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Object Identification for Visually Impaired

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Abstract

Objectives: This paper is based on a device that helps blind people to identify a set of objects used in everyday routine thereby enabling them to work independently. **Method/Analysis:** A new portable camera based method to recognize indoor objects for helping blind people is introduced. A more improvised algorithm called as the Coarse Description Technique has been employed. The coarse description technique can be implemented in two ways: Euclidian distance measurement method and another method that relies on semantic similarity measure modeled by means of Gaussian process estimation. **Findings:** The techniques used currently perform the recognition task by limiting it to a single predefined class of objects. The proposed concept in this paper utilizes a completely different alternative scheme termed as coarse description. Its main objective is to expand the recognition task to multiple objects and keep the processing period under control at the same time. While the Euclidian distance measurement method evaluates every image based on a matrix created using details regarding the pixels of each image, the Gaussian process estimation method compares images using a number of image attributes. **Novelty/Improvement:** PIC controller used in the existing system is replaced by a Raspberry Pi board which provides a computation speed twice as fast as the former.

Keywords: Coarse Description Technique, Euclidean Distance Measurement, Gaussian Process Estimation, Image Matching, Raspberry Pi

1. Introduction

Unlike the techniques used till date which typically performs the recognition task by limiting it to a single predefined class of objects, what is proposed in this paper utilizes a completely different scheme termed as coarse description[1–3]. Its main objective is to expand the recognition task to multiple objects and simultaneously keeping the processing period under control.

People suffer from visual impairments which prevent them from travelling independently. Therefore, a wide range of tools and techniques need to be used to help them in their mobility. Few of these techniques are orientation and mobility specialist which helps the visually impaired and blind people. It also trains them to move on their own independently and safely, depending on their other remaining senses[4,5]. Another method is the guide dogs which are specially trained to help the blind people for their movement by navigating around the obstacles to alert the person to change their ways. However, the difficulty faced in this method is to understand the complex direction of these dogs as they are only suitable for about five years. These trained dogs are very expensive and also it is difficult for the blind and visually impaired people to provide necessary care for another living being.

To enhance the blind movement, there is an international symbol tool of blind and visually impaired[4,5] people just like the white cane with a red tip is used. Nowadays, different types of these canes have been used such as the white cane, the smart cane and the laser cane. The constraints of these tools are long length of the cane, limitations in recognizing obstacle and also difficulty to keep it in public places[6].

2. Implementation

This section covers the details regarding the implementation of the object identification device that is proposed by this paper.

2.1 Components

An overview of the various components used in the prototype is listed in detail as follows:

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2.1.1 Raspberry Pi

The Raspberry Pi model B board comes with a 512 MB RAM along with 2 USB ports in Figure 1. It also provides the option of Ethernet networking and storage is provided using an SD card. The Broadcom BCM2835 System on a Chip (SOC) is at the heart of the Pi. The common hardware components of a PC have been fabricated into a small chip. The CPU is ARM1176JZF-S which runs at 700 MHz and belongs to the ARM11 family. For graphics, Broadcom Video Core IV GPU is used in the Raspberry Pi, which is quite powerful for such a small device and capable of full HD video playback.

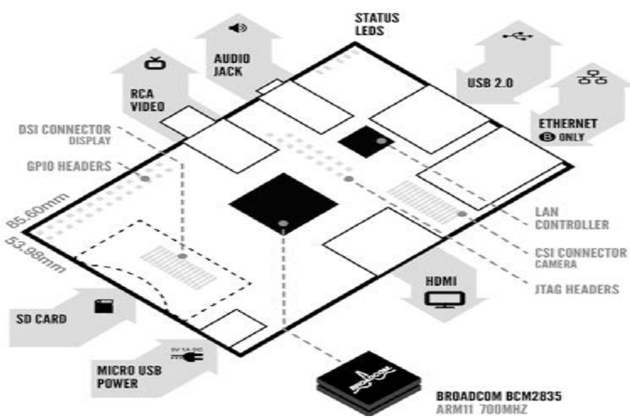

Figure 1. Raspberry Pi block diagram.

2.1.2 Ultrasonic Sensor

An ultrasonic sensor is the main component used for obstacle detection is shown in Figure 2. It consists of a transmitter and a receiver in cylindrical structure placed parallel to one another. The ultrasonic sensor will scan the complete area in the range of the ultrasonic beam. Any obstacle that lies in the scanning range of the beam will be reflected and picked back by the receiver unit in the sensor. The distance determination depends on the body that has caused the beam reflection.

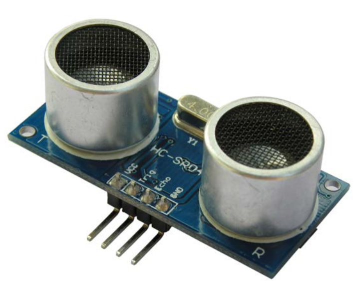

Figure 2. Ultrasonic sensor.

2.1.3 GSM

GSM (Global System for Mobile) in Figure 3 works on frequency 850, 900, 1800 and 1900 MHz. It is very compact in size and easy to use as plug in GSM modem. The modem is used to directly interface with 5 V as well as 3 V microcontrollers. It has internal TCP/IP stack to enable user to connect with internet through GPRS. It is suitable for SMS and data transfer applications[7].

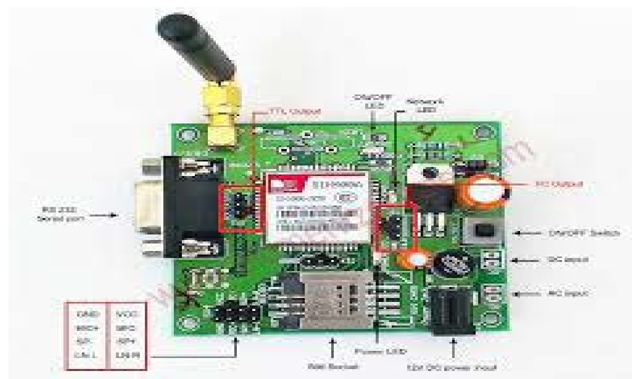

Figure 3. GSM module.

2.1.4 APR9600 Voice IC

APR 9600 recording Voice IC in Figure 4 uses non volatile flash memory technology it does not require a battery backup and operates at 25 mA current. It offers user selectable messaging option with automatic power down feature.

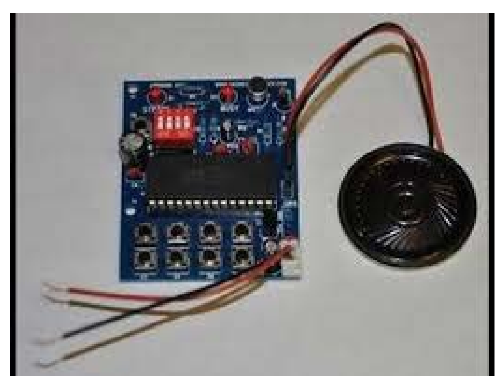

Figure 4. APR9600 voice IC.

2.2 Configuring

2.2.1 Setting up the Raspberry Pi

First the board is connected to a display. Connected along with it are an Ethernet cable, USB mouse and USB keyboard. The SD card which serves as the sole storage medium is inserted on the bottom of the board. A micro USB is connected to power the board. Prior to this step the SD card needs to be flashed with an OS, raspbian in this system. The step by step process is shown in Figure 5.

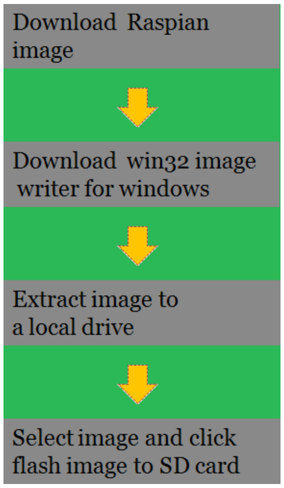

Figure 5. Flowchart showing the steps to flash the SD card.

2.2.2 Camera

The Raspberry Pi board has a specialized port to connect the camera called CSI camera port is shown in Figure 8. But in order to reduce the cost we use an ordinary webcam which is connected with the help of an USB cable. A library is created containing many files, each of which contains images of all the objects from different angles[8] and the process is shown in Figure 6.

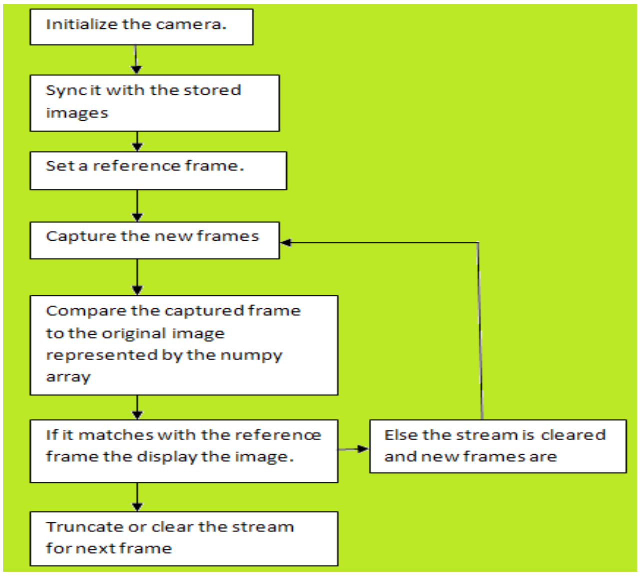

Figure 6. Flowchart showing the steps to setup the camera.

2.2.3 Initializing the Sensor

The threshold distance for obstacle detection is set according to the user's preference. Following which an alarm turns on when an obstacle is detected within the set range is explained in Figure 7.

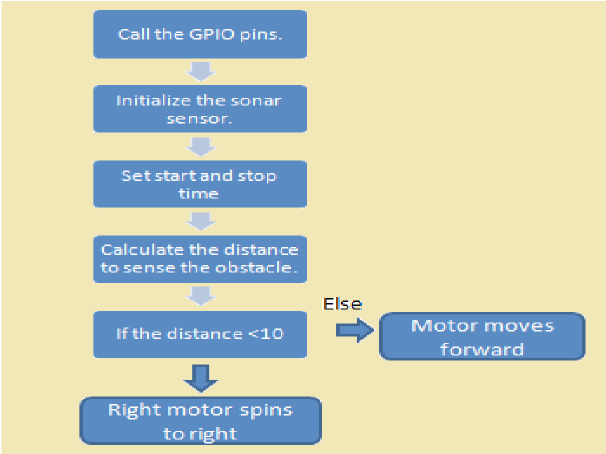

Figure 7. Flowchart showing the steps to setup the sensor.

2.2.4 GSM

The GSM module is interfaced to the Raspberry Pi board with the help of the I/O pins. The pins used for transmission and reception should be connected in reverse order and the pins used for ground must be shorted[4]. A sim card is inserted into the GSM module and the GSM module is powered up. Then wait for a few seconds for the sim to initialize. Python code for making an emergency call to the saved number is dumped into the Raspberry Pi board. An emergency key is interfaced to the board for this purpose[9].

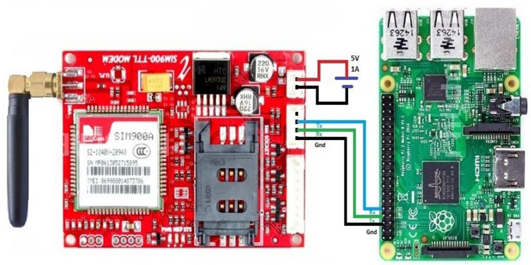

Figure 8. GSM interfaced to Raspberry Pi.

2.3 Working

2.3.1 Image Matching

First the packages that have been created are imported[10].

Camera is initialized and allowed to warm up. The frame is captured by the camera when key 1 is pressed which is then compared to the original image that is represented as a numpy array[3]. The frame is then indicated via a voice output as the name of the object if the frame matches with the reference frame and the steps are explained in Figure 9.

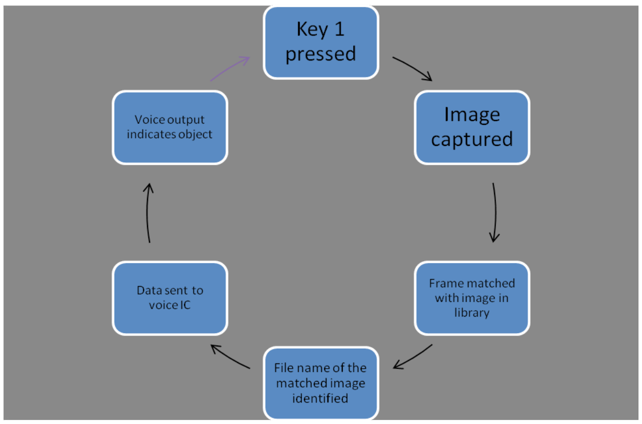

Figure 9. Flowchart describing the action of the device with button press.

2.4 Improvisations Made

- PIC controller used in the previous system replaced by Raspberry Pi board which offers increased memory and fast processing.
- Image processing technique used before is replaced by image matching technique which is easier to implement and produces better results.
- Ultrasonic sensor used overcomes the inaccuracy and environment restrictions observed while using an IR sensor.

2.5 Future Enhancements

- With the addition of face recognition feature, the device can be modeled to store the facial details of people closely related to the user which will help him or her differentiate between peers and strangers.
- The device can be modified to identify numbers, colors and shapes[11] which will be of more use to the user even in the outdoor environment.
- The camera can be made wireless with help of Bluetooth or Zigbee which will reduce the number of wires and thereby reduce errors due to human intervention.
- The single camera can be replaced by many cameras through wireless medium which will be more effective in blind schools and institutions since it reduces the cost and eases the operation for the user.

3. Conclusion

It is a simple, economical, configurable electronic guidance system which is easy to handle and it is proposed to provide constructive assistant and support for blind and visually impaired persons. The system has been designed and implemented. The results of the real-time system are encouraging. The results show that the system is efficient and unique in detecting the distance and identifying the object that the blind person may encounter. For this proposed system, special training is not required. It also resolves limitations of other systems that are related to mobility oriented problems that influences the blind people in their environment. Future work on this system will be focused to enhance the performance of the system and reducing the load on the user and to incorporate additional features thereby making it a more efficient device.

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