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Eyes in Every Step: Navigating the Future with IoT and AI-ML in Smart Wearables for the Visually Impaired

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ABSTRACT

The IoT-based Smart Shoe System revolutionizes independent navigation for the visually impaired through embedded ultrasonic sensors, an Arduino Nano board, and buzzer modules, enabling autonomous road traversal by detecting and alerting users to obstacles. In parallel, Smart Glasses explore the fusion of object detection and face recognition technologies to aid the visually impaired. Its object detection application assists in identifying obstacles, ensuring safer navigation, while the face recognition system, complemented by auditory output, facilitates the recognition of objects and individuals.

Key Words: Camera, Raspberry pi, pi cam, power supply, Headphones, Arduino Nano, Ultrasonic Sensors, Buzzer, Vibration Module, DFX player with Micro-SD card, Speaker.

1. INTRODUCTION

Our paper comprises two groundbreaking solutions for the visually impaired: the IoT-based Smart Shoe System and sensors and microcontroller aids in obstacle detection, ensuring safer navigation. Conversely, the Smart Glasses integrate object and face recognition, along with auditory outputs, providing real-time assistance and enhancing social interaction. These innovations aim to redefine independence and safety, significantly benefiting individuals with visual impairments.

The IoT-based Smart Shoe System and Smart Glasses represent transformative advancements in assisting visually impaired individuals. The Smart Shoe uses sensors and alerts to navigate obstacles, fostering confidence in independent movement. On the other hand, the Smart Glasses employ cutting-edge technology for object identification and social interaction, accompanied by voice-based guidance. Together, these solutions redefine accessibility, offering enhanced mobility and interaction for individuals with visual impairment.

2. EXISTING SYSTEM

Smart Shoes: The device we've developed integrates ultrasonic sensors and a servo motor to detect surrounding obstacles, providing comprehensive coverage. Coupled with buzzers and vibrators, it offers real-time feedback on obstacle proximity and direction, ensuring the safety and independence of visually impaired users. Incorporated into smart shoes, this system empowers users to navigate without constant reliance on others, offering alerts for left/right turns and obstacle proximity. It's an affordable, user-friendly solution designed to significantly enhance the ability of blind individuals to navigate safely, fostering independence and confidence in their daily travels.

Smart Glasses: The smart glasses module includes a secondary radar positioned in the spectacles, covering the user's front head-level area. It contains modules for radar setup and parameter configuration, aiming to enhance obstacle detection and user control. To lighten the load, power can be drawn from batteries or piezoelectric generators in the shoe. Integrated with a Bluetooth hearing device, it can override primary radar commands, crucial for identifying head-level obstructions not picked up by the smart shoe's radar. This design strives to boost safety and usability for visually impaired individuals navigating their surroundings.

3. PROPOSED SYSTEM

"Eyes in Every Step: Navigating the Future with IoT and AI-ML in Smart Wearables for the Visually Impaired," comprises two pivotal components: Smart Shoes and Smart Glasses. The Smart Shoes utilize an Arduino Nano, Ultrasonic Sensor, Buzzer, Vibration module, DFX player with a Micro SD card, and Speaker for object detection with voice alerts. This setup detects obstacles and provides vocal cues for navigation. On the the Smart Glasses incorporate a camera, Raspberry Pi, Pi Cam for object capture, Power supply, and a Jack 3.5mm (headphone) for voice alerts and object information. Object identification employs OpenCV and TensorFlow, utilizing

C++ for the Smart Shoes and Python for the Smart Glasses.By combining these technologies, our system aims to empower visually impaired individuals to achieve self-dependence and navigate their surroundings with ease, leveraging cutting-edge IoT and AI-ML solutions for enhanced mobility and safety.

4. LITERATURE SURVEY

To detect obstacles in a greater area when compared to existing systems using Ultrasonic sensor. To alert the user about an obstacle in his/her way through a Buzzer, so that the user can comfortably change his/her direction. We keep track of the user's location through the GPS module and keep the guardian notified of the user's location through the android app (BLYNK IoT). Using the tilt sensor, we program it at certain degree the angle increases more than the set angle it triggers the sensor and the message is sent to a guardian. [1]

The device that we have developed consists of ultrasonic sensors, IR sensor and Temperature sensor for sensing the surrounding environment for obstacles and covering area up to ten meters connected to the Arduino UNO. These are integrated to buzzers which give feedback to the user about the position of the nearest obstacles in range. [2]

The Smart assistive gadget for the blind people is depicted. The camera connected to the Raspberry Pi will continuously record the live video stream and transfer it to the neural network that has been taught. The blind person's path is obstructed by objects that are detected by the camera and close by objects that are detected by the sonar sensor using sensor fusion. The user's commands will be recognized as speech by the microphone, which will then direct the user via voice interaction based on the speech command received. The created speech recognition system will guarantee that a blind person may receive assistance more successfully by utilizing voice commands and will then give the blind person the essential information. [3]

Internet of Things is amalgamation of multiple technologies such as cloud technology, which leads to real time analytics, machine learning, commodity sensors, and embedded systems. Sensors, actuators, other ICs are embedded with electronics, Internet connectivity, and other forms of hardware like LED lights and LED displays. These hardware components such as sensors and actuators interact with others over the Internet and provide the information collectively and can be monitored and controlled remotely with the help of cloud technology. [4]. The shoe module in prototype consists of a Raspberry Pi, ultrasonic sensor, moisture sensor, Bluetooth module and an Wireless Charging. The raspberry pi in the shoe module is attached with a Bluetooth transceiver which syncs to a smart phone app that uses Google maps to notify the user turn-by-turn information. Moisture sensor detects humidity. [5]

Computer vision and artificial intelligence methods play a key role in the development of smart glass systems it is not possible to build a smart glass system without computer vision methods such as object detection and recognition methods because the input data is an image or a video. Object detection and recognition has garnered the attention of researchers, and numerous new approaches are being developed every year. To reduce the review areas, it analysed lightweight object detection and recognition models designed for embedded systems. [6]

A smart assistive shoe for visually impaired people so they get rid of the shoes and make more independent. The shoes will detect the nearby the obstacles and simultaneously send a message to the receiver audio or vibration form. The integrated smart shoes aims at the development of an Electronic Travelling. [7]

The smart shoe will help the Blind person to reach his destination independently. It is built using IoT Technology in which the shoe will be embedded with various sensors, Microcontroller and buzzers. The shoe warns the user by making noise with the buzzer when he/she walks in front of an obstacle. This device has ultrasonic sensors paired to a servo motor in front of the shoe. [8]

The methodology used in this work detects the obstacles which makes the buzzer to alert to assist the visually impaired people thereby will help to navigate while travelling. To measure the obstacles distance ultrasonic sensor was used. The input consists of two ultrasonic HC-SR04 sensors, which are used to detect obstacles. Ultrasonic sensors are instruments that are used to The methodology used in this work detects the obstacles which makes the buzzer to alert to assist the visually impaired people thereby will help to navigate while travelling. To measure the obstacles distance. ultrasonic sensor was used. The input consists of two ultrasonic HC-SR04 sensors, which are used to detect obstacles. Ultrasonic sensors are instruments that are used to determine the distance from the target objects. The distance between the obstacles and the blind individuals is measured using this ultrasound sensor. [9]

The proposed system is based on an embedded system where the hardware and the software are integrated together thus creating a developed navigational assistance system. Concerning the assembly of the whole system, the fall detection sensor (MPU6050) pins SDA and SCL are connected to the communication digital pins (SDA & SCL) of the Arduino board. [10]

5. COMPARISION TABLE

Table 1 below shows the literature survey comparison table where the survey has been made by referring to the papers and understanding the working and concept that is been described in the paper by the authors.

Table 1: Literature Survey

REFERENCE	TECHNOLOGY	AUTHORS	YEAR	EXISTING SYSTEM	PROPOSED SYSTEM
IRJMETS (International Research Journal of Modernization in Engineering Technology and Science). [1]	Internet Of Things, Ultrasonic Sensors, alert the user with the help of buzzer, GPS module to keep track of user's location, Tilt sensors for angles.	Dr.K. Venkata Rao, Mohammed Ameenulla Z, Damini K Devadiga, Deepa S Rao, Gauthami N.P.	2023	To detect obstacles in a greater area when compared to existing systems using Ultrasonic sensor. To alert the user about an obstacle in his/her way through a Buzzer, so that the user can comfortably change his/her direction.	It detects the obstacles by providing the alert warnings along with Audio command through speakers using Ultrasonic sensors.
IJAEM (International Journal of Advances in Engineering and Management). [2]	1OT, Arduino UNO, Node MCUESP826 6, Ultrasonic sensor.	I.Suneetha, Angeri Sandhya, L.Rama Krishna reddy, H.Reddy Jyothika, C.Tharun.	2023	Temperature sensor for sensing the surrounding environment for obstacles and covering area up to ten meters connected to the Arduino UNO. These are integrated to buzzers which give feedback to the user about the position of the nearest obstacles in range.	We are covering upto 30 cm area connected to Arduino Uno. These are integrated to Buzzer as well as Vibration module which give feedback to the user about the position of the nearest obstacles.
IJEECS (Indonesian Journal of Electrical Engineering and Computer Science). [3]	Deep learning, OpenCV, Raspberry pi, Smart glass Sonar sensor, IOT, Text to speech, Ultrasonic sensor.	Shantappa G. Gollagi, Kalyan Devappa Bamane, Dipali Manish Patil, Sanjay B.Ankali, Bahubali M. Akiwate.	2023	The Smart assistive gadget for the blind people is depicted. The camera connected to the Raspberry Pi will continuously record the live video stream and transfer it to the neural network that has been taught. The blind person's path is obstructed by objects that are detected by the camera and close by objects that are detected by the sonar sensor using sensor fusion.	As we are using Ultrasonic sensor, we don't require sensor fusion. Ultrasonic sensor itself detect the object and the distance between the user and obstacles which helps in easier mobility.
IJSREM (International Journal of Scientific Research in Engineering and Management). [4]	Arduino UNO, IOT, Sensors, Buzzer, GPS and GSM module.	Mr.M.Sai Sandeep, Ms. H. Tejaswini, Mr. K .Rajasheka r Raju, Ms.E. Sowmya, Mr.V.Prem Kumar (UG Student) Dept: Electrical &	2022	Internet of Things is amalgamation of multiple technologies such as cloud technology, which leads to real time analytics, machine learning, commodity sensors, and embedded systems. Sensors, actuators, other ICs are	It detects the obstacles with the help of ultrasonic sensors and gives the Audio cues as the blind person will not be able to see the LED light.

		Electronic s Engineerin g,AITS (RJPT).		embedded with electronics, Internet connectivity, and other forms of hardware like LED lights and LED displays.	
RTCSIT (Recent Trends in Computer Science and Information Technology). [5]	Computer vision, Raspberry Pi, IOT, Object Detection, Navigation, Wireless Charging.	Thanuja C S, Sahana M H, Sindhu G, Shruti B P	2022	The shoe module in prototype consists of a Raspberry Pi, ultrasonic sensor, moisture sensor, Bluetooth module and an Wireless Charging. The raspberry pi in the shoe module is attached with a Bluetooth transceiver which syncs to a smart phone app that uses Google maps to notify the user turn-by-turn information. Moisture sensor detects humidity.	The shoe module consist of Arduino nano, ultrasonic sensors including power supply resulting in haptic audio cues through speaker with the help of DFX player.
MDPI (Electronic Multidisciplinary Digital Publishing Institute). [6]	Smart glasses artificial intelligence, deep learning, low light images, assistive technologies, object detection, refreshable tactile display, IOT.	Mukhriddin Mukhiddinov and JinsooCho	2021	Computer vision and artificial intelligence methods play a key role in the development of smart glass systems. It is not possible to build a smart glass system without computer vision methods such as object detection and recognition methods because the input data is an image or a video. Object detection and recognition has garnered the attention of researchers, and numerous new approaches are being developed every year. To reduce the review areas, it analysed lightweight object detection and recognition models designed for embedded systems.	To identify the objects or the obstacles we are using computer vision and image processing which includes the tools OpenCV and TensorFlow. This results in audio cues through the wired headset about the object information.
IJCRT (International Journal of Creative Research Thoughts). [7]	IOT, Sensors, Obstacle detection, Smart Shoes, Li-Fi technology, Electronic Travelling Aid (ETA).	Pradeepa R, Dr. R. Porkodi	2021	A smart assistive shoe for visually impaired people so they get rid of the shoes and make more independent. The shoes will detect the nearby the obstacles and simultaneously send a message to the receiver audio or vibration form. The integrated smart shoes aims at the development of an Electronic Travelling Aid (ETA) for visually	A smart assistive shoe for visually impaired people so they get rid of the shoes and make more independent. The shoes will detect the nearby the obstacles and simultaneously send a message to the receiver audio signal or vibration form.

				impaired people that will help them to navigate safely.	
ICICT (International Conference on Information and Computer Technologies). [8]	IoT, Arduino UNO, Node MCU ESP8266, Ultrasonic sensor.	Teja Chava, A.Tarak Srinivas, A.Lohith Sai, Venubabu Rachapudi.	2021	The smart shoe will help the Blind person to reach his destination independently. The shoe warns the user by making noise with the buzzer when he/she walks in front of an obstacle.	In our project, Arduino Nano, Ultrasonic Sensor and power supply are interconnected with other components such as speakers, buzzer and vibration module.
ICICV (International Conference on Information and Computer Vision). [9]	Smart Shoe, Arduino Nano, IOT, Ultrasonic Sensor, Buzzer.	M. Anisha, S.Kirthika, D.Jemima h Harline, P. Thenmozhi, Rubala.R, T. Girija Pragathi, M.Benisha , C. Jim Elliot.	2021	The methodology used in this work detects the obstacles which makes the buzzer to alert to assist the visually impaired people thereby will help to navigate while travelling. To measure the obstacles distance ultrasonic sensor was used.	It detects the obstacles by providing the buzzer and vibration along with Audio command through speakers using Ultrasonic sensors.
ICM (International Conference on Microelectronics). [10]	Smart shoes, Obstacle detection, Fall detection Phone application, Location detection, Electrical safe systems, IOT.	Roy ABI ZEID DAOU, Jeffrey CHEHAD E, Georgio ABOU HAYDAR, Ali HAYEK, Josef BOERCS OEK and Jose Javier Serrano OLMEDO	2020	The proposed system is based on an embedded system where the hardware and the software are integrated together thus creating a developed navigational assistance system.	It is an integrated system of software and hardware components which helps in object detection and identification and alerts the user through voice command.

6. METHODOLOGY

The methodology, which aims to create a machine learning-powered sign language converter, can be broken down into several key steps. This methodology is designed to facilitate the analysis and conversion of sign language gestures into text and audio. Here's a step-by-step outline of the project's methodology:

6.1 Data Collection

Gather sensory input data from wearables (cameras, sensors) and process it in real-time.

6.2 Image Recognition

Implement AI algorithms to identify objects, people, and obstacles from captured images.

6.3 Machine Learning Models

Train models to recognize patterns and improve object recognition over time.

6.4 Object Detection

Pinpoints what objects are in an image and where they are located.

6.5 Haptic Audio Cues

Are the sensory hints felt alongside sounds, enhancing user experience with vibration.

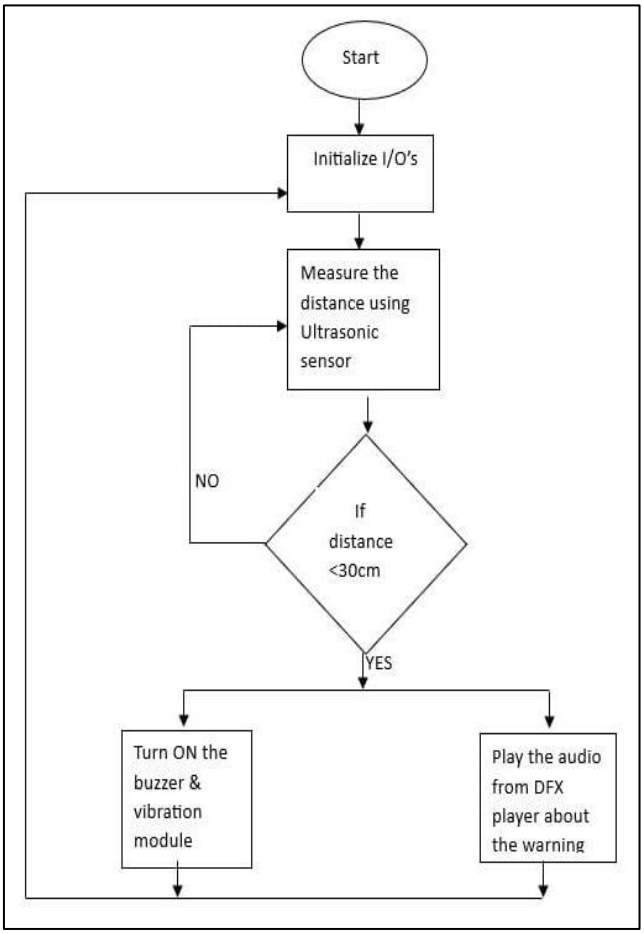

Figure 1: Object Detection

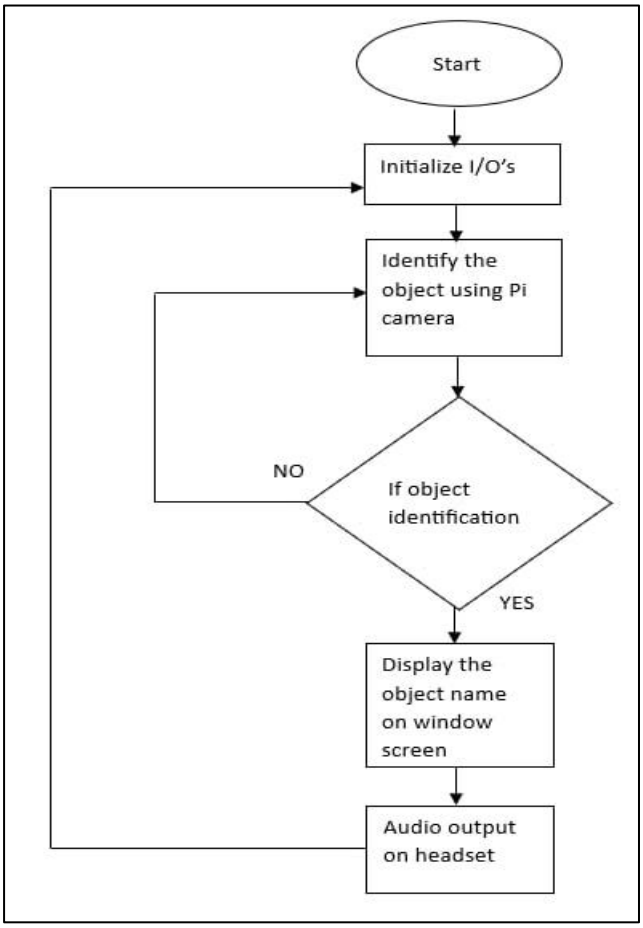

Figure 2: Object Identification

Figure 1 and 2 shows flow charts of the model for Object detection and object identification respectively.

7. CONCLUSION

Our paper presents a transformative leap in aiding visually impaired individuals, combining the IoT-based Smart Shoe System and advanced Smart Glasses. The Smart Shoes, equipped with sensors and alerts, bolster independent navigation by detecting obstacles. Meanwhile, the Smart Glasses, integrating object and face recognition technologies, offer real-time assistance and social interaction cues. By leveraging these innovative wearables and sophisticated technologies like OpenCV and TensorFlow, our system aims to empower individuals with visual impairments, providing them with enhanced mobility, safety, and the confidence to navigate their surroundings independently. This holistic approach seeks to redefine accessibility and foster a more inclusive environment for the visually impaired.

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