VISION CANE: ASSISTIVE SYSTEM FOR THE VISUALLY IMPAIRED

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Abstract—Vision Cane is an accessibility device that helps the visually impaired through immediate voice instruction and vibration feedback for quick and accurate guidance. Vision cane uses the Brunel Navigation system to get the exact position in each step and appropriately guides according to the information given. For indoor mobility, short distance and long-distance obstacle detection is done by the ultrasonic and RFID sensors. Computer vision is used for outdoor mobility to produce accurate results.

Many technologies are present and are in development to help the visually impaired gain safe and accurate mobility. Vision cane is built to achieve the same purpose but to give them much reliable and fast feedback in a cost-effective manner. It aims to diminish the hurdles faced by the visually impaired to achieve maximum mobility.

Index Terms—TensorFlow, Object Detection, Geolocation, Navigation, Google Maps.

I. INTRODUCTION

According to world health organization the global count of visually impaired is approximately 285 million out of which 39 million are blind and 246 million are having low vision. Most commonly blind people depend on the white cane for local navigation by continuously swaying to detect obstacles. In addition to this, they often depend on other humans, trained dogs or special electronic devices as a support system for decision making. Even there are so many ways, these aren't efficient ways. It requires a lot of time as well it is expensive and there is a lot of risk as it includes things that are at immediate depth. The usage of ultrasonic is indeed old but user needs to detect obstacles immediately indoor when there is a possibility of low network. For outdoor navigation more care must be taken, which is why we are introducing computer vision and other factors like ultrasonic and infrared sensing for effective output. But even with the emerging technologies, it is important to understand the user's perspective for daily uses. Real times feedback is given through audio and vibration feedback for quick and better understanding to the user.

II. METHODOLOGY

A. Cane

Three ultrasonic sensors are placed to detect objects in front, left and right respectively as shown in Fig 2.1. When the object is detected by the ultrasonic sensor, the buzzer beeps simultaneously. The distance between the object and the cane is calculated both on the left and right sides. The direction is chosen based on the greater distance between them. It moves left or right depending on the distance and the left and right vibration motor vibrates accordingly. The distance is calculated again. Consequently, the front or left and right vibration motor vibrates.
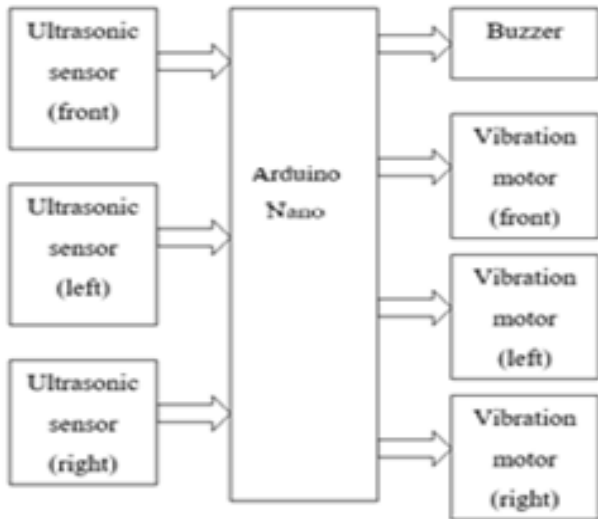
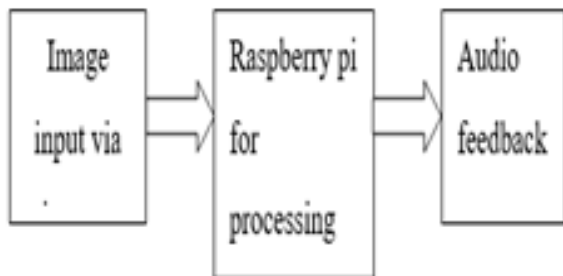Fig. 2.1. Block diagram of cane

B. Headsets

Fig. 2.2. Block diagram of headset

The headset consists of a camera, Raspberry Pi and headphones as shown in Fig 2.2. The camera is placed a little above the eye to give maximum visibility. The real-time image is captured and sent to the Raspberry Pi. The Raspberry Pi detects the object and labels it according to the database. Non repeated data (i.e. number of steps ahead, name of the object etc.) is given as output to the user in the form audio through the headphones.

C. Vision Direction Application

The user can add their required location. This saved location can be selected and viewed on google maps and the directions are given accordingly. The address of the unselected location can be directly viewed on the map as shown in Fig 2.3.

In case of emergency, when the phone is tilted twice, the immediate location is sent to their emergency contacts. Additional apps that will help them in easy navigation such as Be My eyes and M-indicator can be accessed from the application using a gesture.
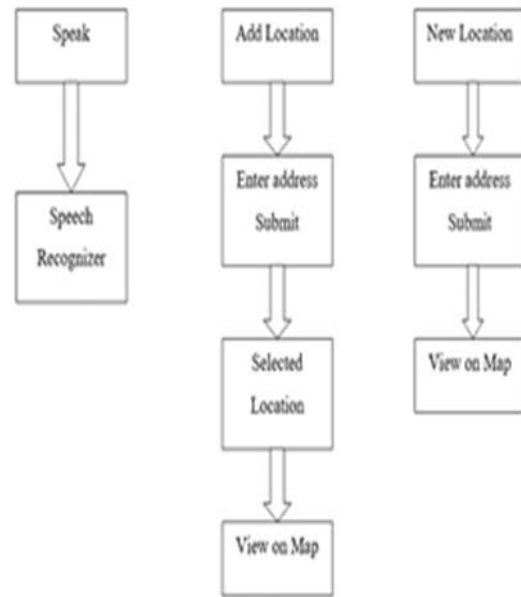

Fig. 2.3. Block diagram of application

III. WORKING

When the ultrasonic sensor detects an obstacle, the buzzer is activated. The distance of the obstacle and the user is calculated immediately. If the left distance is greater than the right side, then the left vibration motor vibrates, again it checks if there is any obstacle in front then the front motor is activated or else again the distance is calculated and the respective vibration motor is activated.

The captured image undergoes processing and the TensorFlow algorithm is run to detect and obstacle ahead of the user. The TensorFlow algorithm preprocesses the data, then builds the model and is also trained accordingly to detect certain obstacles. The object labeled is spoken out and brought to the user through Bluetooth speaker.

When we scroll across the application and click on the "Add Location" button, once we edit the address required, the address is saved so that the user can immediately find it in the "Selected Address "list. Once we click on the "view on map" option, the geolocation of the given address is immediately opened on Google Maps through where we can get directions easily. To find the current location click on "My Location on Map" and the geolocation of your current address is shown Google Maps. The flow charts are as shown in Fig 3.1, 3.2 and 3.3
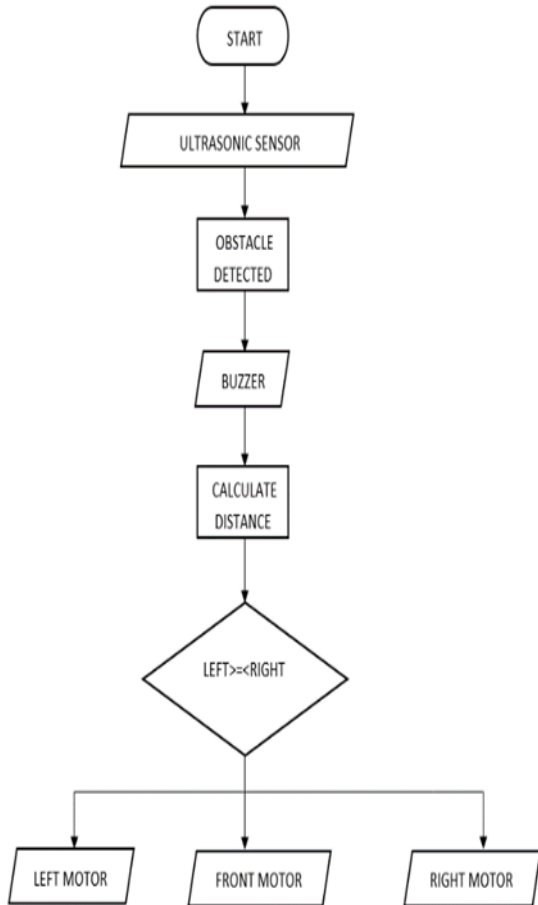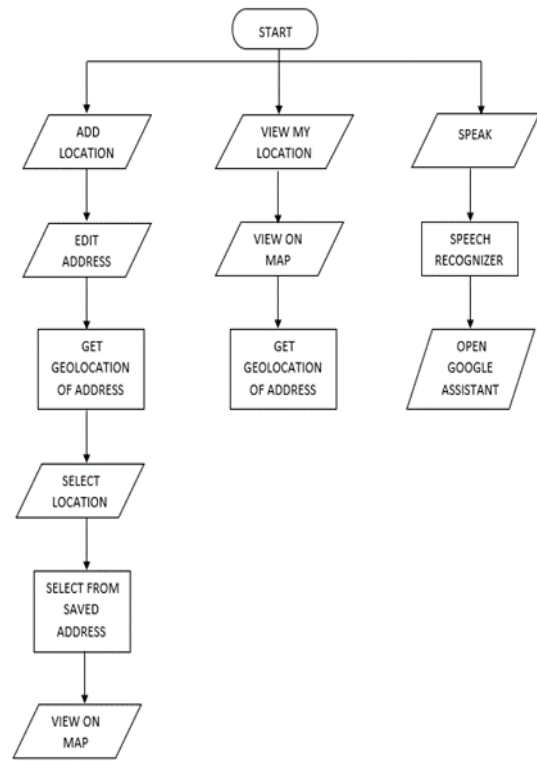
Fig. 3.1. Flowchart of cane

Fig. 3.2 Flowchart for headset

Fig. 3.3. Flowchart for application

IV. HARDWARE AND SOFTWARE REQUIREMENTS

A. Raspberry pi 3b
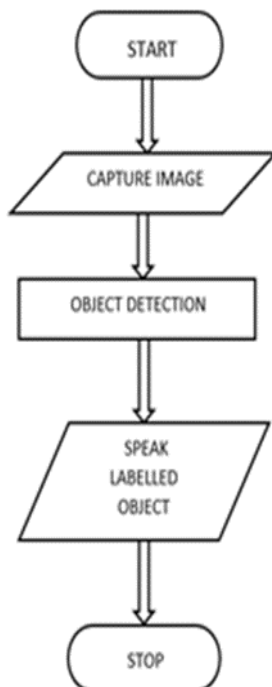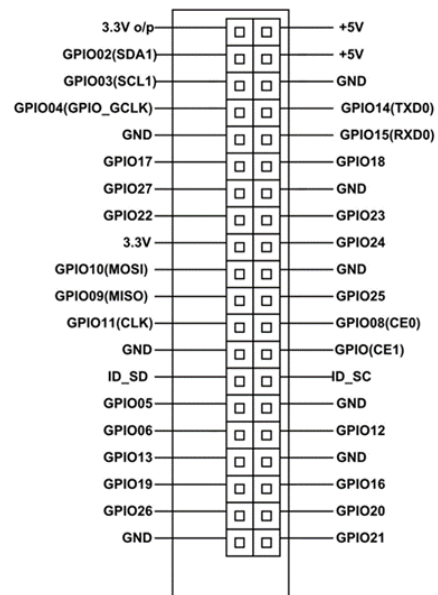

Fig. 4.1 pin diagram of Raspberry pi

The latest product in raspberry pi 3 range that is raspberry pi 3 model B+ as shown in Fig 4.1 is used which is featured with 64-bit quad-core processor running at 1.4GHz with inherent metal heatsink, dual-band 2.4GHz and 5GHz wireless LAN, faster Ethernet (300 Mbps), and PoE capability via a separate PoE HAT. The

Raspberry Pi detects the object and labels it according to the database. The real-time image is captured and sent to the Raspberry Pi.

B. Pi camera

This raspberry pi infrared IR night vision surveillance camera module 500W webcam can be used in both day and darkness of night. It presents 5MP with Omni Vision 5647 sensor which is in fixed focus mode. It captures the continuous image and is sent to the raspberry pi.

C. Bluetooth Speaker

It comprises of one amplifier and loudspeaker with Bluetooth wireless connectivity that is paired with one or more smartphones, tablets, iPods or computers. The objects that are detected, the labeled object is known to the user by speech through the speaker. A Bluetooth speaker is used for further privacy for the user.
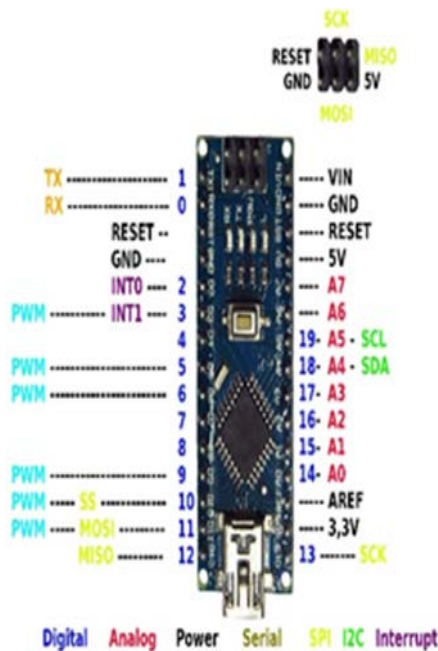
D. Arduino nano

Fig. 4.2 Pin diagram of Arduino nano

E. Ultrasonic sensor

An ultrasonic sensor is an electronic device that is used to measure the distance of a target object based on emitting ultrasonic sound waves, and then converts the sound into an electrical signal. The speed of ultrasonic waves is greater than the speed of audible sound. Three sensors are placed in the cane, each detecting front, left and right respectively to give 270-degree detection.

F. Buzzer

A buzzer or beeper used maybe a mechanical, electromechanical, or piezoelectric (piezo for short), is an audio signaling device. Various uses of buzzers and beepers are alarm devices, timers, and confirmation of user input such as a mouse click or keystroke. The buzzer is connected to the Arduino and acts as an output of the ultrasonic sensor. When an object is detected by the ultrasonic sensor, the buzzer is activated.

G. Vibration motor

Vibration motor is a compact size coreless DC motor used to inform the users by vibrating and no sound of receiving the signal. Three vibration motors are placed on the top of the cane for the user to feel the vibrations. The three sensors are named as front, left, and right. They vibrate accordingly and alerts the user to move based on the respective motor. (i.e. if the left motor vibrates, the user must move left, vice versa).

H. Open CV:

OpenCV is a library of programming used at real-time computer vision. Formerly developed by Intel, it was later supported by Willow Garage then Itseez. Under the open-source BSD license, the library is cross-platform and free for use. OpenCV provisions some models from deep learning frameworks like TensorFlow, Torch, PyTorch (after converting to an ONNX model) and Caffe according to a definite list of supported layers. TensorFlow algorithm is used to detect the objects in the raspberry pi on the Open CV platform.

I. Arduino software:

The Arduino Integrated Development Environment (AIDE) is a cross-platform application transcribed using the functions from C and C++. With the help of 3rd party cores, other vendor development boards, It is used to write and upload programs to Arduino compatible boards. Using special rules of code structuring, Arduino IDE supports the languages C and C++. The Arduino IDE deliveries a software library from the Wiring project. Two basic functions required for User-written code are starting the sketch and the main program loop, that is compiled and linked with a program stub main () into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution.

J. MIT app inventor:

MIT App Inventor is a web application integrated development environment formerly provided by Google. It was later maintained by the Massachusetts Institute of Technology (MIT). It uses a graphical user interface (GUI) alike to the programming languages Scratch (programming language) and the Star Logo, allowing the users to drag and drop visual objects to produce an application that can run on mobile devices. Google drew significant prior research in educational computing in producing App Inventor, and the work was done within Google on online development environments. It is used to create the vision direction application. The inbuilt components such as location sensor, an accelerometer sensor, an orientation sensor and speech recognizer is used. The google maps extension is used to get the directions.

V. RESULTS

We have successfully achieved a low-cost way to help visually impaired users in independent mobility. As shown in Fig 5.1, the user can use the Vision Direction application that helps the user to get directions through Google Maps, with easy accessibility and faster results. Saved address is listed out in the "selected address". The current location can be found by the "My location on the map" to the immediate geolocation of the user. In case of confusion, "Location help" explains how to use the app.
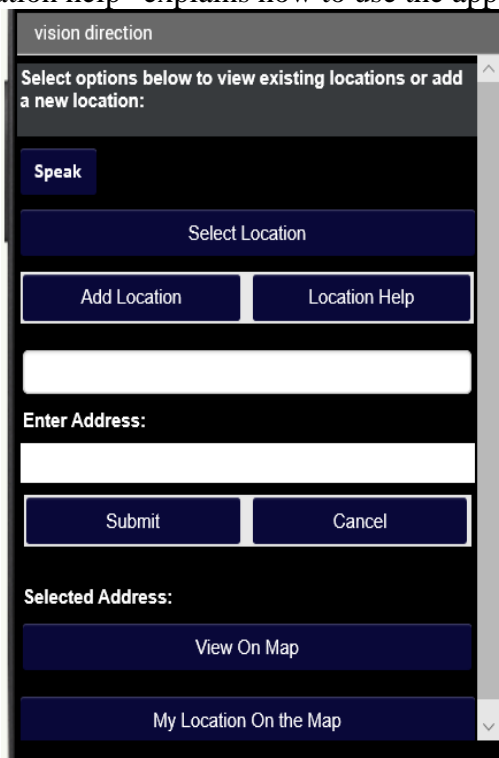

Fig. 5.1 Application (vision direction)

As shown in Fig 5.2 we have detected the object placed in front of the camera using Tensorflow and is processed in the raspberry pi.
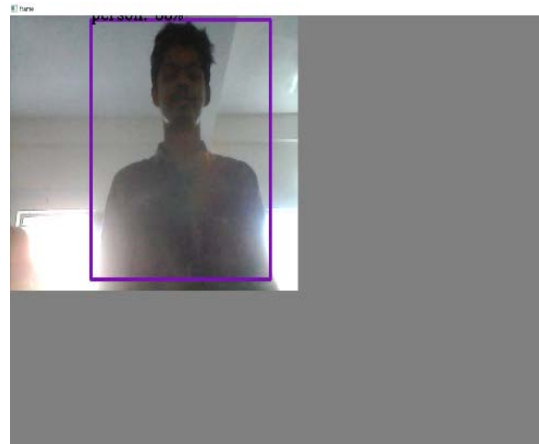

Fig. 5.2 Screenshot of Object detected

The implemented design in Fig 5.3 is of the connections in the cane. Three ultrasonic sensors are placed on the front ,left and right to detect more areas. When the ultrasonic detects an obstacle the buzzer beeps. Three vibration motors each placed in the left, right and front respectively, is activated according its direction to be given, For example if an object is detected, the buzzer beeps and if the left direction is more than the right side then the left vibration motor is activated , the rest vibration motors are activated when there is an obstacle is detected and based on the distance between obstacle and user.
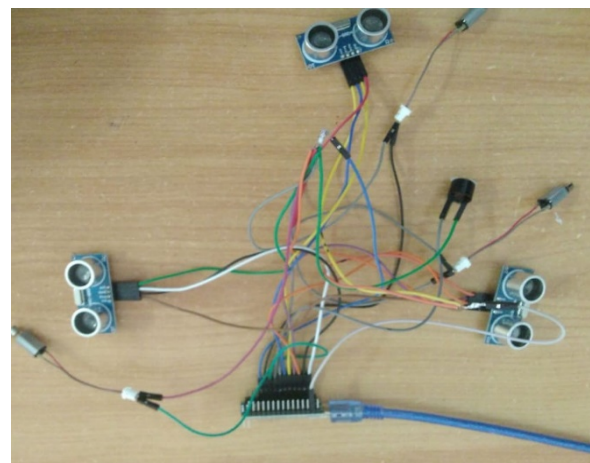

Fig. 5.3 cane

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