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Design of -Enhanced Shoes and Glasses for the Visually Challenged in IOT system

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Abstract: ***The most valuable gift we possess is probably our eyes, which play a significant role in our daily life. We are fortunate to have eyesight, which allows us to see this world. However, there are certain people who struggle to visualize these things. As a result, they face a lot of difficulty moving around freely in public spaces. A new IoT based smart shoe system for the blind is being proposed with the help of an ultrasonic sensor paired to an Arduino Nano and NodeMCU ESP8266 board. Internet of things is all about making physical stuff communicate with humans. It is an enabling technology which is developing rapidly in the market. Almost 40 million people in India are blind, including 1.6 million children. Blind people cannot live independently. In many areas of their lives, they must rely on others. The main problem is when they walk on road. They can't detect every obstacle in their path with a stick in hand. The smart shoe technology offers a long - term solution for the blind people to independently walk on roads. It is built using IoT technology in which the shoe will be embedded with various sensors, microcontroller and vibrators. The shoe warns the user by creating vibrations when he/she walks in front of an obstacle. To improve the efficiency smart glasses are designed using IoT, which is also embedded with sensors and helps in detecting the objects by covering the area at head level.***

Keywords: IOT, Arduino Nano, NodeMCU 8266, Ultrasonic sensor

1. Introduction

Worldwide as of October 2022, it is estimated that 2.2 billion people suffer from a near - or distant visual impairment. Nearly 1 billion or at least half of these cases, involve vision damage that either might have been avoided or is still unaddressed. The majority of people who are blind or have visual problems are over the age of 50years, however vision loss can affect anyone at any age. Regionally, low - and middle - income areas are thought to have a four times higherprevalence of distant vision impairment than high - income areas.

Vision impairment has a profound impact on quality of life in adult populations. Adults with visual impairment frequently have lower participation in the workforce and productivity rates as well as greater rates of anxiety and depression. Adults with vision impairment are more likely to experience social isolation, difficulty walking, increased risk of fractures and falls, and early admission into nursing or care facilities.

The leading causes of vision impairment worldwide are age - related macular degeneration, cataract, glaucoma, diabetic retinopathy and uncorrected refractive errors.

2. Related Work

This article was proposed as a prototype of an embedded glove with ultrasonic and flame sensors to provide a convenient and safe way for visually impaired people to overcome difficulties in daily life. A prototype of a smart glove system based on an Arduino UNO microcontroller, ultrasonic and flame sensors, its SIM800L GSM module for communication, and a buzzer for alarm notifications. (1) A full device prototype was then tested in both the acrylic box and the embedded hand to highlight the reliability and usability of the work. The results show that the ultrasonic sensor works well to detect objects covering a range of 40 cm from the blind. The fire/flame sensor uses fire detection mode to detect small fires from matches or lighters about 15cm away, or large fires from burnt paper about 20cm away, and send them to your respected person via SIM800L. It also works well for sending short messages. GSM.

In another work, finding an object is meaningless if the distance is greater than 3 meters, but meaningful and noisy if the distance is less than 300 cm. The same approach is used in many applications as well (2) Making the environment more accessible to the visually impaired is the goal of intelligent glasses systems.

Smart ultrasonic glasses for the visually impaired consist of wearable glasses, an ultrasonic sensor that detects obstacles in the path of the visually impaired, a buzzer that emits sound according to the direction of obstacles from the visually impaired, and an Arduino NANO that receives It consists of a central processing unit. Information from the sensor is distanced from obstacles, processed information according to the coding done, and sends output via a buzzer. Power is given to the central processing unit, which distributes power to the various components. (2) Mount the sensor between the optical glass top bar and the bridge. All components are connected to the central unit via single - core copper wires, and the central unit is powered via a USB cable. The best sensor to use is an ultrasonic sensor, because ultrasound is a force, the energy consumption of slow waves that travel relatively long distances in the medium. Therefore, it is often used for long range distance measurement.

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3. System Design

a) Smart shoes architecture

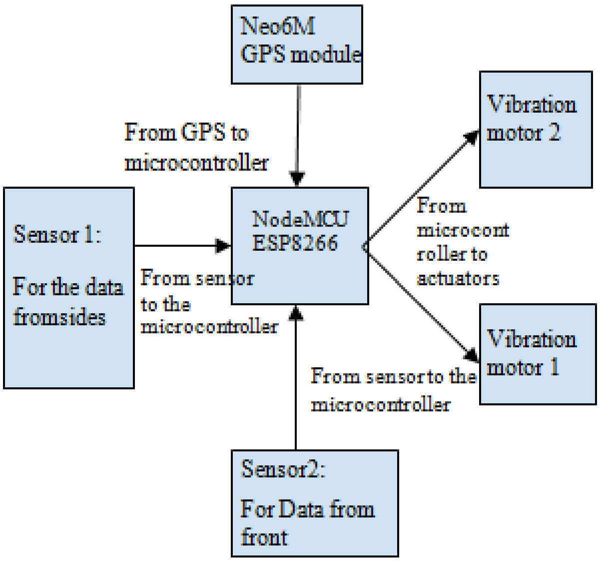

Figure 1: System architecture of smart shoe with Node MCU 8266

In this module the sensors are placed on top and side of the shoe and positioned in such a way that it covers the area in front as well as side of the user.

- This module has two sub modules, one is detecting the object and the other is creating vibrations as per the distance of the user from the object.
- This smart shoe runs on the power generated by onboard Lipo 3.7V batteries which generates power sufficient for running the on board systems.
- This is connected to a Low - power DC Vibration motor that triggers vibrations for alerting the user to avoid obstacles present in front or side of him at lower heights.
- A GPS module is also attached to the shoe to track the live location of the user.

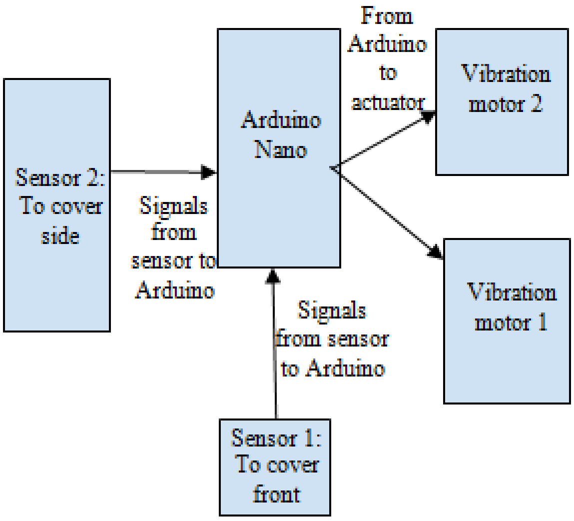

Figure 2: System architecture of smart shoe with Arduino Nano

A. Smart glasses architecture

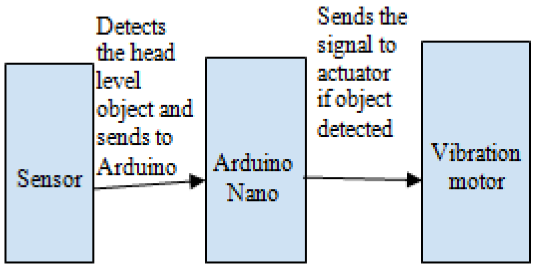

Figure 3: System architecture of smart glasses

- In this module, a sensor is embedded into the glasses and positioned in such a way that it covers the area in front of the user at the head level.
- This module also has two sub modules, one being detecting the obstacle and the second being setting vibration intensity for the module.
- These smart glasses are powered by a 3.7V Lipo rechargeable battery.

4. Proposed System

The proposed system has two main modules which work in tandem for better efficiency. The modules are:
1) The Smart shoe module
2) The Smart glasses module

1) Smart shoe module:

The system designed consists of sensors and vibrators to scan surrounding obstacles and provide visually impaired users with feedback on the location of the closest obstacle within range. It aims to extend the user's senses after a training period without extra effort. Proposed system consists of smart shoes for the visually impaired. The hardware is fixed to the user's shoes. When the user puts on the shoes and drives somewhere, sensors attached to the hardware detect obstacles and the vibrator vibrates left and right along the road. It also uses a buzzer to notify you of approaching obstacles. With the Smart Shoe, blind people don't have to worry about being dependent on others for mobility. This document describes the architecture and discusses the potential benefits of the system we designed. The work system is designed with a cost - effective and easy - to - use intelligent guidance system for the visually impaired. It is used in a variety of fields, independently of others, to improve mobility for both blind and partially sighted people. Sensors are used to detect obstacles and vibrators vibrate depending on the direction (i. e. left, right or forward). The right vibrator vibrates when turning right, and the left vibrator vibrates when turning left. If a person needs to move forward the vibrator in front will vibrate and if a person needs to stop he will vibrate all four vibrators. Our approach is to create a simple, hands - free and user - friendly application that allows the visually impaired to navigate safely on their own anywhere. The module of the smart shoes is shown in fig 1.

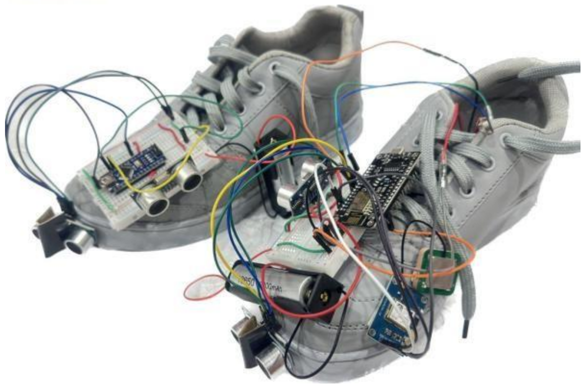

Figure 1: Smart shoes module

a) Smart glasses module

In this module, a secondary sensor is embedded in the glasses and positioned to cover the area infront of the user at the head height. The module of the smart glasses is shown in fig 2.

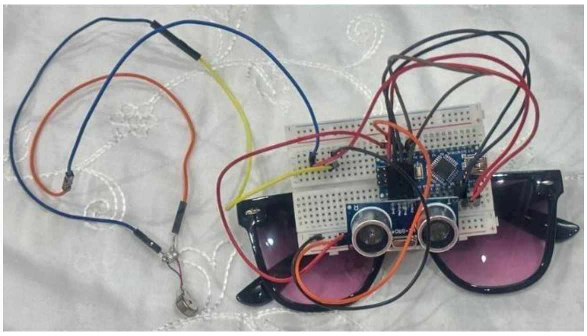

Figure 2: Smart glasses module

This module also has two sub - modules, one is the configuration of the primary sensor and the second is setting parameters for the module. These smart glasses are powered by a 2000mAh lipo lithium ion battery which is easily rechargeable. This also helps in detecting any obstruction at head level of the user which cannot be detected by the primary sensor on the smart shoe.

5. Working

Once the system starts it tries to find the saved Wi - Fi. If it didn't get the saved Wi - Fi then it generates its hotspot. The user can connect to the system generated hotspot from a laptop or mobile and then it will redirect it to a page consisting of all the available Wi - Fi networks.

Users can select and enter their SSID and password. Once the credential is entered the system will be connected to the Wi - Fi and the credentials get saved for next time usage.

Soon after getting connected to the internet, the system then tries to connect with the cloud. In this case Blynk IoT cloud. Once the system is connected to cloud, the system starts sending the GPS location data to the cloud. Any user with the credential can access the data using either a web app or a mobile app. The setting of the app is explained in detail in the Software setup part.

One Shoe consists of two sensors and two vibration motors. Both the sensors cover the front and side hence giving detection from all directions except the back.

And vibration motor will actuate and tell in what direction the obstacle is.

On the shoe side, we have 4 sensors 2 to cover the front 1 - cover the left side and 1 - cover the right side.

Each sensor associated with the vibration motor indicates the obstacle position.

On the glasses side, we have one sensor which detects if any obstacle is on a head level at front.

In this combination, the user can easily detect the obstacles all around and can avoid and detects the path.

1) Left shoe: This consists of one sensor to detect from the front side and one sensor to detect from the left side. If the object is detected then the signal is sent to a respective vibration motor so the user can know the direction of the obstacle and walk accordingly.
2) Right shoe: This shoe consists of one sensor to detect obstacles from the front and one sensor to detect the obstacles from the right. If the obstacle is detected it gives the signal to the respective vibration motor. This shoe also consists of a Wi - Fi module and GPS, which sends the live GPS data to the cloud (Blynk IoT) and user with credentials can access it (note for first - time usage or usage after long time the GPS take time to cold start i. e. detecting satellite and gathering data. This process can take up to 10min according to environmental conditions).
3) Glasses: The glasses consist of one sensor and one actuator. If the user gets any head - level obstacle like a wall or another person then the glasses will detect and the vibration motor vibrates accordingly.

All the sensors detect the object if the object is closer than 100 cm and the vibration motor vibrates for 0.5sec (here the loops run continuously hence 0.5sec don't feel inconsistent but it saves the motor from overheating).
Both the shoes and glasses are powered by the 2000mah Lipo battery which is rechargeable.

6. Result

The status of the proposed system in idle mode is when there is no obstacle in front of it, the buzzer remains silent which means that the user can move forward safely. The status of the proposed system in usage mode is, when there is an obstacle in front of it, the buzzer vibrates which guides the user to avoid the obstacle and he/she can move around safely. The proposed system is capable of covering more area infront of the user as compared to the existing systems. The proposed system also provides an edge over the existing systems in a way that the modules cover the foot as well as head level for detecting the object. The entire system is powered with the help of lipo batteries. Also, the live location of the user is trackable using a mobile application.

7. Future Work

Google maps can help blind people to get source and destination route information and find the shortest and the best path with real time co - ordinates.

The glasses can be upgraded to include a camera module that can map the complete space in front of the user along with machine learning techniques for a better evaluation.

8. Conclusion

In the proposed project we developed two different systems, the first one being the smart shoesand the second one being the smart glasses. In this system we are also deploying Lipo 3.7V batteries to generate energy while the user is walking and this can easily be mounted on any shoe or glasses. The proposed system is built in such a way that even if one system malfunctions for any reason, the second system would still operate independently and detect obstacles without being hampered. Using this GPS data, the guardian or the family members can easily track the user in real time. The blind will benefit greatly from this technology because it will enable them to commute independently both indoors and outdoors, empowering them to become self - sufficient without the need for technological expertise to operate this system. The system will have many provisions for future improvement, and integrating new sensors or other components will be very easy for future enhancements.

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