A
Project Phase-I Report
On

Smart Wearable for Blind People Navigation

SUBMITTED BY

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PROJECT GUIDE

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CERTIFICATE

This is to certify that following students of B.E. Electronics & Telecommunication have completed the project phase-I on **'SMART WEARABLE FOR BLIND PEOPLE NAVIGATION'** satisfactorily under my guidance and submitted the project phase-I report in partial fulfillment of requirement for the award of Bachelors Degree of Engineering course under the Savitribai Phule Pune University during the academic year 2020-2021.

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Abstract:

Recent studies on global health estimate that **217 million** people suffer from visual impairment, and 36 million from blindness. The affected have their autonomy jeopardized in terms of many everyday tasks, with the emphasis being placed on those that involve moving through an unknown environment.
Most people with poor vision are in the developing world and are over the age of 50 years. Rates of visual impairment have decreased since the 1990s. Visual impairments have considerable economic costs both directly due to the cost of treatment and indirectly due to decreased ability to work.
The number of **elderly persons** is rising. The already high burden of visual impairment in elderly persons is projected to increase even more in the future. Uncorrected refractive errors and cataract are the two commonest causes of visual impairment. Cataract remains the leading cause of blindness in low- and middle-income countries
Over the last decades, the development of navigation devices capable of guiding the blind through indoor and/or outdoor scenarios has remained a challenge.
The goal of this project is to develop a device which tries to solve that issue and study various research going on today.

Our team is trying to solve this major issue by making a device which will make live of visually impaired people little bit easier. **Smart wearable for blind people navigation** is a wearable device which is designed to be worn like a wrist band. Using its advance computer **vision techniques** and **algorithms** we developed work together with the various onboard **sensors** to easily guide a blind person to navigate around easily.

Chapter 1: Introduction

Generally, individuals rely primarily on vision to know their own position and direction in the environment, recognizing numerous elements in their surroundings, as well as their distribution and relative location. Those tasks are usually grouped under the categories of "orientation" or "wayfinding," while the capability to detect and avoid nearby obstacles relates to "mobility." A lack of vision heavily hampers the performance of such tasks, requiring a conscious effort to integrate perceptions from the remaining sensory modalities, memories, or even verbal descriptions. The need for assistive devices for navigation and orientation has increased. The simplest and the most affordable navigations and available tools are trained dogs and the white cane. Although these tools are very popular, they cannot provide the blind with all information and features for safe mobility, which are available to people with sight

All the systems, services, devices and appliances that are used by disabled people to help in their daily lives, make their activities easier, and provide a safe mobility are included under one umbrella term: assistive technology
visual assistive technology is divided into three categories: vision enhancement, vision substitution, and vision replacement. This assistive technology became available for the blind people through electronic devices which provide the users with detection and localization of the objects in order to offer those people with sense of the external environment using functions of sensors. The sensors also aid the user with the mobility task based on the determination of dimensions, range and height of the objects

The vision replacement category is more complex than the other two categories; it deals with medical and technology issues. Vision replacement includes displaying information directly to the visual cortex of the brain or through an ocular nerve. However, vision enhancement and vision substitution are similar in concept; the difference is that in vision enhancement, the camera input is processed and then the results will be visually displayed. Vision substitution is similar to vision enhancement, yet the result constitutes non-visual display, which can be vibration, auditory or both based on the hearing and touch senses that can be easily controlled and felt by the blind user.

1.1 About the project

This project falls on the third category that is the vision replacement category. The aim of this project is to make a device which can worn like a wrist band on the hand and it will provide virtual assist to the visually impaired person using its state-of-art computer vision solutions, thus allowing for both the positioning, and monitoring of the user's surrounding area. The key focus of this project is to provide information about

- Determining obstacles around the user body from the ground to the head.
- Affording some instructions to the user about the movement surface consists of gaps or textures.
- Finding items surrounding the obstacles.

- Providing information about the distance between the user and the obstacle with essential direction instructions.
- Proposing notable sight locations in addition to identification instructions.
- Affording information to give the ability of self-orientation and mental map of the surroundings.

1.2 Technology Used

- Machine Learning for detection of Humans, Objects, Obstacles etc.
- TensorFlow, OpenCV are opensource libraries for object detection
- Lidar sensor for accurate distance measurement
- Speech/voice enable system for verbal assist
- Raspberry Pi Zero Wireless microcontroller for processing all the data
- 3D Printer to print the required project parts
- MATLAB for simulation and prediction

1.3 Device Operation

The system consists of a microcontroller, a camera, lidar sensor, microphone, and speaker along with a heat signature sensor which work together according the algorithm and sequence of operation later, an output is generated which is conveyed to the person via haptic feedback using a 4 x 4 array of vibrating motors (haptic sensors)
The algorithm which decides what operation is to be performed when is described in the flow chart (Section 3.2) but the basic trend is as follows

A. Power on

B. Navigate button pressed

C. Camera turns on and detects for objects and obstacles or person

D. If object is close, distance sensor gets activated to measure distance

E. Heat sensor turns on to detect if there is any elevated temperature object nearby

F. Based on above information, the output is calculated and conveyed via vibrations, code, buzzer, and speech system

Chapter 2: Literature Survey

	Title of the Paper	Year	Abstract	Journal/Publication
1	Sensor-Based Assistive Devices for Visually-Impaired People: Current Status, Challenges, and Future Directions	2017	This paper contains information about assistive devices, visually-impaired people, obstacles detection, navigation and orientation systems, obstacles avoidance	Molecular Diversity Preservation International (MDPI)
2	BLI – NAV Embedded Navigation System for Blind People	2010	BLI -NAV is a blind navigation system exclusively designed for blind people using GPS receiver; GIS database;	IEEE
3	AN ULTRASONIC NAVIGATION SYSTEM FOR BLIND PEOPLE	2007	The aim of this paper is to investigate the development of a navigation aid for blind and visually impaired People. It is based on a microcontroller with synthetic speech output.	IEEE
4	Wearable Navigation Assistance System for the Blind and Visually Impaired	2018	This paper contains information about Blind, Visually Impaired, Navigation Assistance, Infrared Cane, Ultrasonic Sensor, Wearable Technology	IEEE
5	A Navigation tool for blind	2007	This paper describes the development of a navigation aid in order to assist blind and visually impaired people to navigate easily, safely and to detect any obstacles.	ResearchGate
6	Navigation system for blind people	2005	This paper informs about Accelerometer Inertial navigation Integration Switch Microcontroller Navigation system Obstacle detection Speech	ScienceDirect
7	Multiple Object Detection using OpenCV	2018	Object Detection is a computer technology related	IEEE

			to computer vision, image processing, and deep learning that deals with detecting instances of objects in images and videos	
8	Multiple Object Detection using TensorFlow	2019	The TensorFlow object detection API is the framework for creating a deep learning network that solves object detection problems. There are already pretrained models in their framework which they refer to as Model Zoo	IEEE
9	Real Time Distance Measurement Using Camera	2019	a real-time method which can measure distance using a modified camera. The camera's image sensor is inclined by a certain angle.	IEEE
10	MULTIPLE OBJECT DETECTION AND TRACKING USING MATLAB SIMULINK	2017	This paper helped with multiple objects tacking, detection, people detection and MATLAB Simulink	ScienceDirect
11	Pedestrian Detection System with a Clear Approach on Raspberry Pi 3	2018	This paper helped with Support Vector Machines (SVM), Histogram of Gradients (HOG), Computer Vision, Machine learning, OpenCV	IEEE
12	Object Detection and Human Identification using Raspberry Pi	2019	Raspberry Pi, Ultrasonic Sensor, Camera Module, Harr Classifier, Ad boost, Object detection, Facial Recognition	IEEE

Chapter 3: Block Diagram

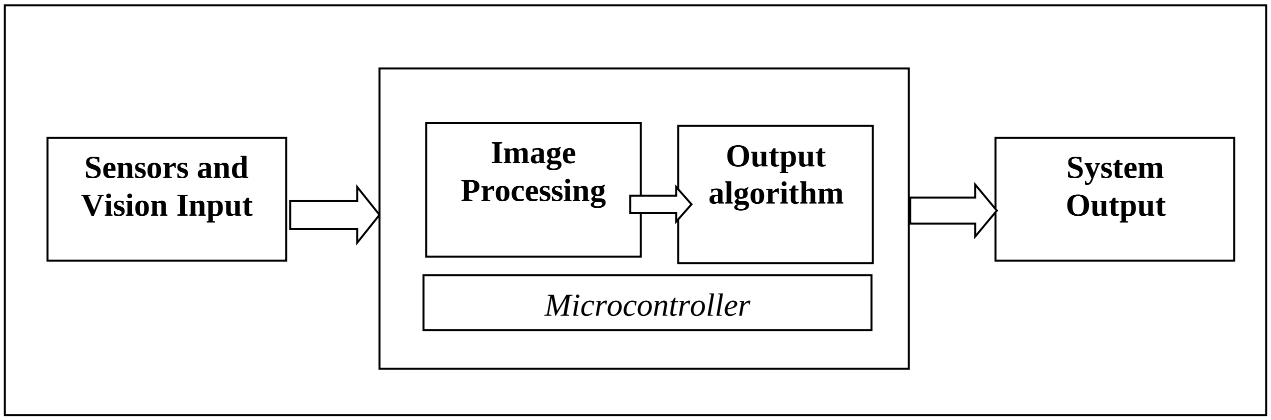

Figure 1

The above block diagram (figure 1) represents the working of entire system. First the input is taken via onboard sensors and camera, data is fed into the controller where the output is calculated via image processing algorithm and using other sensors data.

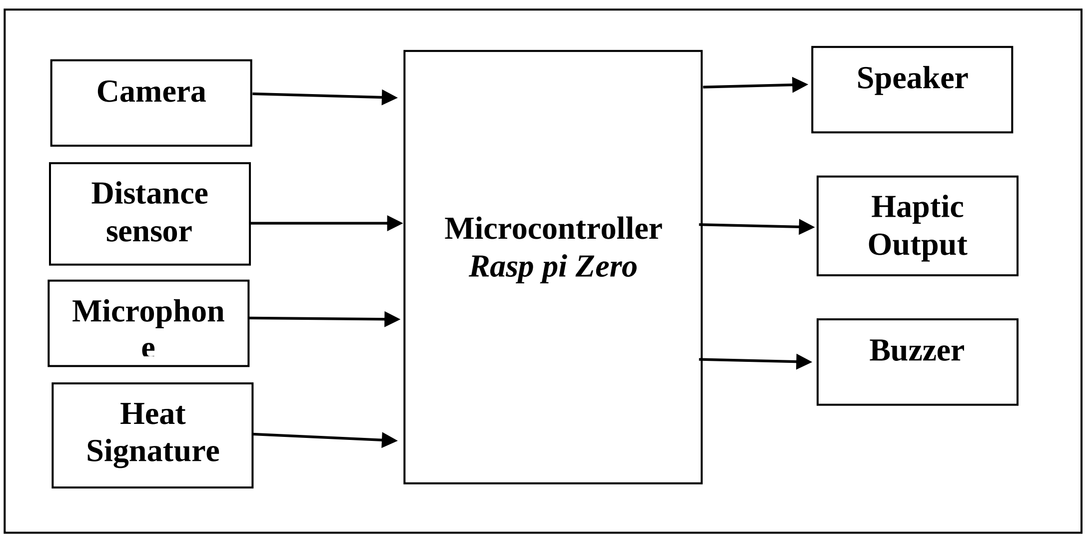

Figure 2

The above block diagram (figure 2) represents the entire system with all the sensors and equipment used in the device, in this system various inputs and taken like vision input, distance input, audio and heat signature, based on all these data input is given to microcontroller and output is processed and calculated signal is conveyed via 4 x 4 array of vibrating motors along with speech and buzzer output if required

Chapter 4: Circuit Diagram

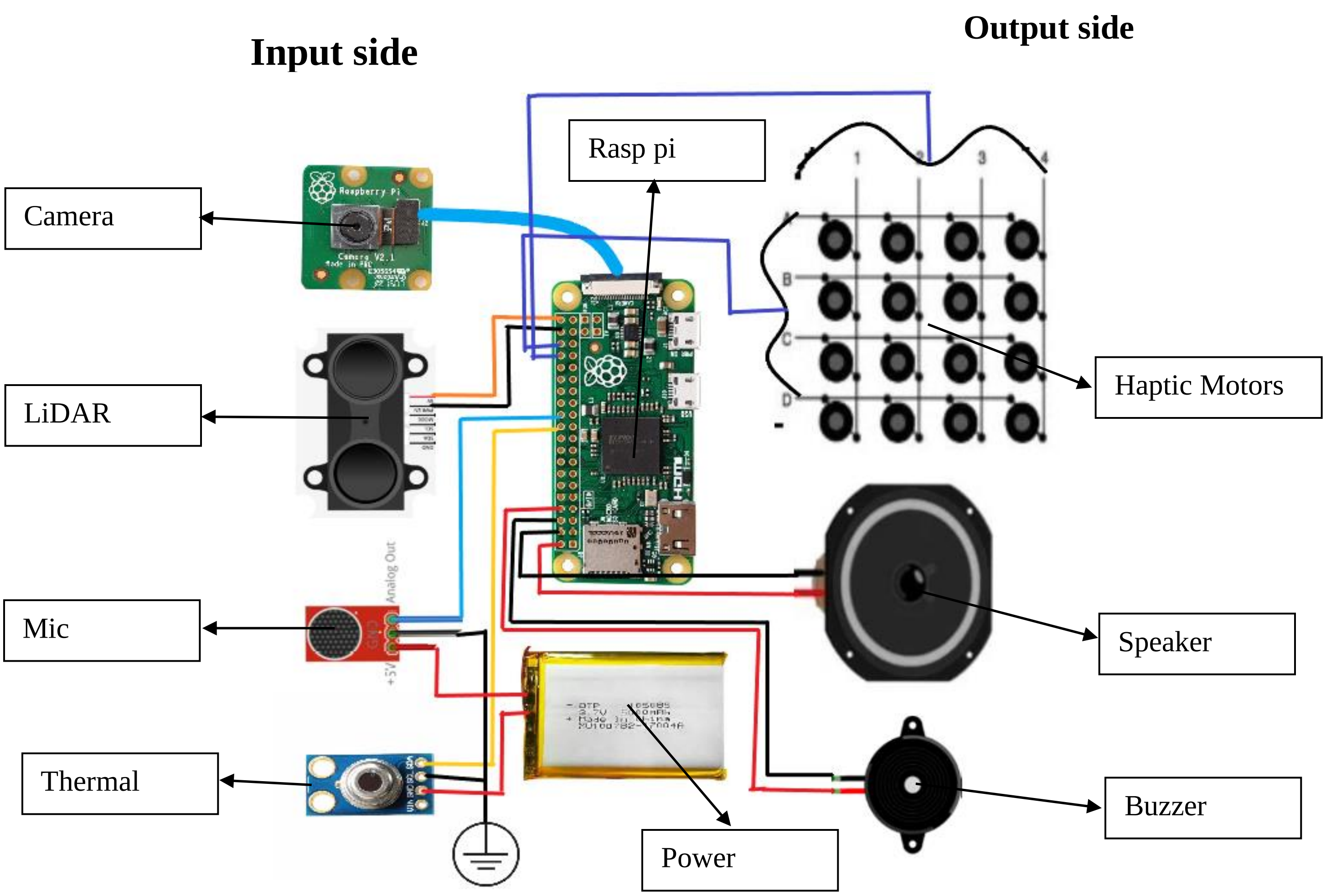

Figure 3

Design Steps:

1. Connecting power supply

   - Connect the positive terminal an negative terminal of a battery is connected to the raspberry pi via micro USB connector.
   - All the ground of sensors and controller is connected to common ground

2. Operating a device

   - Device consist of power on and off switch which control power of entire device
   - There are various buttons which performs different functions

Chapter 5: System Specifications

Raspberry Pi Zero:

Sr.No.	Specification	Description
1.	Microcontroller	Raspberry Pi Zero
2.	Operating Voltage	5V
3.	RAM	512MB
4.	Wireless	802.11n/BLE 4.1
5.	Ports	Micro USB, mini-HDMI
6.	I/O	40 GPIO
7.	Weight	9 grams

Pi Camera v2:

Sr.No.	Specification	Description
1.	Camera	Pi Zero camera v2
2.	Resolution	8 Megapixels
3.	Video Mode	1080p30,720p60
4.	API	V4L2 Driver
5.	Sensor	Sony IMX219
6.	Weight	3 grams

Distance Sensor (LiDAR):

Sr.No.	Specification	Description
1.	LIDAR	Distance measurement
2.	Range	0.3m-12m
3.	Voltage	5v
4.	Frequency	100HZ
5.	Size	42x15x16mm
6.	Weight	4 grams

Microphone:

Sr.No.	Specification	Description
1.	Microphone	Sound Application
2.	Voltage	2 – 10 v
3.	Current	0.5mA
4.	Frequency	20hz-12khz
5.	Impedance	<2.2kOhm
6.	Weight	3 grams

Thermal Sensor:

Sr.No.	Specification	Description
1.	Model	AMG9933
2.	Operating Temp.	0 – 80 degrees
3.	Current	10mA
4.	Range	7m
5.	Interface	I2c
6.	Weight	7.8g

Haptic Motor:

Sr.No.	Specification	Description
1.	Model	1034
2.	Voltage	3v
3.	RPM	9000
4.	Current	90mA
5.	Dimensions	O-D 10mm
6.	Weight	2.5 grams

Speaker:

Sr.No.	Specification	Description
1.	Model	8ohm 5watt 14595
2.	Impedance	8Ohm
3.	Power	5W
5.	Sensor	Sony IMX219

Passive Buzzer:

Sr.No.	Specification	Description
1.	Model	Passive Buzzer
2.	Voltage	5V
3.	Resistance	42Ohm
4.	Frequency	2048Hz
5.	Diameter	6mm

Chapter 6: Simulation Results

1. Device Overview and Layout:

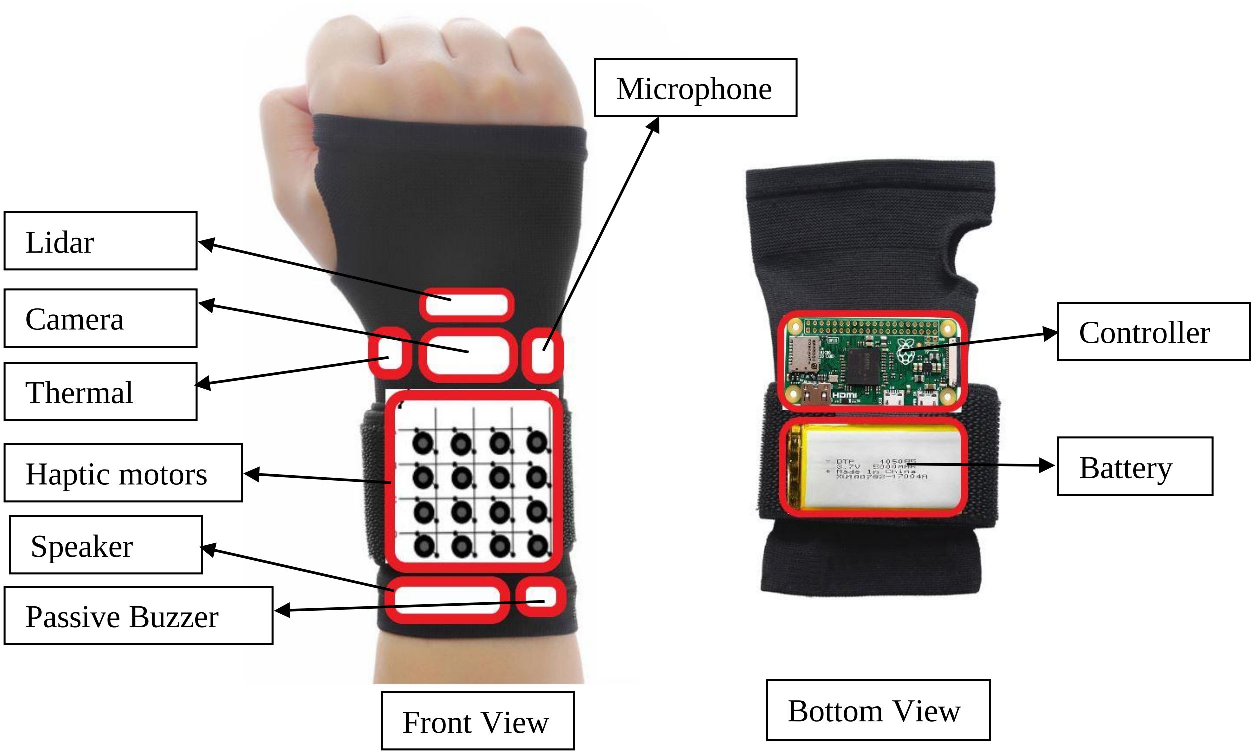

Figure 4 (approximately the actual scale)

2. Output Delivering ways:

Following are the ways by which our device and convey information to the blind person

1. Via Haptic feedback system which consist of 16 small vibrating motors which vibrate in a specific pattern to convey information of direction and obstacle via ability to feel and interpret patterns on human skin (Hand in this case).

2. Scene describer is a feature which describes whatever information is captured by the camera with machine learning models and then spoken out loud via onboard speaker. Scene describer gets activated via dedicated button

3. Thermal sensor can detect heat signature and human presence even at night. It can warn individual if he/she is going to touch hot substance also detect human presence at night via ML techniques

4. Onboard buzzer and speaker can warn if there is obstacle in front and describe the correct path via speech engine

3. Haptic feedback System Explained:

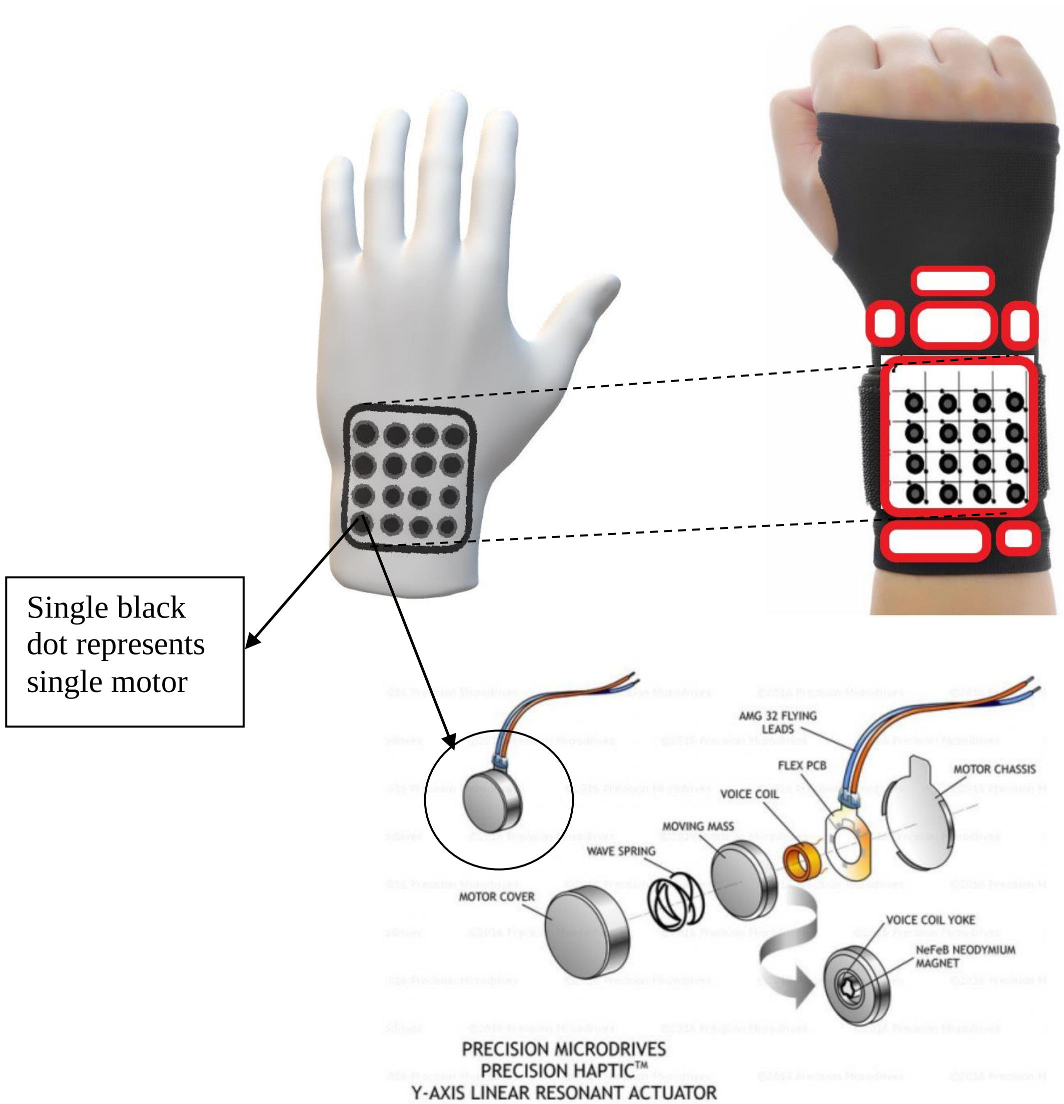

Figure 5

Above figure shows the exploded view of single motor (Single black dot represents single motor) There is total 16 motors in 4 x 4 array format. Each and every motor can be controlled individually thus allowing us to activate motors in the pattern that we want and e can program various patterns like GO FORWAD by activating sequence of motors from bottom row to top row like wise GO BACKARD, GO LEFT, GO RIGHT.

Hardware is currently not accessible so our team is currently focused on the simulation in a virtual environment like MATLAB and Python IDE for the image processing, Object tracking feature of our project. Below are the results of all the simulations so far.

Figure 6

Above image is the demonstration of how objects and people can be detected using raw image data of raspberry pi camera and opensource library known as OpenCV and Google tensor-flow API, which is an opensource library for Machine Learning, they have COCO - Common Object in Context. Lots of models set are also available.

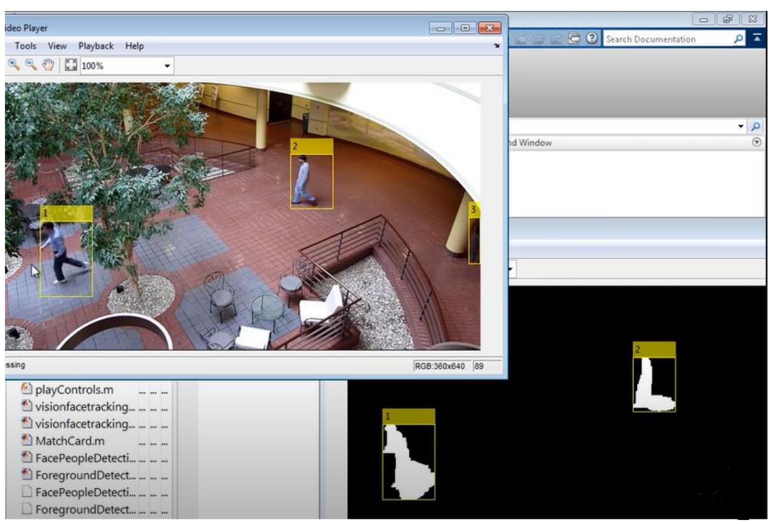

Figure 7

Above image is from the working simulation we performed on the MATLAB software. It focuses on the object tracking and of object we are tracking is hidden (due to obstacles e.g., tree) in few frames then our model can predict where the object will appear again based on the speed and velocity of object being moved

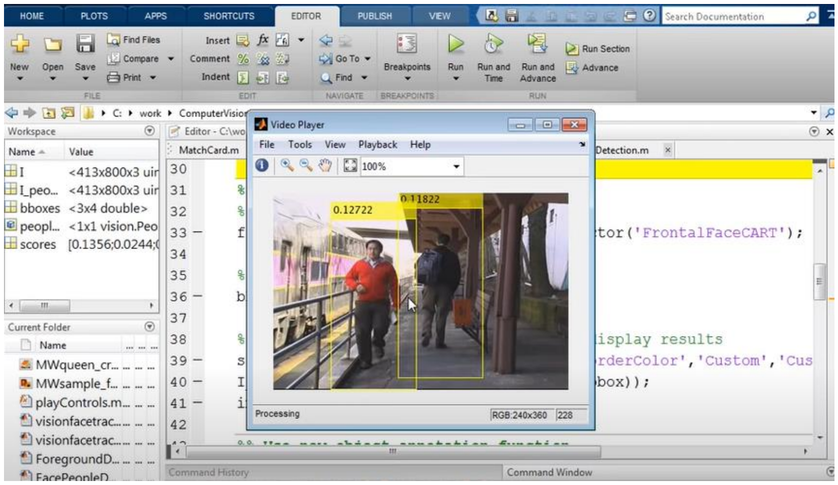

Figure 8

Above image is from the working simulation of people tracking from the video input at 10 - 15 frames per seconds. The importance of this simulation is that our device having this feature can easily keep the number of people around and track them here they are at and describe it to the user. (“e.g., A person is moving towards left 5 meters away”)

Chapter 7: Results

1. Successful simulation of circuit.
2. Successfully built the model and design of final device.
3. Successful implementation of Object detections algorithms.
4. Worked on MATLAB for prediction and object detection.
5. Successfully developed various patterns for haptic vibration output.

Chapter 8: Application

The main application of this project is the help a visually impaired person with navigation, describing the real time situation and give the person freedom and confidence to navigate free and openly.

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