprets the signals the user's brain is generating and then executes what he or she is thinking about doing. For instance, if I were to think about switching a light on, I can make it happen by thinking about it. This device will enable disabled people to complete their tasks by only thinking about the task that needs to be done. The only downfall with this type of sensor is that you have to teach the headset how your brain reacts when you are thinking or even smiling. An emotive headset is depicted in figure 6.

## Results

The above seven ideas had to be narrowed down to two ideas, one of which the students in the United States will work on and one of which the students in South Africa will work on.

Several important aspects were considered when we looked at all of the mentioned ideas. The product should:

- Be adaptable in regards with the physical ability of the ALS individual.
- Be widely and commercially available, if something were to break it can easily be fixed.
- Obtain minimal levels of intrusiveness.
- Blend in with the individual's daily accessories and style, thus it should look appealing to the eye.
- Be easily used in various positions, for instance lying or sitting.

The mentioned aspects were of importance to the team as they stood out from all the rest. A survey/questionnaire was handed to individuals in the ALS community and based on all of the responses and above mentioned key aspects the team decided to work on the MyoWare Muscle Sensor and the SoftPot Membrane Potentiometer.

### *Final Design Description*

The final design of the project consists of a computer, an Arduino, and a sensor. The computer, or the SGD, uses an open source program called Optikey that the user can use to type the sentence he/she wants to say. The Arduino receives the desired emotion from the sensor and tells Optikey to speak in the selected emotion of the user. The sensor, or sensors in our case, allows the user to choose the desired emotion that he/she wants the SGD to speak with. The two sensors that the user can choose to use depending on their personal preference are the MyoWare Muscle Sensor and the SoftPot Potentiometer Membrane sensor.

The MyoWare Muscle Sensor can be put on any muscle group that the user wants to use to select their desired emotion. For example, the user can put the muscle sensor on their forearm and use that muscle group to select their desired emotion. To select a desired emotion the user will twitch the muscle group that the sensor is on. For example, one twitch will select a happy emotion, two twitches will select a sad emotion and so on. This sensor is for a user that may have lost their fine motor skills, but still has the ability to twitch larger muscle groups. With this sensor not being the most aesthetically pleasing device, a sleeve, like a shooting sleeve worn by basketball players, can be worn overtop the muscle sensor to give the sensor a more aesthetically pleasing look for the user.

*Figure 7 - The MyoWare sensor was designed to easily plug in to any computer using a universal USB type A. The black sleeve pictured, provides coverage and holds all sensor close to skin.*

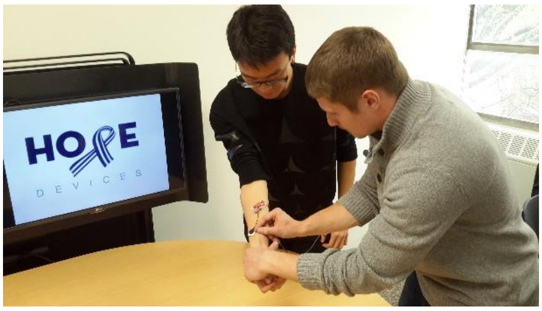


*Figure 8 - Matt Vincent gently securing the EMG sensor for Richard Song to demo.*

The SoftPot Potentiometer Membrane sensor is a very user friendly sensor. It is user friendly in the fact that it can be put on any hard, flat surface where the user would like to have it. That may be on their computer, the armrest of their wheelchair, or any other place they may want to put it. This can be done because the SoftPot is put on a thin plastic sheet that has an adhesive backing that can stick to any surface. Covering the SoftPot and the thin plastic sheet is a fabric that has colors indicating where to press to select a desired emotion. For example, if the user wanted the SGD to speak in a happy tone they would press the yellow color. If they wanted the SGD to speak in a sad tone they would press the blue color. This sensor is for users that may have lost control of major muscle groups, but still have the ability to use small muscles like muscles in their fingers to press on the SoftPot to select their desired emotion.

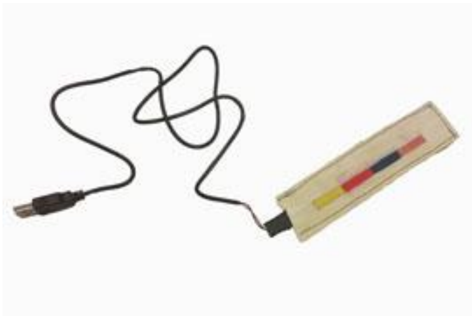

*Figure 10 - The SoftPot sensor with four colors corresponding to different emotions. The SoftPot was also made to be easily connected to a laptop through a universal USB type A connection.*

*Figure 9 - Matt Vincent is demoing the use of our SoftPot membrane sensor integrated into the open source speech generation software, Optikey.*

***Cost***

Our cost of parts is $53.96 for the SoftPot sensor and $109.34 for the MyoWare sensor. This includes an Arduino, sensor, and packaging materials. To reduce overall part production cost we will lay out a customized Printed Circuit Board (PCB) for our EMG technology. This will reduce the initial cost of the off-the-shelf product, $37.95, to a cost of $11.01. This reduces material, overhead, and labor cost by 73% for the EMG circuit board. Orders will be placed in bulk quantities of 100 to reduce costs. Electronic Service & Design Corp. was identified as a local PCB layout company and is located in Harrisburg, PA.

Electrodes have an adhesive backing that can lose electrical conductivity after a day. For this reason, electrodes will be used and disposed of after a day's use. Generic EMG electrodes come at such a low price that creating a strategic relationship with the manufacturer would be more advantageous than manufacturing for Hope Devices only. 3M sells a 50/bg at $13.00. Mouser Electronics sells competitive pricing for the SoftPot membrane sensor at $6.17 each if bought at 100/bag. This is a more cost effective option as compared to our EMG sensor that requires the user to maintain a stock of disposable electrodes for daily use.

*Table 1 - A cost breakdown of the complete package of Hope Devices*

| **Product** | **Cost** |
|---|---|
| Arduino | $29.99 |
| Softpot/MyoWare sensor | $6.79/$62.17 |
| OptiKey | Free |
| Packaging materials | $17.18 |
| **Total** | $53.96/$109.34 |

***Outcome***

We have tested our current alpha-prototypes and have demonstrated that our source code can be integrated into the open-source eye-tracking software Optikey. Microsoft Speech allows us to change the pitch, rate, range and volume of the sentence that is spoken. This results in a person selecting an emotion through the use of one of our sensors, the Arduino recognize the input and send the selected emotion to Optikey, where Optikey speaks the user's sentence in the emotion he/she selected.

The testing of our project is still in progress, however we found that it will be possible to use either of the sensors with the Arduino and selected software. This will ensure that users' have options through the regression of his/her disease to select from.

## Links

HOPE Devices Website - http://hopedevices.cloudaccess.host/
HOPE Devices Video - https://www.youtube.com/watch?v=U8jcNr6pFT0

## Supplementary Materials

### *Proposed use of award funds*

If HOPE devices is selected as the winner of the Student Research & Design Competition: Tone of Voice in AAC Systems, we will use the winning funds to further our research to better help the ALS community. Team members will continue working on the project and use the funds to go to other seminars and speak to engineers that have experience in the field of Alternative and Augmented Communication (AAC). We would fund a trip for our group to visit our advisor, Godfrey Nazareth, a biomedical engineer with ALS. We also would like to launch an awareness campaign of the tone of voice problem through our website and social media efforts. Funding will also be used to fund team's website online on a more permanent basis. The site will be used as platform where the public can communicate with the team and give feedback on the project.

We also will use $1,500 to fund expenses associated the expenses to attend the 2016 RESNA Conference in Arlington, Virginia.

### *Acknowledgements and References*

We would like thank our instructors Mike Erdman and Francois Venter for their mentorship in this project. Also thanks to David McNaughton who has encouraged us and to Godfrey Nazareth who gave us insight into the life of a person with ALS.

### In-Text Reference

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