eyeAssist

Group 40: Annamika Dua, Sahil Kamesh, Veda Menon

Introduction

The visually impaired are a unique demographic who face many challenges that still have not been fully addressed.

Two major problems they face are:

- Reading: Reading any kind of text can be burdensome and audiobooks or braille options are often inaccessible
- Mobility: Navigating environments is crucial in our lives and can also be burdensome for the visually impaired without assistance

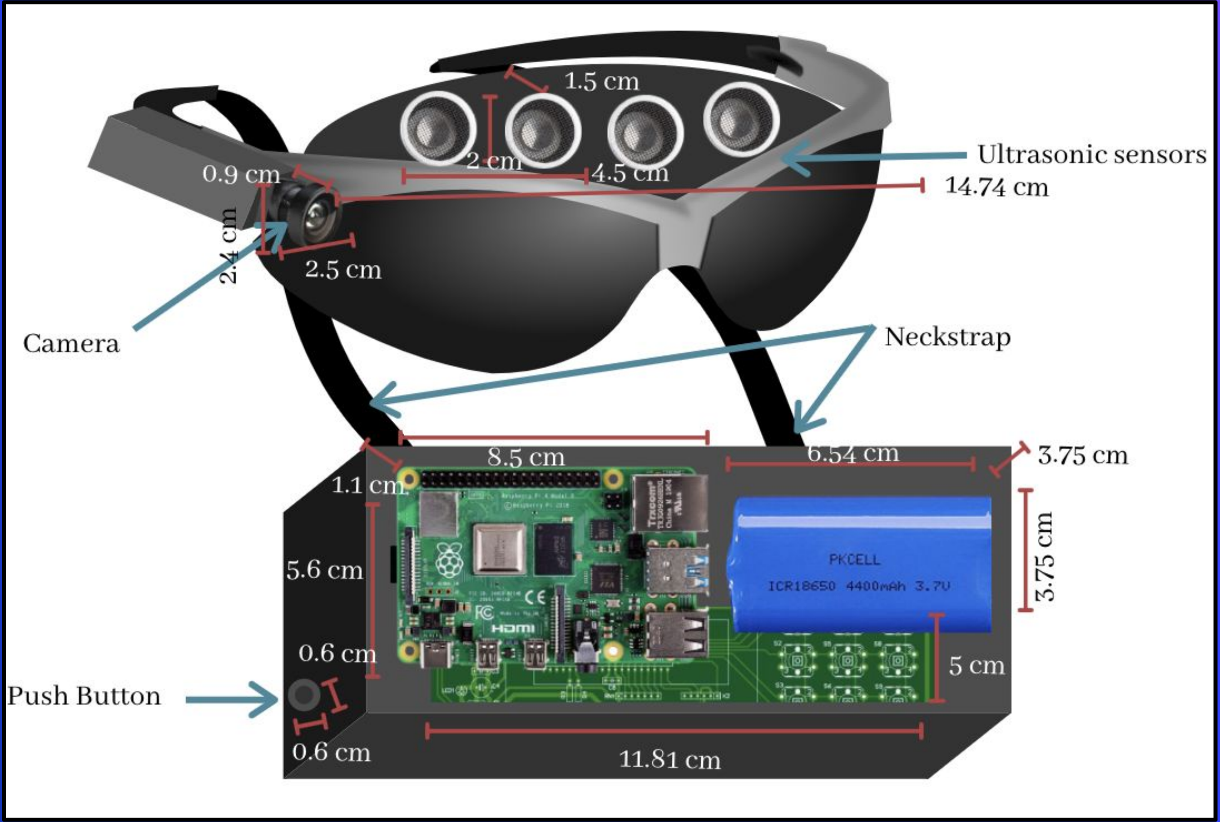
Objectives

- Developing tools to cater to these key difficulties the visually impaired encounter on a daily basis
- Create a compact and convenient solution that solves these two issues of reading and navigation for the visually impaired

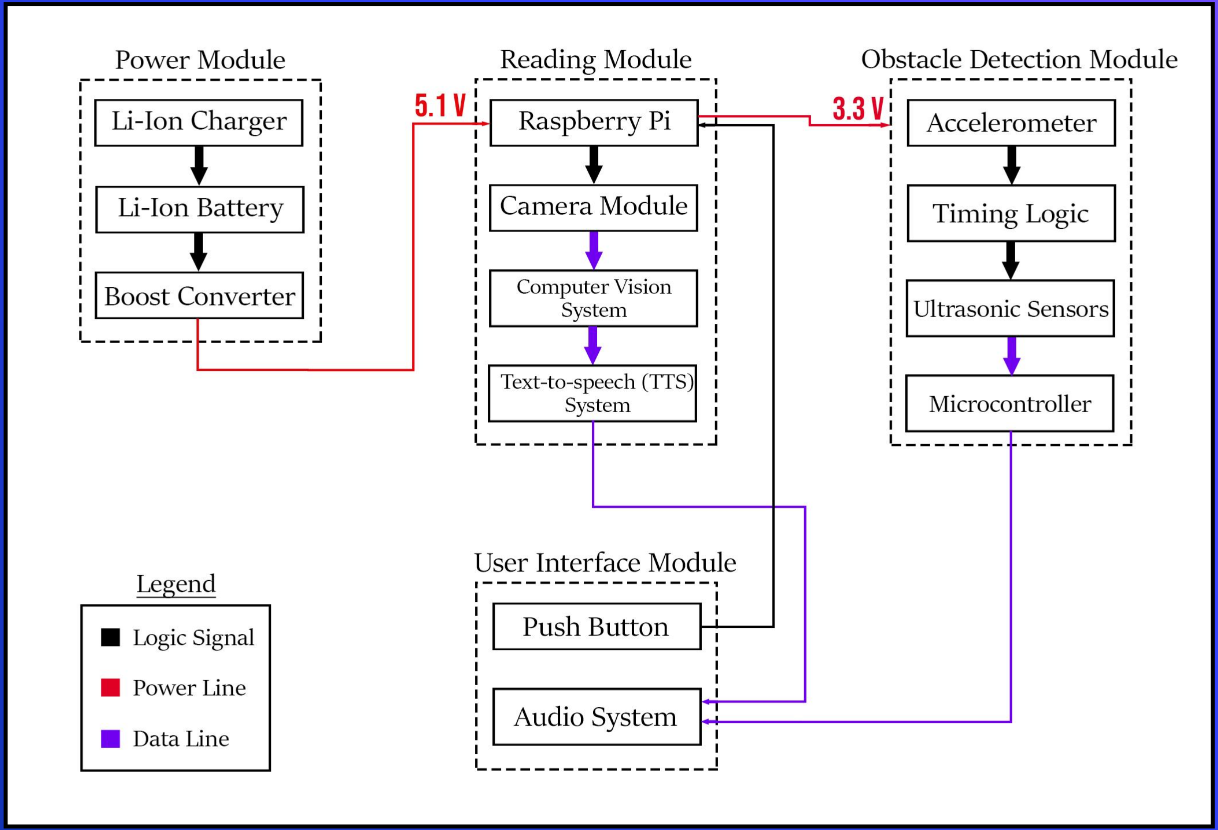
Our Solution

Multi-purpose assistive eye glasses with real-time reading and obstacle detection capabilities.

Physical Design

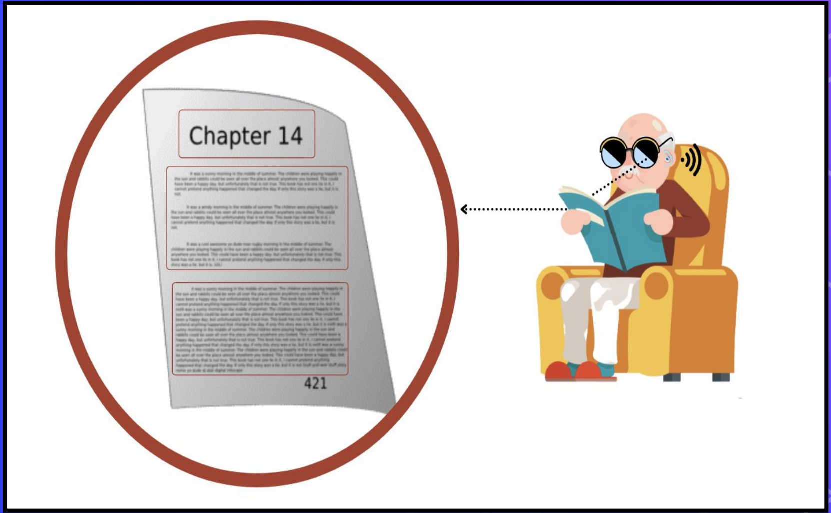


Block Diagram



Reading Module

- User wears glasses and looks at text to be read
- Reading module uses OCR to detect and process the text
- Reads out text using to user using text-to-speech



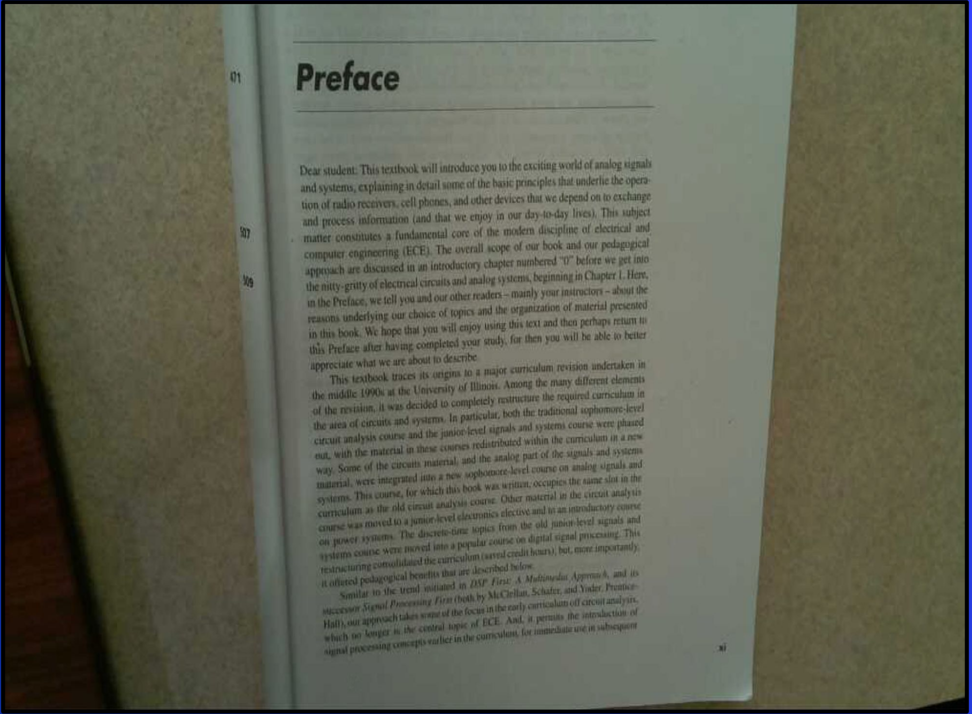
Reading Module

Reading Module

- After a short button press, the Pi Camera's 8-megapixel sensor captures high quality images of the text

- Image is pre-processed for more accurate text detection using OpenCV libraries
  - Grayscale
  - Thresholding
  - Skew correction
  - Cropping
  - Page Segmentation

Preprocessing



Preface

Dear student: This textbook will introduce you to the exciting world of analog signals and systems, explaining in detail some of the basic principles that underlie the operation of radio receivers, cell phones, and other devices that we depend on to exchange and process information (and that we enjoy in our day-to-day lives). This subject matter constitutes a fundamental core of the modern discipline of electrical and computer engineering (ECE). The overall scope of our book and our pedagogical approach are discussed in an introductory chapter numbered "0" before we get into the nitty-gritty of electrical circuits and analog systems, beginning in Chapter 1. Here, in the Preface, we tell you and our other readers – mainly your instructors – about the reasons underlying our choice of topics and the organization of material presented in this book. We hope that you will enjoy using this text and then perhaps return to this Preface after having completed your study, for then you will be able to better appreciate what we are about to describe.

This textbook traces its origins to a major curriculum revision undertaken in the middle 1990s at the University of Illinois. Among the many different elements of the revision, it was decided to completely restructure the required curriculum in the area of circuits and systems. In particular, both the traditional sophomore-level circuit analysis course and the junior-level signals and systems course were phased out, with the material in these courses redistributed within the curriculum in a new way. Some of the circuits material; and the analog part of the signals and systems material, were integrated into a new sophomore-level course on analog signals and systems. This course, for which this book was written, occupies the same slot in the curriculum as the old circuit analysis course. Other material in the circuit analysis course was moved to a junior-level electronics elective and to an introductory course on power systems. The discrete-time topics from the old junior-level signals and systems course were moved into a popular course on digital signal processing. This restructuring consolidated the curriculum (saved credit hours); but, more importantly, it offered pedagogical benefits that are described below.

Similar to the trend initiated in *DSP First: A Multimedia Approach*, and its successor *Signal Processing First* (both by McClellan, Schafer, and Yoder, Prentice-Hall), our approach takes some of the focus in the early curriculum off circuit analysis, which no longer is *the* central topic of ECE. And, it permits the introduction of signal processing concepts earlier in the curriculum, for immediate use in subsequent

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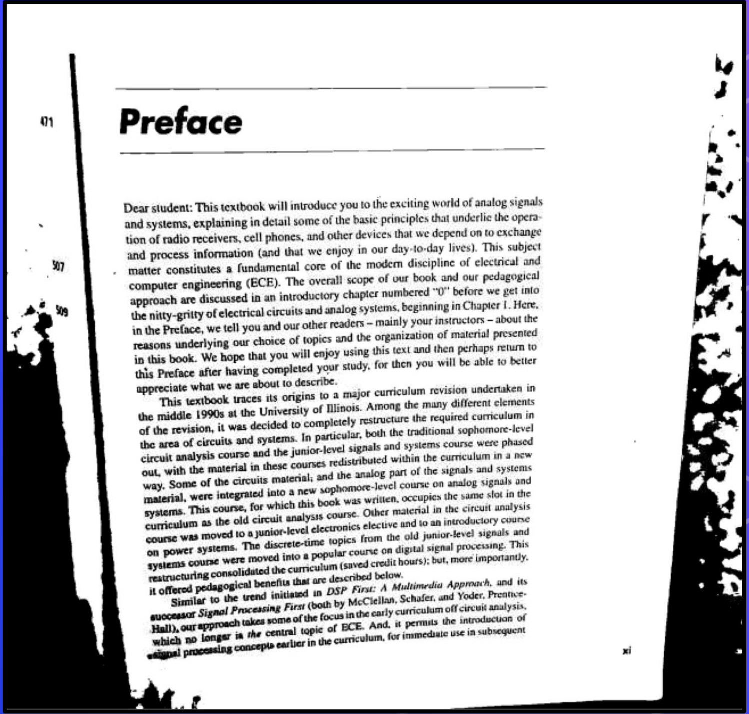

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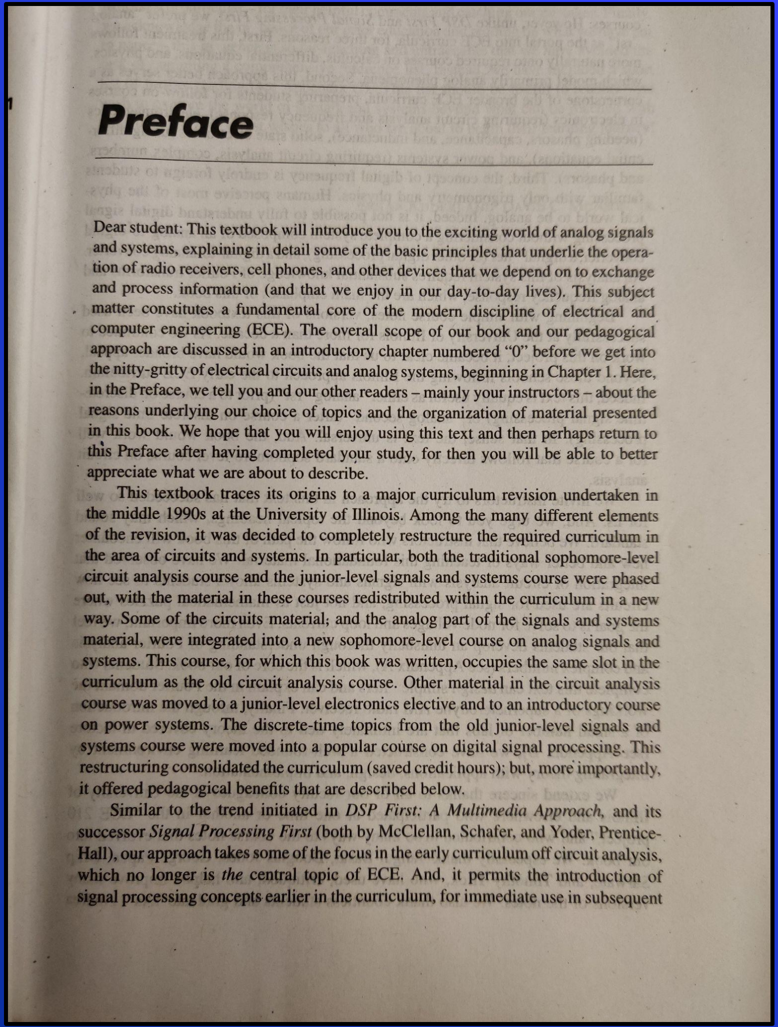

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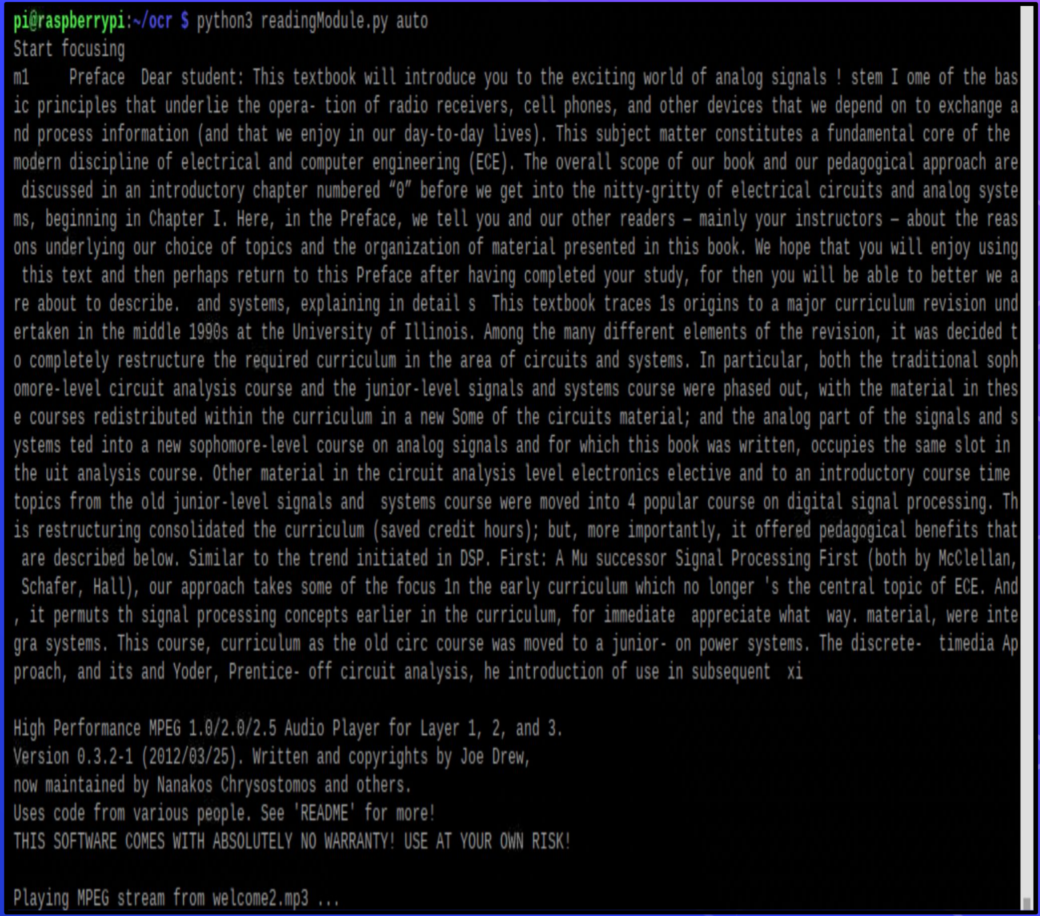

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Start focusing
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High Performance MPEG 1.0/2.0/2.5 Audio Player for Layer 1, 2, and 3.
Version 0.3.2-1 (2012/03/25). Written and copyrights by Joe Drew,
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Uses code from various people. See 'README' for more!
THIS SOFTWARE COMES WITH ABSOLUTELY NO WARRANTY! USE AT YOUR OWN RISK!

Playing MPEG stream from welcome2.mp3 ...
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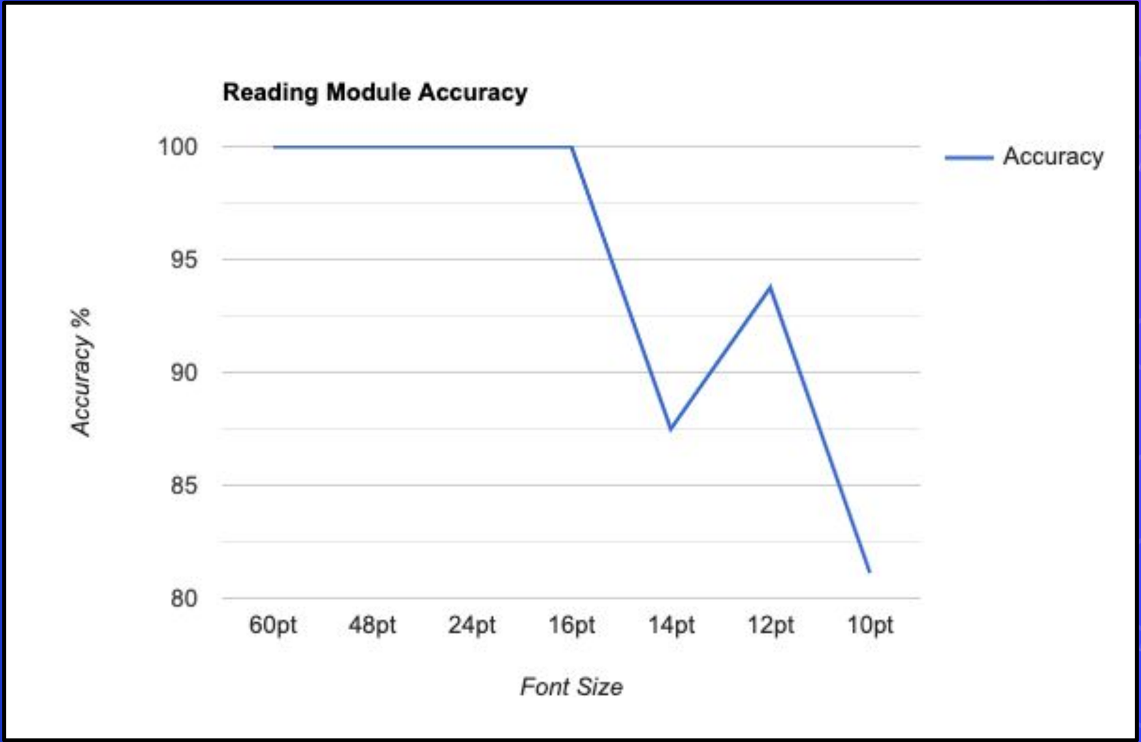
93% Accuracy

Reading Module

- We use Google Tesseract, an Optical Character Recognition (OCR) engine to process the image and convert it to text.
- Text is used in the text-to-speech conversion component and is sent to the user feedback module to be read aloud to the user.

Requirement & Verification #1

- ***The reading module must read out unobstructed text within a distance of 30 cm (1 foot) with an accuracy of >= 85%.***
    - We verified this requirement by wearing the glasses and placing various books and pages of text at a distance of 1 foot from the glasses.
    - We tested this out with various fonts and font sizes by printing them out on pages of text. We found that our Reading Module can accurately read fonts of Times New Roman, Arial, Calibri, Garamond, Verdana, and Helvetica for sizes 12 pt to 60 pt.



As expected, the accuracy reduces with the size of the font. We see a small outlier in the font size change from 14pt to 12pt, however we can account for this by considering other factors of the pictures, ex: Lighting, quality of picture etc.

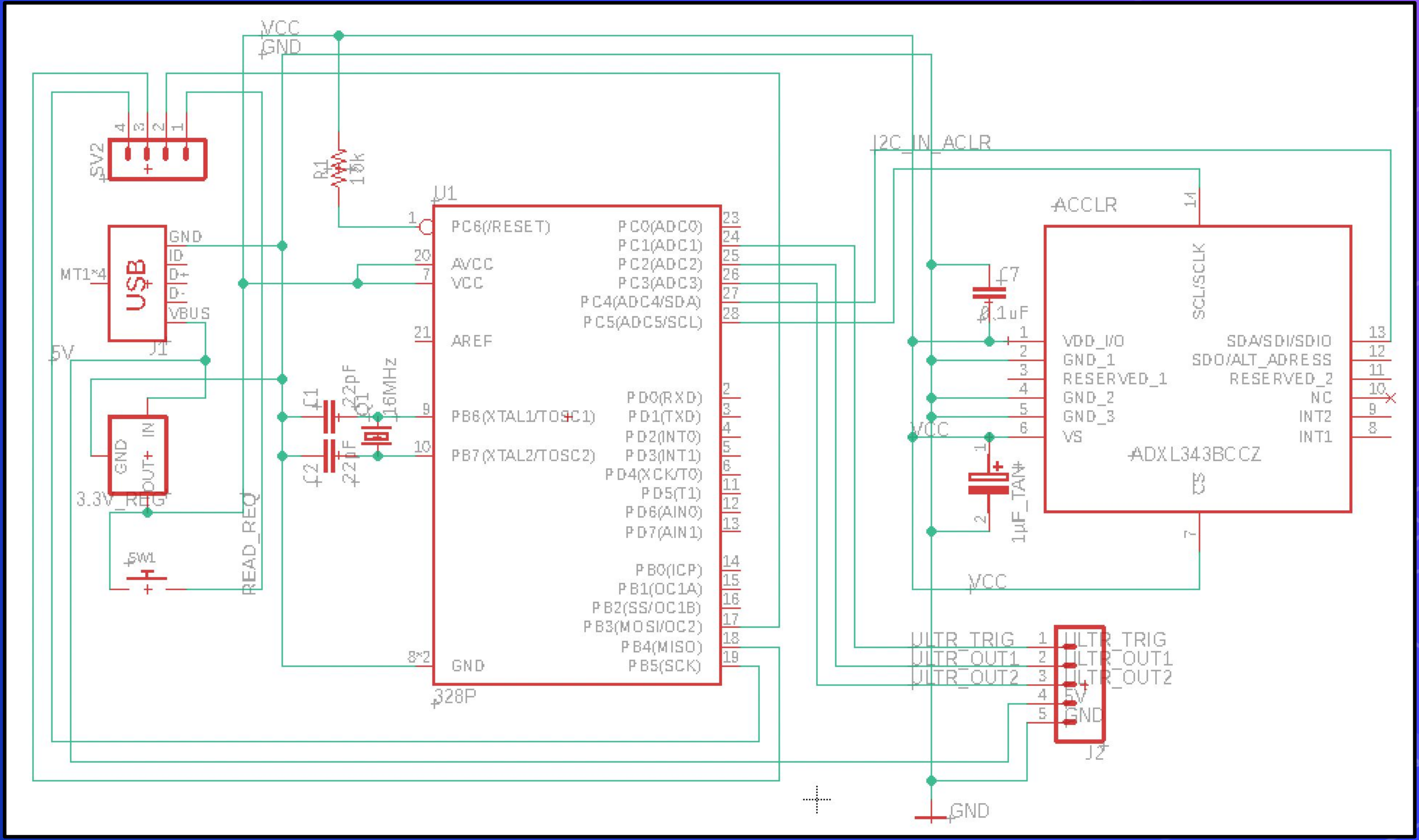
Requirement & Verification #2

- ***The reading module must be able to process a page of text and send the result to the audio system in <= 3 minutes.***
    - We verified this requirement during all of our testing of various pages.
    - Once our reading module starts reading the page, it takes 30 seconds on average to start reading it out aloud.

Obstacle Detection Module

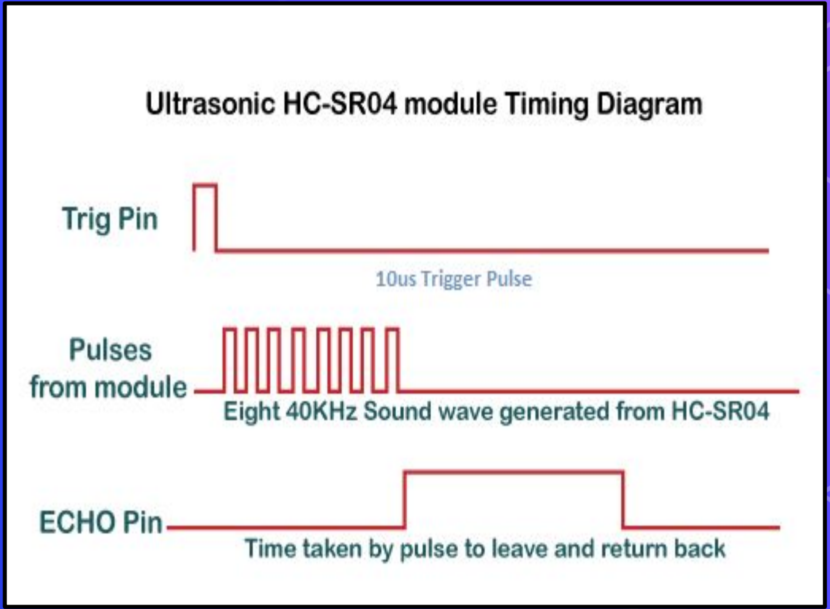
- Detects and alerts users of obstacles in their path for safe navigation

- Ultrasonic sensors mounted on the glasses detect obstacles ahead of the user and within an angle of 45 degrees


VCC
GND
SV2
R1
10k
U1
PC6(/RESET)
AVCC
VCC
AREF
PB6(XTAL1/TOSC1)
PB7(XTAL2/TOSC2)
GND
PC0(ADC0)
PC1(ADC1)
PC2(ADC2)
PC3(ADC3)
PC4(ADC4/SDA)
PC5(ADC5/SCL)
PD0(RXD)
PD1(TXD)
PD2(INT0)
PD3(INT1)
PD4(XCK/T0)
PD5(T1)
PD6(AIN0)
PD7(AIN1)
PB0(ICP)
PB1(OC1A)
PB2(SS/OC1B)
PB3(MOSI/OC2)
PB4(MISO)
PB5(SCK)
328P
USB
GND
ID
D+
D-
VBUS
MT1*4
J1
5V
3.3V_REG
GND
OUT+
IN
SW1
READ_REQ
C1
C2
22pF
Q1
16MHz
I2C_IN_ACLR
ACCLR
C7
0.1uF
1µF_TAN+
SCL/SCLK
VDD_I/O
GND_1
RESERVED_1
GND_2
GND_3
VS
SDA/SDI/SDIO
SDO/ALT_ADRESS
RESERVED_2
NC
INT2
INT1
ADXL343BCCZ
U3
VCC
ULTR_TRIG
ULTR_OUT1
ULTR_OUT2
5V
GND
J2

Obstacle Detection Module

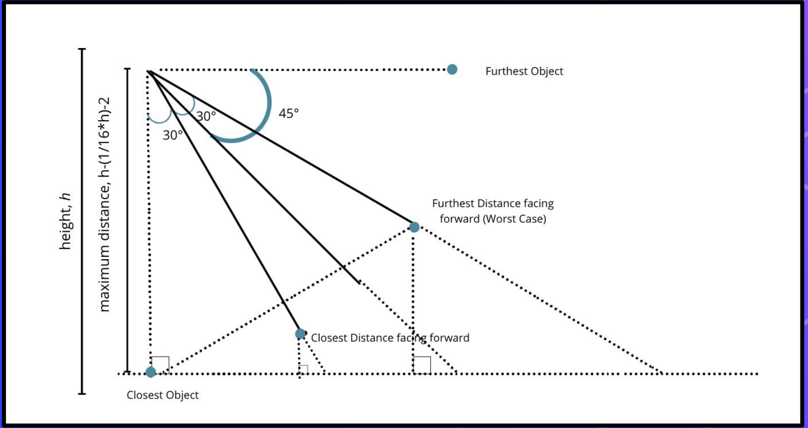
- Upon long button press, microcontroller activates output pin to generate a high signal of at least 10 μS
- Trigger pin of the ultrasonic sensors will transmit eight 40 kHz ultrasonic pulses and check if it receives any signals back
- Time it takes for signal to be received is sent to microcontroller and used to calculate the distance of the obstacle from the user



Obstacle Detection Module

- Provided the sensors are angled 45 degrees downwards, we calculated our best, worst, and average case scenarios

- Best case: Object detected two inches off floor directly below user.
- Average case: Object detected around knee level and about 3 feet, for user walking with head facing forward.
- Worst case: Object detected 5 feet away at a height of 2 feet



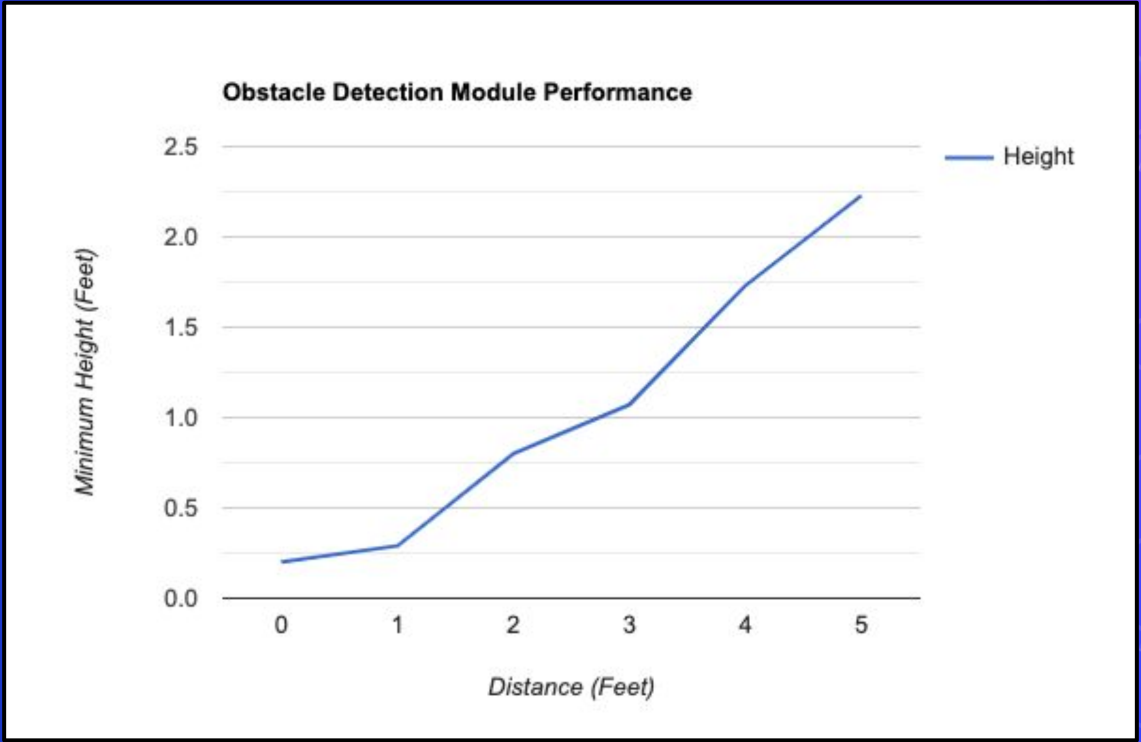
$$\sin(30°) = \frac{\text{Closest distance when facing forward}}{\text{Maximum detected distance}} \quad (1)$$

$$\cos(30°) = \frac{\text{Maximum detected distance}}{\text{Total hypotenuse}} \quad (2)$$

$$\text{Uncovered distance} = \text{Total hypotenuse- Maximum detected distance}$$

$$\cos(30°) = \frac{\text{Closest height when facing forward}}{\text{Uncovered distance}} \quad (3)$$

$$\text{Closest height when facing forward (from ground)} = \text{Closest height when facing forward} + \text{2 inch buffer} \quad (4)$$



As we calculated in the Tolerance Analysis, the minimum height detected at the feet of the user is around 2 inches, and at the maximum distance of 5 feet, the minimum height detected it increases to a little over 2 feet.

Requirement & Verification #1

- ***Ultrasonic sensors should detect objects within <= 2 meters and a combined 50 - 60 degree field of view.***
    - We verified this requirement by setting up an experimental environment with obstacles at various distances and angles.
    - We ran our obstacle detection module and ensured obstacles were detected within the angles necessary for our requirement and the calculated distances (from the previous slide) aligned with our pre-measured distances.

Requirement & Verification #2

- ***Accelerometer must detect if the user is in motion, i.e. if the linear acceleration is greater than 1 m/s^2, and start the obstacle detection process.***

    - We did not end up meeting this requirement and the verification.
    - This was due to the delays in the delivery of our initial PCBs, which caused us to realize the flaws in our design close to the final demo, and by the time we got our final working PCB delivered, we did not have time to integrate the accelerometer.

Conclusion

STRENGTHS

85-95% accuracy of text recognition, clear text to speech delivery, and detection of obstacles on either side of user within 2 meters

WEAKNESSES

Physical design constraints with size of glasses and camera positioning

OPPORTUNITIES

Enhancing lighting for camera and increasing user friendliness of product

FAILURES

PCB and accelerometer integration as a result of PCB delivery delays and soldering issues

Future Work

- We really hope our product will facilitate the way in which the visually impaired go about their daily lives
- Future work
    - Include enhanced lighting features for poor lighting and shadows for reading module
    - Improve overall compactness of the design with minimum external wiring and smaller components
    - Make design more user-friendly and accessible with a mobile application instead of a push button

Thank You!

Questions?