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A Novel Design of Smart Navigation System for Blinds

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ABSTRACT: Obstacle avoidance and navigation are key issues for blind persons who need assistance in getting around securely. This paper describes an obstacle avoidance system for blinds that uses image processing and some Machine Learning (ML) concepts to assist blinds, as well as YOLO Data, set techniques, and some Python libraries to detect the items he encounters in his path, and navigation modules for blind safety so that they can live their lives independently. Navigation system for the visually impaired refers to systems that use sound commands to assist or guide people who are partially or completely blind due to vision loss. Many researches are on-going to aid visually impaired people in a variety of ways, including voice-based assistance and computer-assisted navigation. Researchers are attempting to provide real eye transplantation with robotic eyes switches capable of plotting the real image over the patient retina using some biological technologies utilizing camera-based assistance, ultrasonic-based assistance and in some advanced ways, researchers are attempting to provide real eye transplantation with robotic eyes switch. In other words, some products can be improved by combining sensing technology with a voice-based guidance system has been built that could outperform individual technologies. The proposed system's main goal is to make people aware of what they're working on as well as any potential roadblocks.
Keywords: Image processing, Machine Learning, voice-based assistance, camera-based assistance, YOLO Data set, Python libraries, navigation modules.

I. INTRODUCTION

Blindness is a condition that impairs a person's ability to see is impaired owing to neurological or physiological reasons. Secure movability is one of the most difficult difficulties faced by blind pedestrians in their daily lives. According to (WHO), there were approximately 285 million visually impaired persons in 2012, with 39 million being blind, including 90 million children (under the age of 15), and this figure is expanding at an alarming rate. [1] As a result, some sort A navigation system is needed to help or guide these individuals. Many studies are being carried out to improve navigation. Blind people's systems all of these technologies have limitations because of the challenges of accuracy, interoperability, and usability coverage, which are difficult to overcome with present technology. There is indoor and outdoor navigation available. [2] The new plan focuses primarily on two components: detection of the sudden change in surrounding environment for visually impaired people against obstacles and warning about the optical via vibrations in the environment combination with a voice feedback system, and also detecting the objects in front of him using image processing and machine learning concepts.

Vision is one of the most vital senses for survival. Visual impairment affects millions of people throughout the world. These people have trouble traveling freely and safely, and they have trouble acquiring information and communicating. The suggested project's goal is to convert the visible world into an aural world by alerting blind people to objects in their path. This will be beneficial. The real time object detection allows visually impaired people to navigate autonomously without the need for external support. The program employs image processing(IP) machine learning(ML) techniques to detect real-time objects with the camera and notify blind individuals about them via audio output.

The suggested system employs machine learning technology to detect and recognize the object, as well as to educate the user about it via audio output. Embedded Systems are also employed, which use an ultrasonic sensor to calculate distance and inform the user if they are getting too close to the object.

II. LITERATURE REVIEW

Another appropriate solution that works without the use of a smartphone to alert visually impaired users to the existance of static or dynamic impediments within a few metres of them employs a camera to detect background motion. This technique can withstand background motion and complex camera and requires no prior knowledge of the obstacle's shape, size, or position. This used camera-based image processing system may be a good option, but it needs a lot of power, which makes it bulky, expensive, and difficult to transport. [5]

Ultrasonic sensors were used to construct a vibration and voice-controlled navigation system that detects obstacles. Even though visually impaired people have a stronger sense of hearing and perception than the general public. As a result, this system provides alerts via vibration and audio input. The prototype can be used for both indoor and the outdoor navigation, with the attention on continuously sensing surrounding impediments and notifying users via vibration and voice input. Different intensity levels are delivered to the vibration motor depending on the distance between the obstacle and the user to warn the user's mobility. [2]

The use of an ultrasonic navigation device allows visually impaired people to move around more independently. It is made up of a portable device with a microcontroller and synthetic voice output, as well as an obstacle detecting system that uses ultrasounds and vibrators. To detect obstacles in the way, this device depends on the rule of reflection of a high-frequency ultrasonic beam. [11]

[12] proposes a wearable jacket-style pattern. On a jacket, sonar sensors and vibrators are placed to show the direction from where an obstacle is approaching. For real time navigation with an obstacle avoidance system, another jacket-type system using an RGB-D camera and haptic systems [13] is proposed. The RGB-D camera produces depth data that is registered with RGB pictures, and travers ability maps are produced to show which spaces are free and which are occupied (obstacle). Users are given instructions such as "Go straight" and "Turn right" via four tiny vibrating motors on a jacket.

A location-finding system with verbal aid is developed for both outdoor and indoor navigation system. The system is made up of a walking stick with a GSM module that may send a message to an authorised person in the event of a tragedy, and an RF transmitter, sonar sensors and receiver. RFID is employed for indoor localization, and a GPS system is used for outside the localization. As a result, this GPS system in the walking cane reduces the expense of inserting several RFID in the outdoors to identify the location. [14]

A multi-sensor system that can be worn on the chest. [15] uses a laser with range finder to identify the barriers and tactually displays them to the sight disabled.

III. PROPOSED SYSTEM

The proposed system is primarily aimed at a novel approach to designing and developing a complete navigating system that instructs clients about the environment, obstacles, and objects in order to assist blind people in moving on various surfaces and in various paths, and the system we are proposing is a completely portable system with ground level obstacles detection and object detection along with his path. By fusing visual sensing technologies, object detection technology, and voice direction technology.

To design and build a system that will help blind people to navigate the streets in real-time. This system used to:

- To recognize the objects in the surrounding using machine learning technology
- To detect the distance of nearby objects using embedded systems.
- To know the exact location of themselves using maps.
- To get alert notifications to the concerned people if the blind person is at risk or in danger.
- To record and save the view of the blind person using a camera and save it on a Server for security issues.

The proposed system involves:

1. **Blind Shoes:** Description We're working on a pair of smart shoes that can identify obstructions and inform the blind person via vibrations or other alert signals as part of this project. This helps a blind person to walk around obstacles in his path. We generally utilize ultrasonic sensors to detect obstacles in his path.

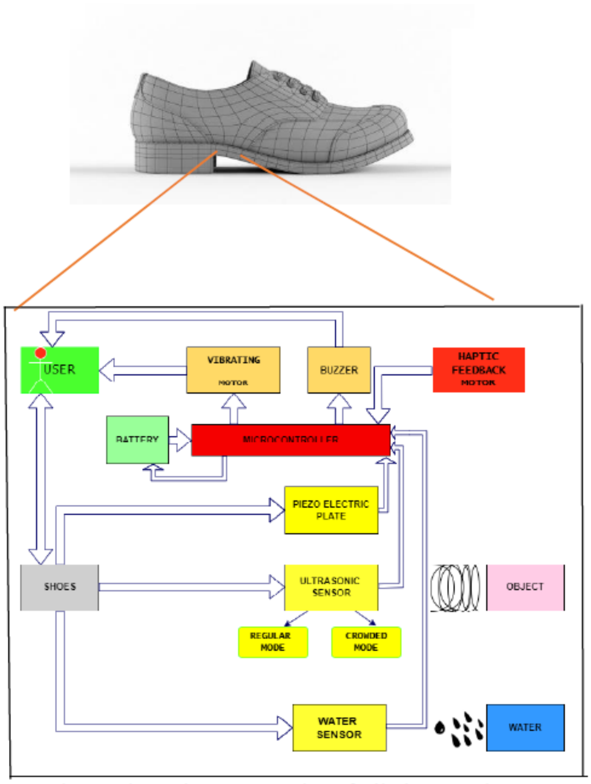

Fig 1: Schematic representation of Blind Smart Shoes

a. **Microcontroller:** The suggested system's processing unit consists of a Raspberry Pi-4 microcontroller that is required to manage all of the functions such as image processing, object detection, and executing python

libraries that are part of machine learning, as well as recording video footage for quality purposes.
It also aids in the detection of ground-level obstacles.

Fig 2: Raspberry Pi-4

b. **Ultrasonic sensor:** This sensor is located in front of the shoes and is utilised to sense obstacles in front of the blind. It primarily operates in two modes, which are useful in both congested and unpopulated areas.
Mode1: Regular mode
Mode2: Crowded mode
In regular mode: Ultrasonic sensor senses the obstacles within a 5-meter range.
In Crowded Mode: Ultrasonic sensor senses the obstacles within a 2-3 meter range.

Fig 3: Ultrasonic Sensor

c. **Vibrating motor:** The vibrating motor in our device plays an important task in supporting a blind person who is wearing it. It gets information from a sensor that we installed in the shoes to identify obstacles surrounding it. When it detects obstacles, it activates and vibrates at different frequencies to alert the blind person. Different frequencies are used to alert the blind to obstacles; for example, if the object is far away from the smart shoes, it will vibrate at low frequencies; as it gets closer, the frequency and strength of the vibration will rise. This is how a vibrating motor assists the blind in avoiding obstacles in his path at ground level.

Fig 4: Vibrating Motors

d. **Buzzer:** This performs nearly the same role as the vibrating motor, but as an audio output, it will not convey the output as object names in front of it; instead, it will notify the blind person as soon as it receives output from the water sensor, informing them of the existence of water in front of them. This will assist visually challenged people in avoiding water contact and related disasters.

Fig 5: Buzzer

e. **Haptic feedback system:** It is an advanced haptic technology that adds tactile feedback to electronic devices, and it refers to the haptic sensation of touch. This touch-based technology is becoming more common in touchscreen-enabled consumer, industrial, and automotive electronic devices. The output is created to deliver a completely new and improved user experience.

f. **Battery:** Every component in this device, as we all know, requires a power supply. As a result, we'll need to utilize a component that can power all of the devices we're using. The microcontroller we're using, the Raspberry Pi 4, can be powered up using the built-in USB-C connector, and the battery can be recharged using a USB-C or micro-USB cable. As you might assume, this battery pack can also be used to charge your smartphone or tablet. It may also charge your smartphone while giving power. This makes it an excellent all-around portable battery for your preferred technology, particularly the Raspberry Pi 4.

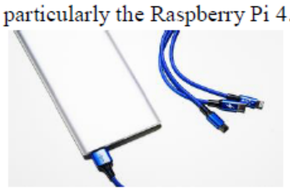

Fig 6: Power Bank for Power Supply

g. **Water sensor:** The water sensor is designed to detect water and can be used to detect spills on the ground or on the path that the blind is travelling. It can also detect rainfall, water leaks, and water level, but we're applying it here to detect the presence of any water. The sensor contains an array of exposed traces that read LOW when water is detected, and the sensor's buzzer output will alert the blind to the presence of water.

Fig 7: Water Sensor

2. Smart glasses:

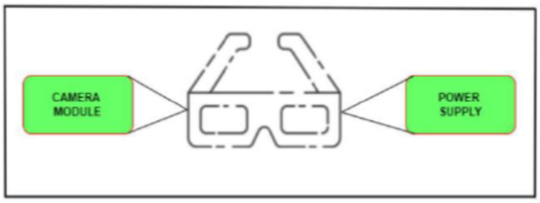

Fig 8: Schematic representation of Smart Glasses

Smart Glasses are another important component of our navigation system; we will attach a camera module to these glasses and power it up so that it can capture the objects in front of them. We just need to mount the camera on the blind's glasses because we need to identify the names of the objects that appear in their path. We'll use this data to analyse it using Python modules and the YOLO Data Set.

3. Smart device:

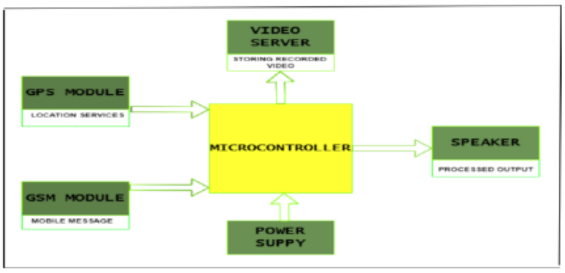

Fig 9: Schematic representation of Smart Device

Another component of our system is this Smart Device, whose primary functions include coordinating with the camera module, receiving input from it, and processing it to locate the object in real-time while also revealing the name of the object observed. This device also provides security functions such as detecting a person's actual location, issuing alert messages to concerned individuals, recording video, and storing it on a server for quality and security reasons. All of these components are placed in a jacket that may be used by visually impaired persons and used as a portable device that they can take with them wherever they go. It handles all of these things by utilizing our central processing unit, which is a Raspberry Pi-4 microcontroller that we use in smart shoes.

GPS Module: To accurately determine their position on Earth, the Global Positioning System (GPS) uses signals provided by satellites in space and base stations on Earth. Signals received from the satellites and ground stations have time stamps indicating when they were transmitted. Calculating the time the time dissimilarity between when the signal was transmitted and when it was received. The actual position of the GPS will be triangulated using data from three or more satellites.

GSM Module: Raspberry Pi connects to a cellular GSM network through GSM! It connects to Raspberry Pi directly and lets you send/receive SMS, as well as make and answer phone calls. We're using the gsm module to send alert messages in the event of an emergency or disaster; they'll get a message with the blind person's exact location if he's in danger.

Video Server: One of the useful and innovative applications of this smart device is to record video in front of it, which aids in preventing any illegal activities or accidents that occur in front of blinds, as they are unable to see anything in front of them. This footage will also be very useful in serving them justice if necessary. This recorded film will be saved on a server, and we are deliberately employing a server to store it because the footage stored on a server cannot be simply corrupted.

Speaker: The Speaker is one of the most crucial component devices in our project since it displays the item in front of the blinds in the form of music, and we use Earphones to represent the object's names.

Datasets used in Real-Time object detection:

We're using one of the most extensively used datasets, YOLO Datasets (you only look once), to detect objects in real-time. YOLO is the best neural network-based real-time object identification technique. This algorithm is very popular due to its speed and precision. It has been used in different variety of applications to detect traffic lights, people, parking meters, animals, and many other things.

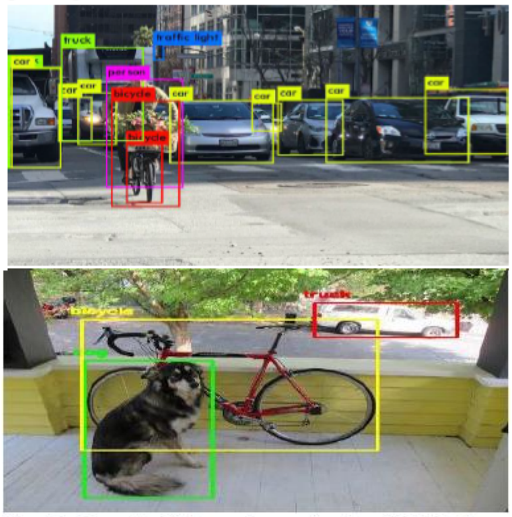

Fig 10: Sample Objects detected using YOLO dataset

IV. REQUIREMENT ANALYSIS

Hardware Requirements:

- Raspberry Pi.
- Camera
- Speaker.
- Ultrasonic sensor.
- buzzer.
- Haptic Feedback motor.

Software Requirements:

- Python IDE

V. Applications

- These blind shoes are used to detect and sense the obstacles present in front of a blind person.
- This is used to get alert warnings if any obstacles are present.
- This device aids a visually impaired person in detecting objects and finding what is in front of him, which is extremely beneficial because it performs the function of an eye and an ear in a normal human being.
- With the help of image processing and machine learning techniques, this Smart device can identify the names of objects in Real-time, allowing a blind person to feel safe on the streets, wherever he goes.
- A blind person can benefit from smart glasses in a variety of ways. The recorded video is kept or preserved on the webserver, where it is difficult to corrupt the recorded video.
- This recorded video can be utilized in legal matters such as theft, when a blind person is harmed by a rule when an accident occurs, and so on. In such cases, the judicial body will need an eye witness or another witness. Because the person is blind, he will be unable to observe anything that occurred in that situation, hence no evidence of accidents will exist. If we have a video taken and preserved on the server, we can use it to serve the correct justice in a court of law or for any other case study needs.
- This research can be used in military applications such as recognizing barriers in the dark and detect objects that are appearing but are not observed by the user. This technology will be extremely beneficial in military applications in these situations.

VI. CONCLUSION

In this proposed prototype more attention is given to assists blind about the objects in front of him, obstacles and also providing security using GPS, GSM, Video server, seamless transition between outdoor and indoor navigation, route announcing, and reducing the amount of infrastructure constraint required for user localization.

As a result, the ultimate goal is to build and create a portable, simple, and low-cost technology that will assist visually impaired persons in moving around in unfamiliar environments. The proposed system is created with all ages in mind, is user-friendly, and does not require any prior training or understanding of advanced technologies.

The major aim of this system is to create a prptotype which is both cost-effective and simple to use, especially for visually handicapped illiterates.

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