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An Innovative Smart Assistance Footwear for Visually Impaired People

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Abstract*—Today technology is evolving at a rapid pace. Based on the recent survey of the World Health Organization (WHO) it is estimated that there are almost 1.3billion people who suffer from some form of vision impairment. This paper addresses the complete integration of system which can facilitate the blind as well as visually impaired individuals to understand the surrounding beside them. The proposed system will provide a low-cost portable solution to help the blind people. It consists of shoes having ultrasonic sensors to survey the scene. Once the sensors detect the object in front of the person the camera module gets activated. After detecting the object, camera module clicks the image of an object which is in front of the people and then it will be processed to detect the object type, according to which information will be sent as audio via a Bluetooth headset to the user. So, the visually impaired human will get the audio instructions accordingly about the obstacle in the dynamic environment.*

Keywords—Navigation, Object recognition, prerecorded voice, Visually Impaired, YOLO algorithm.

I. INTRODUCTION

The 2018 World Health Organization report estimates that about 1.3 billion people bear some kind of vision impairment. Considering the distance vision, 188.5 million people suffer from mild vision impairment, whereas 217 million have moderate to severe vision impairment, and about 36 million people suffer from complete blindness. With regards to near vision, about 826 million people suffer from near vision impairment [1].

Over years several rehabilitative and assistive devices were invented to help the visually impaired and blind. These devices make use of various technologies like GPS devices like Mobile Geo, sensory substitution devices like "the vOICe", RFID tags were used for distinguishing and detecting the objects at different locations, stereo vision camera are used to form aids for assisting the blind during navigation. There are tools like screen readers to assist the blind to use the internet with help of OCR and alternative technologies [2].

The VI used solutions such as walking canes, guide dogs and even human volunteers to travel from source to destinations. The previous researches include the obstacle detection portable devices embedded into shoes, belts, and canes. The problems such as having to carry extra items for aid, no object identification, etc. should be eliminated and the Visually Impaired should be able to walk around like any other normal person.

This paper proposes a prototype model of smart shoes – an electronic aid for the VI. This system is meant to provide overall measures to detect obstacles that come into their way such as stairs, manholes, human beings, etc. The main objective of thesystem is to provide an voice assistant to the Visually Impaired People. The system would serve as a guiding assistance to them. The system also focuses on helping the blind and visually impaired people, making them confident to walk around and navigate without any volunteering and external help.

II. RELATED WORK

According to the studies, K. Laubhan, et. al. [3], presented a system that consists of the ultrasonic sensors detect the obstacles and compares with the threshold. If the threshold value is crossed then the user gets information about the position of the obstacle via the Bluetooth headset. N. Mahmud, et. al. [4], presented system which consisted of a White walking cane having ultrasonic sensors and vibrators on it. The system presented in this paper has a built-in voice feedback and vibration module which informs the user about an obstacle which is within 70cm. S. Aymaz, et. al. [5], presented the system consists of Headset which has two membranes, left membrane senses left obstacles while the right membrane senses the right obstacles. Every membrane is covered

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by two ultrasonic sensors which are able to detect right and left obstacles. J. Redmon, et. al. [6], presents a model for object detection using 7*7 grid bounding boxes. Using this system, (YOLO) you only look once at an image for predicting what object is present and where it is located. Dr. B. Muthusenthil, et. al. [7], present a system with the main objective to convert a normal text with different fonts to an audio output using ultrasonic sensors, OCR algorithm and TTS algorithm. B. Mustapha, et. al. [8], presented the system that uses infrared and ultrasonicsensors to detect the object. The user is alerted by the vibration and audio feedback whenever an object is detected.

III. SYSTEM ARCHITECTURE AND OPERATION

The systempresents a model for object detection and identification for the navigation aid of the blind and visually impaired people. It consists of total two modules: obstacle detection and object detection.

The Fig. 1, shows the block diagram of the system. It consists of camera module. Raspberry pi, headphones, vibration motor, three ultrasonic sensors, portable battery.

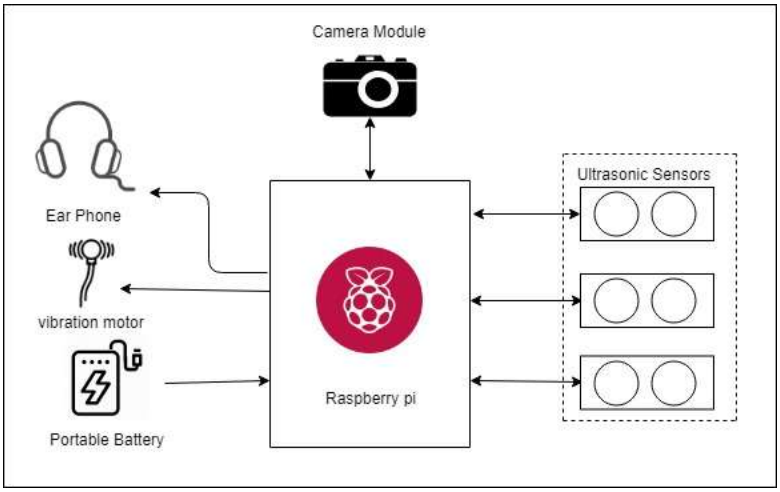

FIG. 1: Block Diagram of the System

The Hardware used in developing the system:

1. Raspberry Pi 0W
2. Ultrasonic sensors HC-SR04
3. Camera Module V2
4. Vibration Motor

Fig. 2 below, shows the system flow of the proposed system.

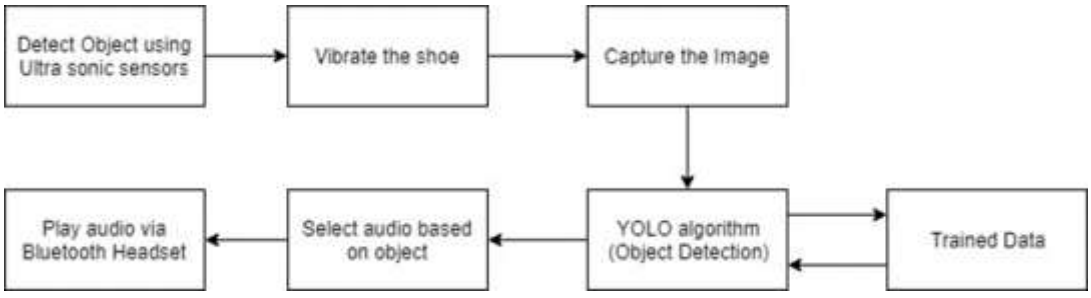

FIG. 2: System Flow of the System.

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The RPi i.e Raspberry pi is a portable debit-card sized computer that plugs into one'sdisplay,mouse and keyboard. It is an absolute Linux computer that provides all the expected abilities that imply, at a low-power consumption level but it is slow than a laptop or desktop. It is versatile to use in many applications likeArcade machine, Media streamer, tablet computer, etc. [9].The obstacle detection is be done by using three ultrasonic sensors HC-SR04. The ultrasonic sensors constantlyemits a short burst of ultrasonic sound to a target, which reflects the ultrasonic sound back to the sensor. It is reliable in any light environment and can help in handling collision avoidance for a robot, and being moved often, as long as it's not too fast. On receiving the ultrasonic pulse, the distance is compared to the setthreshold. If the threshold value is crossed, then the raspberry pi activates the vibration module for a fixed fraction of time [10].

Once, the obstacle is detected, the Camera Module is activated. The YOLO algorithm is used for real-time object detection in a video scene. The object detection task consists in determining the location on the image where certain objects are present, as well as classifying those objects. YOLO trains on images as whole and directly optimizes the detection performance. YOLO is extremely fast as it only looks on an image once. The network runs at forty five frames per second with zero batch processing. This suggests we can process videostreaming in real-time with less than twenty five milliseconds of latency.Also, YOLO achieves over double the mean average precision of alternative real time systems [6].

According to the identified object, corresponding pre-recorded audio clip will be played by the system to inform the user about the detected object. The user can hear the audio output through the Bluetooth Headset. The entire processing of object detection and image processing will be done on the raspberry pi.

IV. RESULTS

Ultra-sonic sensors detect obstacle and give feedback in approximate 1s. After receiving the feedback thevibration motor vibrates. Simultaneously the camera module activates and yolo algorithm identifies the object in real time video-scene. The prerecorded audio is played accordingly. The entire processing takes approximately 1-3s.

In the proposed system the YOLO algorithm performs object detection using the pre-trained COCO dataset. The table 1 shows the accuracy of the correct object detection according to the distance the object was placed.

TABLE 1
RESULTS

Object Type	Distance of Object (in cm)	Accuracy
Person	50	89%
Cat	30	86%
Dog	25	92%
Car	50	88%
Bike	20	85%
Bench	35	90%
Table	30	81%
Potted Plant	20	95%

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V. CONCLUSION

The use of object detection for the assistance of blind and visually impaired is proving to be beneficial. The available solutions for the aid of visually impaired include technologies which either include extra items to carry such as walking canes, hats etc. These technologies only detect that there is an object at a particular distance and in a particular location. But they fail to alert the user what type of object is present i.e. object, human, animal, etc. The system presented in this paper detects the object, alerts the user as well as informs about the object type**.**

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