C.A.N.E.
(Computerized Assistive Near Eyesight)

EEL 4914: Initial Project and Group Identification Document

Group: 14

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Project Description

The idea behind this project is to design and implement wearable technology that has the ability to detect its surroundings such as buildings, walls, and other various obstructions from a person's walking path. A wearable device attached to the user would transmit a signal to a computer, the computer will somehow notify the user to the location of an obstacle using haptic feedback and/or audio, which would then enable the user to sense the obstacles in their path, and make navigation much easier for the user.

Motivation

According to the World Health Organization there are thirty-nine million people globally who are blind **(**World Health Organization, 2010). Being blind is a serious handicap and can have an hindrance on this persons' way of life such as trying to find their way around a street or trying to get from one classroom to another. Overcoming these challenges have been manageable with such aids like a seeing eye dog and a walking stick. But seeing eye dogs need to be fed and taken care of and walking sticks might hinder non-blind people or be a nuisance to the people they are trying to help . As years go by, technology is improving the lives of everyone and should benefit the blind as well. A modern replacement for the service animal or walking stick is long overdue. With the aid of a range of sensors, a device could be designed to "see" for the blind.

In 2017, a senior design group created a similar project, which they named the Batpack. The Batpack also aimed to provide visual aid for the blind using sensors and providing feedback with vibrations. They stored their hardware in a backpack and put their cameras and sensors on a pair of goggles. They also provided a belt which vibrated to alert the user of objects. We hope to improve on this idea by requiring less and/or smaller hardware. We hope to fit all sensors and hardware on the glasses, with a hat as a backup plan if additional space is needed. We also plan to provide additional wearable pieces such as anklets, and bracelets on top of the belt, which will allow additional feedback for the user on the height of the obstructions in front. We also plan to introduce an audio feedback aspect, which will provide the user with more detailed information when necessary. The audio will be able to guide the user through doorways, up and down staircases, and provide additional assistance in other scenarios in which vibrations alone might not be enough. Finally, we hope to improve on the Batpack design by providing a full 180 degree view in front of the user.

Goals

The goals of our project are as follows:

- Product must locate obstructions in front of and in close proximity to user
- Product must inform user of obstructions via vibrations or audio feedback
- Product should inform user of the type of obstruction, i.e. wall, pole, stairs
- Product should inform user how far away the obstruction is
- Product should inform user elevation of the obstruction

- Product should improve users quality of life

Design Overview

The idea behind our design is to have a hands-free device that will be easy to use and convenient for users. There will be a pair of glasses to wear, along with wrist and ankle bands for vibration feedback. The glasses will contain the sensors and hardware, which will communicate with vibrations and audio to inform the user that there are upcoming obstructions in their path. Vibrations will indicate the direction in which the obstruction is located, and stronger vibrations will indicate closer objects. Furthermore, the user will be guided through tasks that might be difficult for the visually impaired, such as entering through doorways and traveling up and down stairs. Vibrations and audio feedback will assist in these tasks.

The glasses will contain our array of sensors and the camera for computer vision. The sensors will detect upcoming objects, with different sensors detecting at different ranges for increased accuracy. Computer vision will be used to detect more difficult obstacles, such as doorways and stairs. Vibrations on wrist and potentially ankle bands, as well as audio feedback will keep the user safe and informed about their surroundings.

Through the combination of sensors and feedback, the overall goal for our product is for the user to be able to navigate through any area with ease.

Project Requirements

The components and specifications we anticipate needing for this project are below. Additional research will be required to determine the exact components.

- Camera
  - We will consider min of 120Hz, 60fps, under $200
  - Must be compatible with computer vision technology.
- Various sensors
  - We will use ultrasonic & optical sensors under $10 (each).
  - Sensors will have a minimum sensing distance of 4 meters.
- Feedback
  - Haptic Feedback Pads
    - Buzz when an object is nearby and will increase in intensity as the object gets closer.
  - Audio Feedback
    - Will utilize tones to alert user of potential objects in path

- Headphones
  - Capable of receiving and playing audio from MCU
- Wristband, anklets, belt, vest

- Housing for vibration feedback to the user.
    - Will require research/testing to determine the most efficient and user friendly experience.
- Power supply
  - Rechargeable batteries
  - Min 2000mAh
  - Maximum 10W
- Micro-Controller
  - I/O protocols
    - I2C and SPI protocols required and satisfied by MSP430 board
  - Power requirement
    - Texas Instruments MSP430G2553
      - Recommended Operating Conditions [2]
        - Vcc - Supply Voltage {1.8, 3.6}V
        - T_A- Free-Air Temperature {-40, 85}℃
        - f_{SYSTEM}- Processor Freq. {}MHz
- Housing
  - Ideally on glasses/wristband only
  - Dimensions: To fit on glasses or hat
  - Weight: Less than 2lbs

Block Diagrams

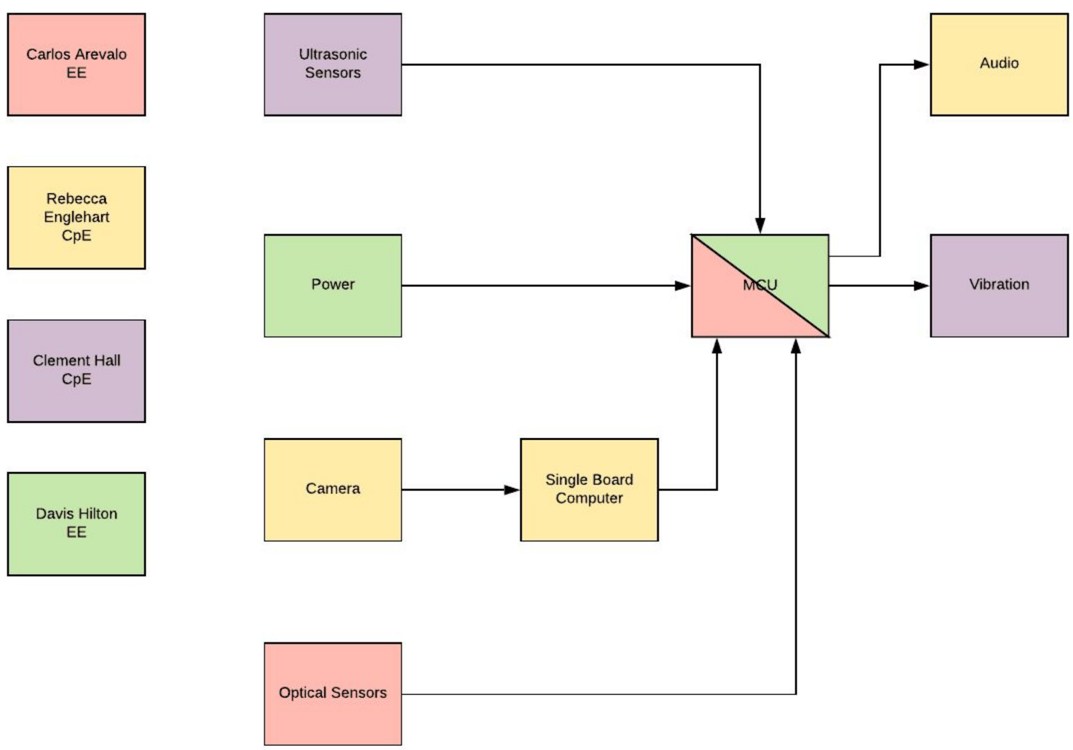

Fig. 1 Block Diagram

House of Quality

- ↑↑ Strong Positive Correlation
- ↑ Weak Positive Correlation
- ◎ No Correlation
- ↓ Weak Negative Correlation
- ↓↓ Strong Negative Correlation

Customer Requirements		*Engineering Requirements:* Power Output	Weight	Cost	Sensor Range	Total Size	Accuracy
		-	-	-	+	-	+
Ease of Use	+	◎	↑	↓	↑	◎	↑
Portability	+	◎	↓↓	◎	◎	↓↓	◎
Cost	-	↓	◎	↑↑	↑	◎	↑
Reliability	+	◎	◎	◎	↑↑	◎	↑↑
Safety	+	↓	↑	◎	↑	◎	↑↑
Battery Life	+	↑	◎	◎	◎	◎	◎
Target		≤10W	≤10lbs	≤$500	3-4m	$\leq 1m^2$	≥95%

Fig. 2 House of Quality

Budget and Financing

For reference, the Batpack budgeted initially budgeted $506 for their project, and ended up spending $1018. They mentioned in their report that their final product could be built for around $400; the extra costs were for other sensors and equipment that they tested but didn't end up using. We are hoping to improve on the Batpack's design while keeping our budget lower.

The projected budget for this project is below. Further research will allow us to narrow down the budget and select specific manufacturers and parts to use.

Part Description	Quantity	Price per Unit	Manufacturer
Camera	1	$40 - $200	Unknown
Ultrasonic sensors	2	$18 - $40.00	Unknown
Optical sensors	2	$10 - $90	Unknown
Glasses	1	$5.00 - $15.00	Unknown
Wrist/ankle bands	4	$0.01 - $5.00	Unknown
Headphones/Earbuds	1	$5.00 - $20.00	Unknown
Vibrating Motors	5-7	$2.00	Unknown
Power Supply	1	$10 - $25	Unknown
Micro-Controller	1	$20	Texas Instruments
Total	**13**	**$121.04 - $399**	

Table 1

Considerations

As stated previously under the Budget and Financing section, the group intends to spend less money on the overall project compared to the groups who have done this project before. In order to accomplish this consideration, many of the items that will be used in our project will be more affordable while being able to maintain the certain functionalities that will meet the requirements of the project.

The second consideration when choosing parts is to make sure the user is comfortable. When looking for parts the weight shall be a factor. This means parts that are chosen should be light, sleek, and not bulky.

Utilizing different sensors may bring unique challenges to each one. Weather, time of day, and product functionality all are at play. The way each of the sensors is setup may lead to accurate or unstable readings if not tested correctly. If the product gets wet while raining, will it still function properly or will a little water be alright? Would the sensors be able to record accurate measurements if a snow storm occurs or heat wave?
We also have to be careful in how we implement the audio feedback. Too much information may end up flooding the user with so much info that it becomes noise & useless. If we provide too little info then the user does not benefit from our product.

Project Milestones

DESCRIPTION	SEMESTER	START	END	DURATIO N	DAYS UNTI L DUE	% COMPLETE
BRAINSTORM SENIOR DESIGN IDEAS	**SD1**	**5/14/2020**	**5/14/2020**	**1 day**	**Past date**	**100**
CONFIRM PROJECT IDEA	**SD1**	**5/15/2020**	**5/15/2020**	**1 day**	**Past date**	**100**
GOALS AND OBJECTIVES FOR PROJECT	**SD1**	**5/15/2020**	**5/15/2020**		**Past**	**100**
INITIAL PROJECT DOCUMENTATION	**SD1**	**5/18/2020**	**5/29/2020**	**2 weeks**	**Past**	**100**
MEETING WITH PROFESSOR	**SD1**	**6/2/2020**	**6/2/2020**	**30 mins**	**Past**	**100**
RESEARCH SENSOR TECHNOLOGY	**SD1**	**6/1/2020**	**6/8/2020**	**1 week**	**3 days**	**0**
RESEARCH SENSOR COMMUNICATION	**SD1**	**6/1/2020**	**6/8/20201**	**1 week**	**3 days**	**0**

PROTOCOLS						
60 PAGES DOCUMENTATION DRAFT	**SD1**	**6/1/2020**	**7/3/2020**	**5 weeks**	**28 days**	**0**
100 PAGE DOCUMENTATION SUBMISSION	**SD1**	**6/1/2020**	**7/17/2020**	**7 weeks**	**42 days**	**0**
FINAL DOCUMENTATION DUE	**SD1**	**6/1/2020**	**7/28/2020**	**9 weeks**	**63 days**	**0**
FINALIZE COMPONENTS	**SD1**	**TBD**	**-**	**-**	**-**	**0**
PCB LAYOUT	**SD1**	**TBD**	**-**	**-**	**-**	**0**
RESEARCH CODING LANGUAGES	**SD1**	**TBD**	**-**	**-**	**-**	**0**
ASSIGN PROGRAMMING TASKS	**SD1**	**TBD**	**-**	**-**	**-**	**0**
ORDER COMPONENTS	**BREAK**	**TBD**	**-**	**-**	**-**	**0**
INITIAL TESTING	**SD2**	**TBD**	**-**	**-**	**-**	**0**
BUILD PROTOTYPE	**SD2**	**TBD**	**-**	**-**	**-**	**0**
TEST & DEBUG PROTOTYPE	**SD2**	**TBD**	**-**	**-**	**-**	**0**
FINAL DOCUMENTATION DUE	**SD2**	**TBD**	**-**	**-**	**-**	**0**
PEER PRESENTATION	**SD2**	**TBD**	**-**	**-**	**-**	**0**
FINALIZE PROJECT	**SD2**	**TBD**	**-**	**-**	**-**	**0**
FINAL PRESENTATION	**SD2**	**TBD**	**-**	**-**	**-**	**0**

Table 2

Citations

[1] “Global Data on Visual Impairment.” *World Health Organization*, World Health Organization, 8 Dec. 2017, www.who.int/blindness/publications/globaldata/en/.

[2] Texas Instruments, “MSP430G2x53, MSP430G2x13 Mixed Signal Microcontroller datasheet (Rev. J),” SLAS735J datasheet, Apr. 2011 [Revised May 2013], https://www.ti.com/lit/ds/symlink/msp430g2553.pdf?ts=1591326600167