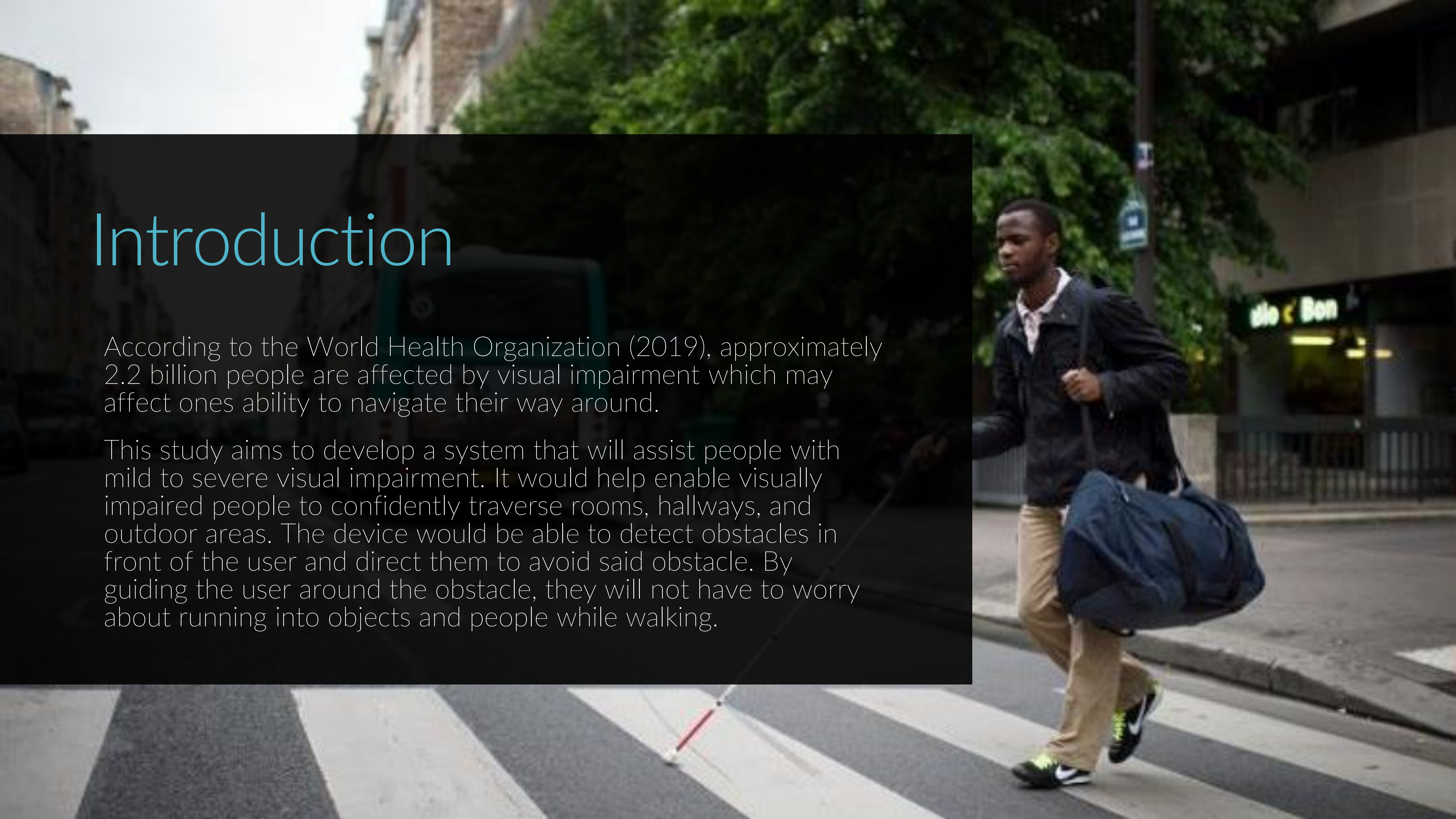
PATHFINDER

Device for Obstacle Detection and Avoidance to Help The Mobility of Visually Impaired People

Introduction

According to the World Health Organization (2019), approximately 2.2 billion people are affected by visual impairment which may affect ones ability to navigate their way around.

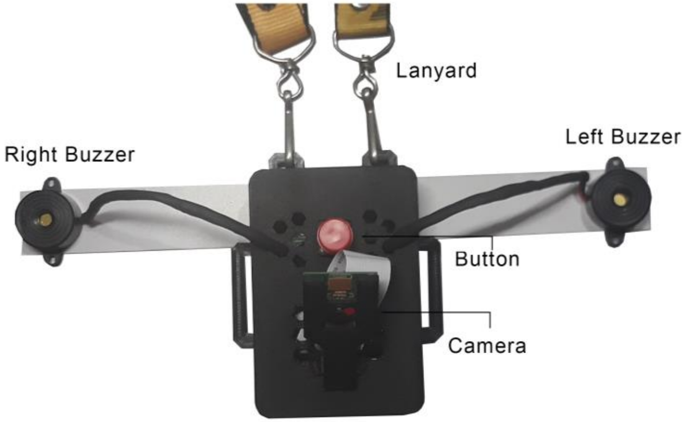
This study aims to develop a system that will assist people with mild to severe visual impairment. It would help enable visually impaired people to confidently traverse rooms, hallways, and outdoor areas. The device would be able to detect obstacles in front of the user and direct them to avoid said obstacle. By guiding the user around the obstacle, they will not have to worry about running into objects and people while walking.

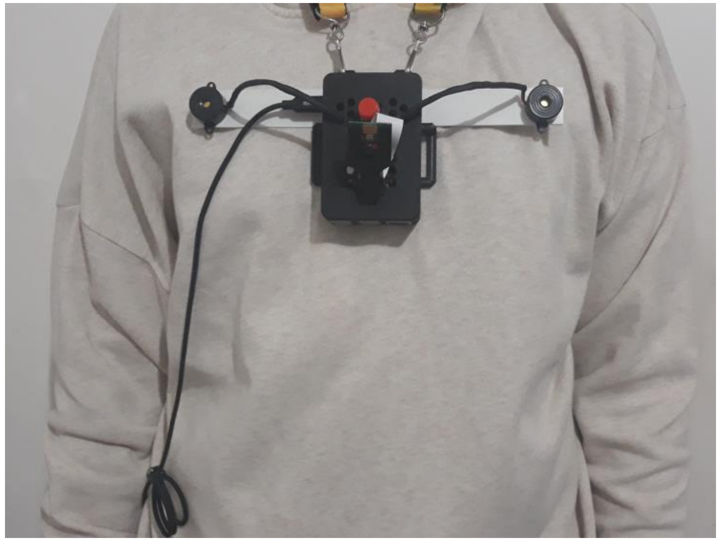


Objectives

This study aims to create a portable device prototype which will help the navigation of visually impaired people

- To use digital image processing techniques for obstacle detection
- To detect obstacles within 3 meters from the user
- To notify the user of the obstacle and redirect them to avoid it





Methodology

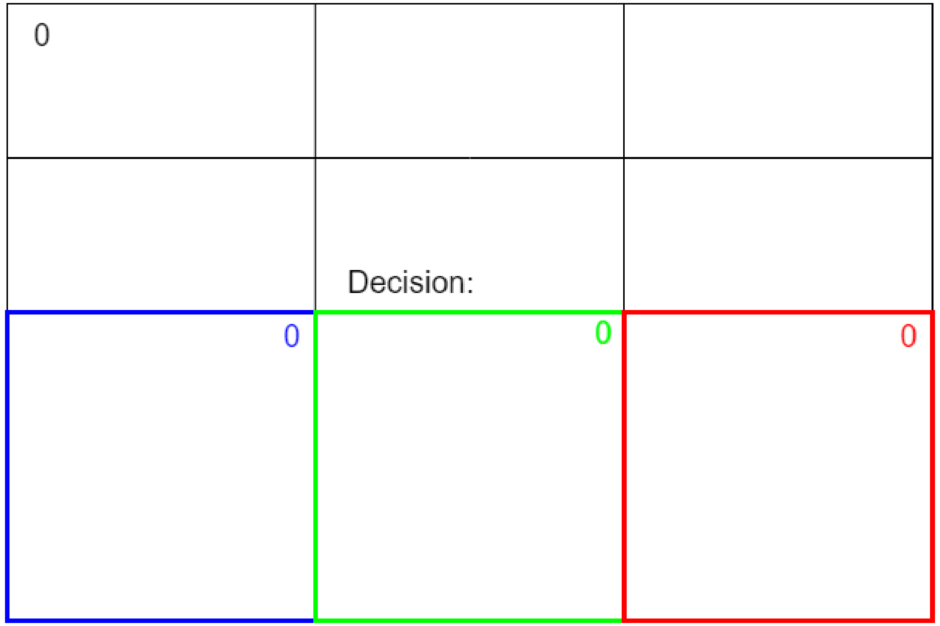
Instrument Build Specifications

Components

- Raspberry Pi 4 (16GB storage, 4GB RAM)
- Raspian Buster OS
- 5MP Raspberry Pi camera module Rev 1.3
- 12000mAh powerbank / DC 5V 2.1A output

3D Printed Housing

Methodology
Obstacle Detection



Grayscale was first be applied into the frame for better measurement of the varying pixel intensity.

Noise reduction was accomplished by applying a Gaussian blur to smooth the frame.

The Shi-Tomasi Algorithm was applied to detect the feature points of an object. The feature points are the basis for detected obstacles.

The bottom row of the search space, divided into three parts, served as the region of interest. The number of feature points per region was counted. A threshold of 0.01 determined a feature point. Points Within the search space were counted as obstacles.

Results and Discussion

Precision Testing

Testing comprised of 10 different paths with varying amounts of obstacles.

The precision of the system pertains to the relevance of the points detected.

The recall pertains to the correctness of these points.

Precision = $\frac{|G \cap D|}{G}$ Recall = $\frac{|G \cap D|}{D}$

G – obstacles detected by a human observer

D – obstacles detected by the device

Path Number	Obstacles found by Human (G)	Obstacles found by System (D)	Precision $\|G \cap D\|/G$	Recall $\|G \cap D\|/D$
1	8	6	0.75	1
2	9	8	0.89	1
3	10	8	0.8	1
4	10	8	0.8	1
5	11	11	1	1
6	12	11	0.92	1
7	13	11	0.85	1
8	14	10	0.71	1
9	15	12	0.8	1
10	16	12	0.75	1
			0.83	1

Results and Discussion

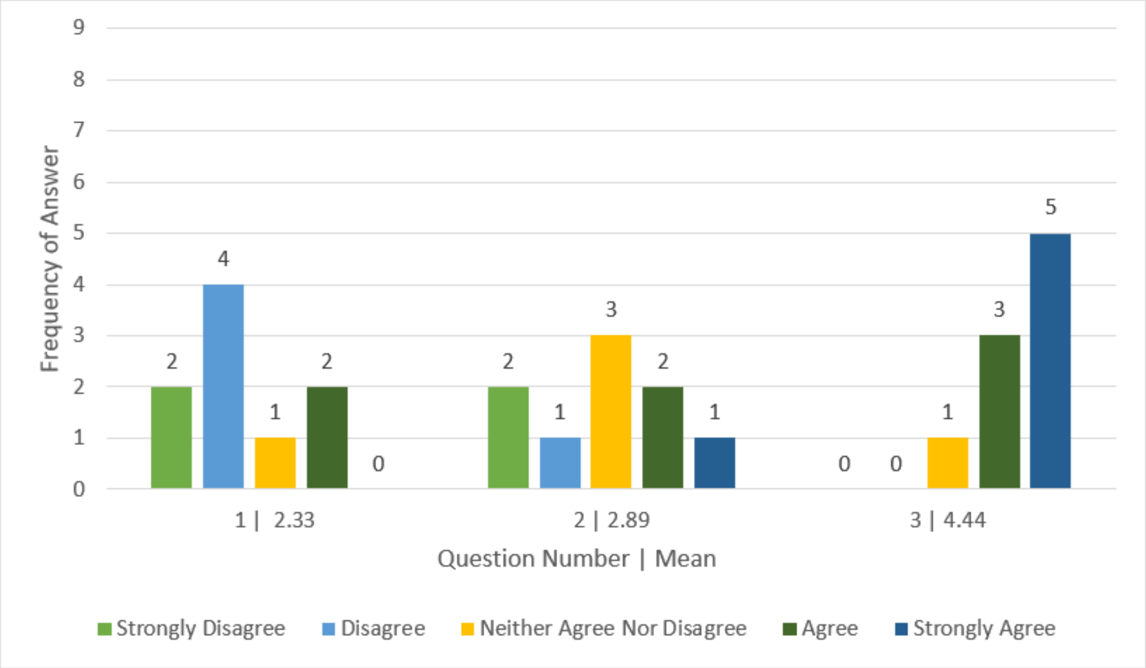
End-user Testing

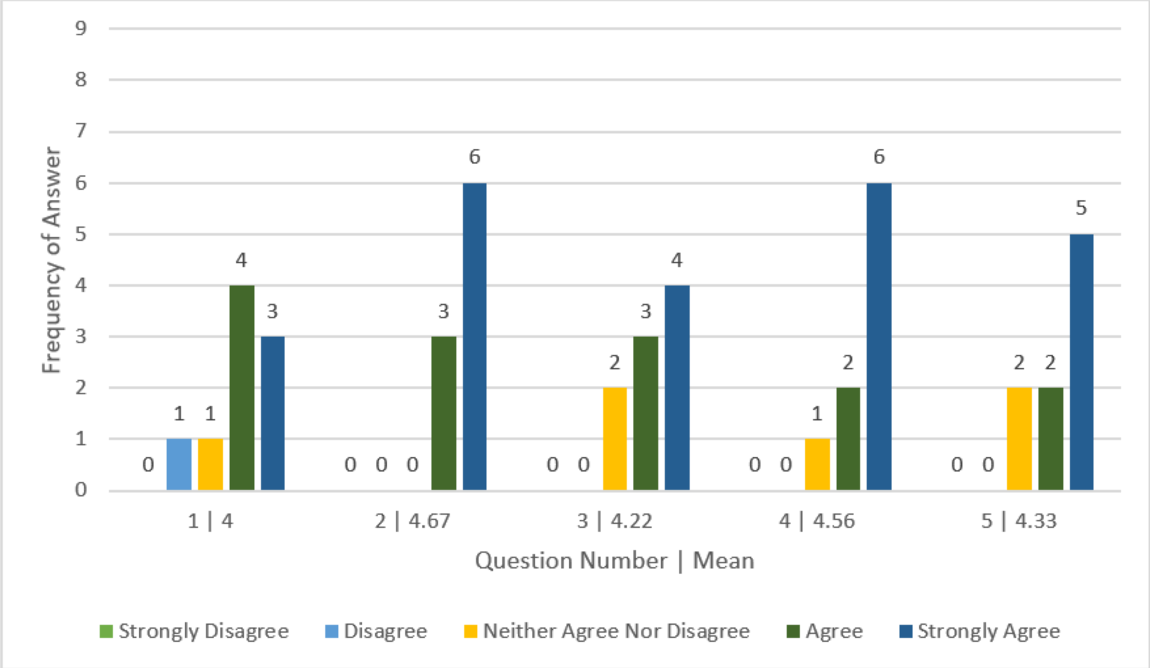
The trials are meant to compare the effectiveness of the different methods of navigation.

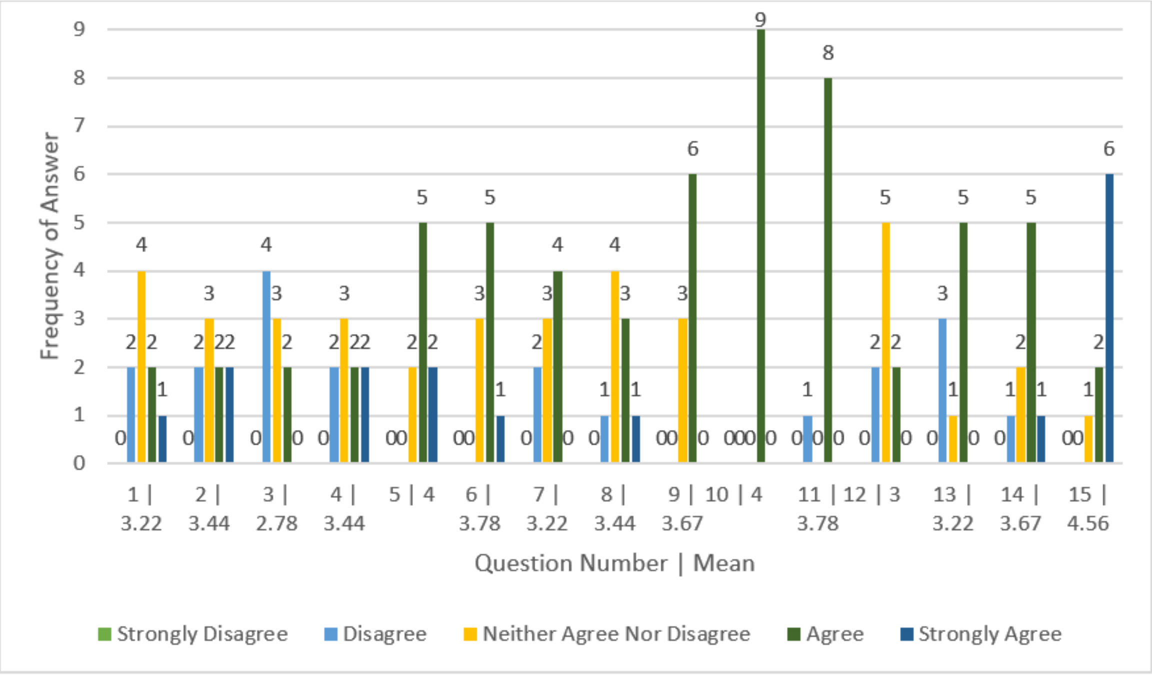
The first trial required the user to traverse the obstacle-ridden path with only a blindfold.

The second trial required the user to traverse the same pathway with a blindfold and a cane.

The third trial required the traversal of the same pathway using the device itself.







Results and Discussion

Users' Response

Results and Discussion
Time and Mistakes

Average Time

Test No.	User									Min	Max	Mean
	1	2	3	4	5	6	7	8	9			
1	20.29	20.08	16.31	17.04	31.88	36.64	43.55	22.62	38.00	16.31	43.55	27.38
2	28.24	17.21	18.07	17.02	22.90	20.91	36.64	24.22	32.62	17.02	36.64	24.2
3	36.92	16.95	19.70	18.37	29.33	41.23	40.65	23.00	39.70	16.95	41.23	29.54

Average Mistakes

Test No.	User									Min	Max	Mean	Mode
	1	2	3	4	5	6	7	8	9				
1	6	3	2	2	4	3	3	2	6	2	6	3.44	2, 3
2	2	0	0	0	0	0	0	0	0	0	2	0.22	0
3	2	0	0	0	2	2	2	2	1	0	2	1.22	2

Conclusion and Recommendations

4.56

Average Rating on production of a successful device.

1.22

Average Mistakes made with the device following the 0.22 average mistakes with the cane.

Hardware

Gymbal system

Buzzers

Software

Distance Covered instead of time

Wall Detection