December 4th, 2025

LA-32 Team Jim:
Tom Nguyen, Tyler Lee, Coen Devlin,
Alexandra Borvanova, Andrew Ye,
Mario Roque, Maryam, and Amitoj Brar

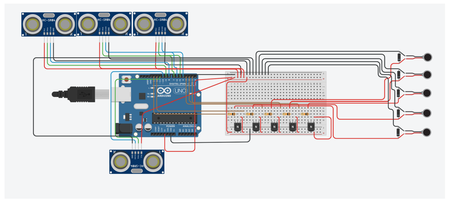
N.A.V.I

Navigational Aid for the Visually Impaired

SFU SIMON FRASER UNIVERSITY

Abstract

- Problem Statement:
  - Challenges of navigating space safely (e.g. obstacle, stairs, and approaching people)
  - Existing solution like canes or guide dog are helpful but have limitation
  - The need for compact, hand free and affordable device
- Objective: "To develop a wearable navigation device that enhances awareness for visually impaired individuals using ultrasonic sensors and haptic feedback."



Introduction

- Overview of technologies:
  - **Ultrasonic sensors**: Detect distance by emitting and receiving sound waves.
  - **Haptic feedback**: Vibrations to alert users to obstacles or drops.
  - **Arduino Microcontroller**

•Discuss why these technologies are suited for visually impaired individuals:

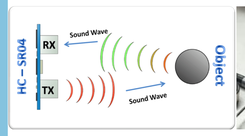
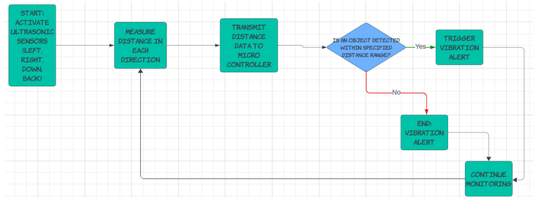


Diagram of ultrasonic sensor functionality

Vibration Motor

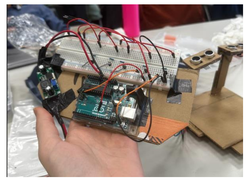
Arduino UNO Microcontroller

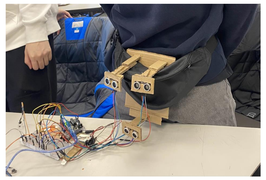


Block Diagram

Hardware Set Up

•**Front sensors**: Three ultrasonic sensors in the fanny pack to detect:
  •Obstacles in front.
  •Obstacles to the sides.
  •Drops (stairs or curbs).
•**Rear sensors**: Ultrasonic sensors to detect approaching individuals.
•Vibration motors for haptic feedback.
•Power source (9V battery).
•Microcontroller (Arduino Uno) for processing signals.





Programming / Software

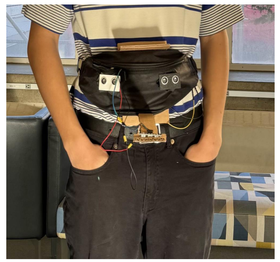
```
dLeft = sonarLeft.ping_cm();
dRight = sonarRight.ping_cm();
dBack = sonarBack.ping_cm();
dDown = sonarDown.ping_cm();

fall = !dDown;
wall = abs(dLeft - dRight) < 5 && dLeft && dRight;
stair = dDown < 70 && dDown;
right = dRight < 100 && dRight;
left = dLeft < 100 && dLeft;

if(rBack - dBack > 5 && dBack) digitalWrite(motorBack, HIGH);
else digitalWrite(motorBack, LOW);

if(stair || fall) digitalWrite(motorDown, HIGH);
else digitalWrite(motorDown, LOW);

if(wall || right || stair) digitalWrite(motorRight, HIGH);
else digitalWrite(motorRight, LOW);

if(wall || left || stair) digitalWrite(motorLeft, HIGH);
else digitalWrite(motorLeft, LOW);

delay(50);
```

- Written in Arduino C++
- Ultrasonic sensor inputs will lead to outputs on vibrational motors
- Use of NewPing Library, measures distance readings from sensors

Coding Logic:
- Checks for drop-offs, right obstacles, left obstacles, stairs, and approaching pedestrians from behind
- Each condition triggers their corresponding motors
- Detecting drop offs will trigger the bottom vibrational motor
- Obstacles on the left and right side will trigger the motor on the corresponding side
- A rapidly approaching pedestrian or object will trigger the motor on the back
- Staircase ahead will trigger all three motors on the front

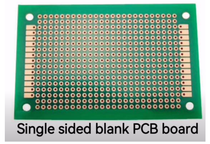
Results

- Successful implementation of the device on the fanny pack
- Subtlety was compromised due to challenges we faced
- Successfully detected steps down/up
- Right and left sensor collision detections were consistent and accurate
- Back sensor detected approaching people



Future Improvements

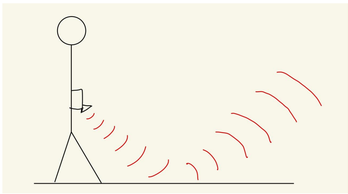
- Implement different types of sensors, such as LiDAR (Light Detection and Ranging), IR
- Improve subtlety, for example locate sensors in different locations
- Increase motor life by the implementation of convertors
- Optimize the angles for obstacles that aren't head on, such as steps down/up
- Alternatives for breadboard, for example a PCB board
- More sensors for a broader field of view
- Switch to turn device on and off



Single sided blank PCB board

Challenges

- Reliable drop-off detection, using ultrasonic sensors at an angle
- Design changes due to sensor reliability at angles
- Buck converter was not implemented correctly



Acknowledgements

We'd like to thank the Professors: Ash, Mike Hegedus, for their feedback, and Dave (Tom's Roommate) for parts