engineering proceedings

MDPI

Proceeding Paper

Multipurpose Smart Shoe for Various Communities

Vijayaraja Loganthan [1,*], Dhanasekar Ravikumar [2], Gokul Raj K [3], Sarath S [4], Theerthavasan M [5] and Rupa Kesavan [6]

[1] DEEE, Sri Sairam Institute of Technology, Chennai, Tamilnadu, India; vijayaraja.eee@sairamit.edu.in;dhanasekar.eee@sairamit.edu.in; sit21ee008@sairamtap.edu.in, sit21ee048@sairamtap.edu.in, sitl22ee02@sairamtap.edu.in

[2] DCSE, Sri Venkateswara College of Engineering, Sriperumbadur, Tamilnadu, India; rupakesavan@svce.ac.in

* Correspondence: Correspondence vijayaraja.eee@sairamit.edu.in;

† Presented at the 10th International Electronic Conference on Sensors and applications, place, and 15-30 Nov 2023

Abstract: A recent survey depicts that across the globe there are nearly 36 million visually impaired people facing serious issues in accessibility, education, navigating public spaces, safety concerns, and mental health. Now the evolutions of obstacle detectors for blind people have been from the usage of people, sticks, smart glasses, and smart shoes. Among the above, the major problem faced by all blind people is to walk independently to every place, so to make them feel independent while they walk, here is a proposal for an intelligent shoe. The proposed intelligent shoe consists of a controller connected with an ultrasonic sensor, voice alert system (VAS), vibration patterns, GPS navigation, connectivity with a smart-phone or smart-watch, voice assistance, feedback on gait and posture, and emergency features that are embedded with each other to communicate the presence of obstacles in the directions of the path of the blind. The sensor identifies an obstacle in the direction present then it passes the signal to the controller that activates the VAS and the vibration patterns present in that direction. Therefore, by the proposed concept of vibration sense and VAS with GPS navigation, connectivity with a smart phone or smart-watch makes the system easy access for the blind to identify the obstacle present on their way and make them social inclusion.

Keywords: Arduino board; Ultrasonic sensor; Vibrator; Voice alert system (VAS)

Citation: Loganthan, V.; Ravikumar, D.; Raj K, G.; Sarath S; Theerthavasan M; Kesavan, R. Multipurpose Smart Shoe for Various Communities. **2023**, *5*, x. https://doi.org/10.3390/xxxxx

Academic Editor(s):

Published: 15 November 2023

1. Introduction

The blindness is a defect that is divided into 2 types, one is caused by the hormones from the older generation which is said as permanent blindness and the other one is caused by more usage of radiations this is called as temporary blindness to humans. System of network connections that is present in-between electronic components and humans is represented as Internet of Things (IoT), where the electronic components transmit, the signal to the humans by means of data. An obstacle, pothole, slippery surface detection, health tracking, and heat sensing is done by Arduino board. The work includes GPS-GSM navigation and location tracking, as well as it has an emergency-SOS facility to assist blind people [1]. A hardware component [2] for blind people using IOT technology to facilitate people with vision deficiency for solving their issues faced everyday with the support of technology which is used to solve the issues face by the visually-impaired. A smart shoe [3] for blind which conveys the presence of obstacle through vibrational form by usage of vibrators. Here the shoe [4] not only conveys the presence of obstacle but also tells the presence of underground holes present in the form of an audio. In [5], the designed shoe has 2 modules namely shoe and phone module's, the shoe module consists of a controller and sensors whereas the phone module is linked with GPS system. The controller is embedded with a Bluetooth transceiver which is linked to a smart phone app that uses Google maps that directs the blind to the required destination by audio message.

In [6], the system embedded in shoe detects the presence of obstacle present at certain distance and conveys the information either through a vibrator or audio and by the usage of alarm sound the blind can detect the presence of obstacle. An assistance system [7] which uses computer vision algorithms which is written with certain functions such as obstacle detection, avoidance and navigation. Here the obstacle detection is done by sensors present and the presence is conveyed using smart phone audio which gives a haptic-feedback to the blind. In [8], an intelligent shoe is embedded with sensors, buzzer and microcontroller. Once after detection of object the buzzer indicates the presence of obstacle for better accuracy smart glass is used. Here [9], three pairs of ultrasonic sensors placed on the medial, central, and lateral part of the shoe which is used to detect the presence the holes and pits. Here is a usage of piezoelectric transducers for recharging the battery on walking. The wearable shoe [10] is used to detect the presence of obstacles, wet floor and patient's falls by using voice alarms. The additional method is to prevent accidents, falling off, and getting lost in some unknown areas by the visually impaired by communicating these, information to the caretaker by mobile application. With respect to the above studies, some feasible solutions presented for the blind people all around the world. There is usage of either audio form or vibration form for transmission of message of the detection of obstacle.

i) The usage of GPS module to communicate the location of the visually impaired person.

ii) Usage of smart glass for further more detection of obstacles.

In connection with this here is a design of intelligent shoe that transmits the detection of obstacle by both vibration and audio form that is embedded with the micro-controller. Once after the detection of obstacle, the alert mode either by voice or vibration is passed to the blind to avoid the upcoming obstacle. Further the design is embedded with the GPS module which locates the blind, so as to transmit the location to the care-taker at emergency situations.

2. DESIGN OF SMART SHOE MODEL:

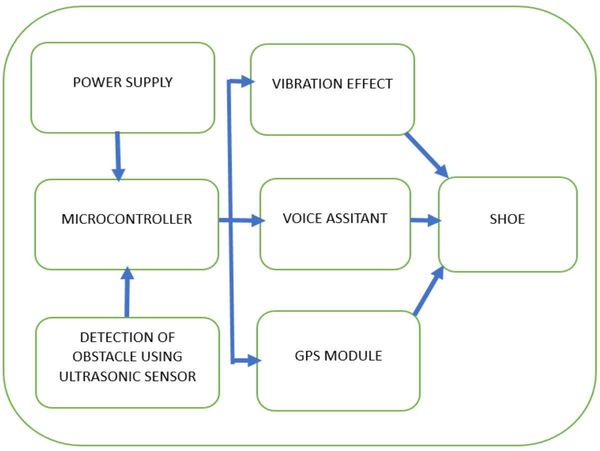

Figure 1. Block diagram of smart shoe.

By the usage of ultrasonic sensor combined with pre-programmed Arduino controller it is easy to detect the object present before the visually impaired one's. The Arduino's coding is in such a way that once after detection of object the controller passes the message to the vibrator and VAS. Once after receiving the command from controller the object detection is represented by means of vibration through vibrational motor and voice alert through speaker attached to it. Using IoT technology in the shoe that is been wore by the visually impaired which makes them independent to walk wherever the blind think. Here is the proposal of a smart shoe for blind that indicates the obstacle in the directions such as in the front, left, right and in the upper part of the visually impaired making them more independent to walk along the path without depending on others. There is also ultrasonic sensor present at the upper part of the breadboard/shoe which is used to detect the obstacle that is present at the upper view of the blind and making those visually challenged to analyze that there is obstacle in the upper part of the visually challenged. The components used for making of this model are, a battery, motor, ultrasonic sensor, Arduino board, vibrator and a breadboard/shoe. If there is any detection of obstacles in the fixed path of the ultrasonic sensor then the ultrasonic passes the received signal to the Arduino board. Once after receiving the signals feedback from the ultrasonic sensor, the Arduino which is pre-programmed to send or transmit the signals to vibrator and VAS. The received signal from the Arduino makes the vibrator to vibrate and VAS to interact with user and inform about the obstacle. By this method it is easy to make the blind to detect where the object is present and avoid it so that he/she can walk freely in the road. By using the GPS module along with the shoe, the location of the blind can be shared with the care-taker at emergency conditions. By using the CNN algorithm in the camera module of the shoe, the upcoming obstacle's name can be mentioned to the blind person and the distance between them and the obstacle can be accurately determined. The Fig 1 represents the block diagram of the smart shoe. The Fig 2 shows the simulation model in off state where if the distance of the ultrasonic is less than the fixed range the light source is turned OFF. The Fig 3 shows the simulation model in on state as the distance of the ultrasonic is more than the fixed range the light source is turned ON to indicate the presence of obstacle, in on state the ultrasonic sensors work based on the order:.

i) If the obstacle is identified in the 1st ultrasonic sensor, then the vibrational motor on the right-side glows up (turns on) and the vice-versa.

ii) If the obstacle is identified in the 2nd ultrasonic sensor, then the vibrational motor present at the 2nd position from the right-side glows up (turns on).

iii) If the obstacle is detected in the 3rd ultrasonic sensor, then the vibrational motor present at the 2nd position from the left side glows up (turns on).

iv) Finally, if an obstacle is detected at the 4th ultrasonic sensor, then the vibrational motor present at the left side glows on (turns on).

This is how the stimulation model works, so based on this working the obstacle present at each direction can be identified and based on the vibration caused by the vibrational motor the object detection can be done.

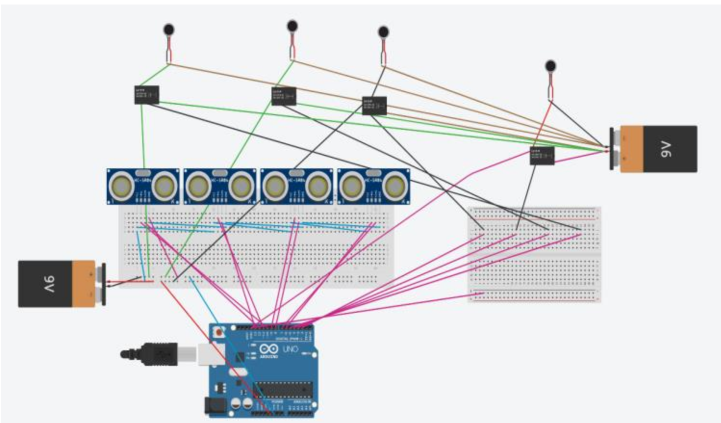

Figure 2. Simulation in off state.

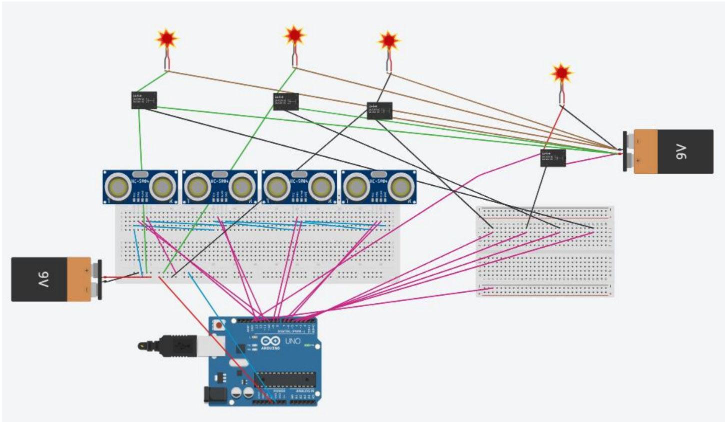

Figure 3. Simulation in on state.

3. Prototype Of Smart Shoe

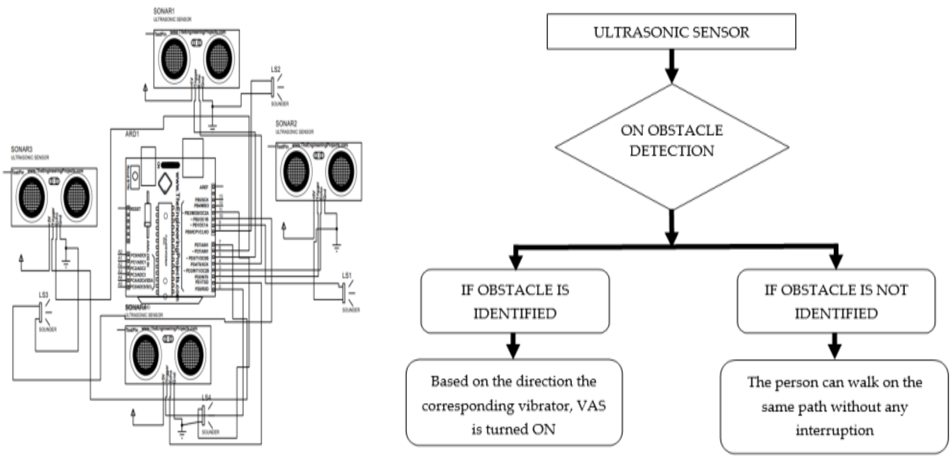

Figure 4. a, 4b. Schematic of sensor placement in proposed smart shoe, Workflow of obstacle detection by proposed smart shoe**.**

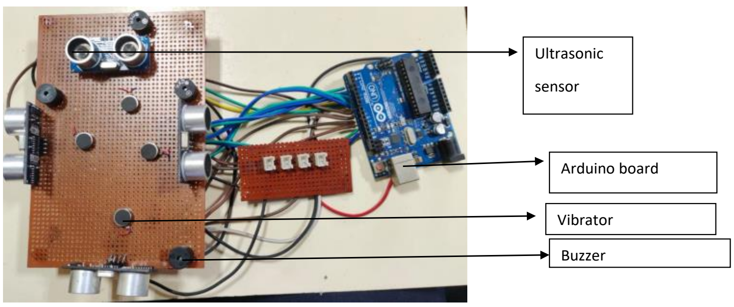

Figure 5. Hardware Model.

The schematic diagram Fig 4a is sketched for the circuit connection of the prototype model and for the proceeding of the prototype model, the workflow diagram Fig 4b is designed. The prototype model is shown in Fig 5 that consists of 4 ultrasonic sensors with a range of distance coverage between 2cm to 300cm. Here the 4 ultrasonic sensors are used to detect the presence of obstacles in the directions such as: in the right, left, straight and in the upward direction of the blind person, 4 vibrators, 4 speakers and the process of obstacle detection will take place in the following pattern: As shown in the Fig 6a, if the obstacle is identified in the 1st ultrasonic sensor which is present on the forward direction, then the vibrational motor on the front side vibrates and also the VAS present on the front side produces an alert which indicates the presence of an obstacle.

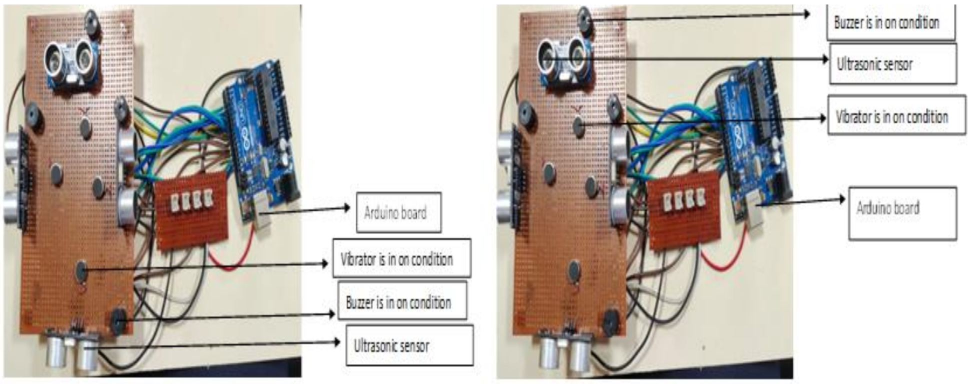

Figure 6a, 6b. Obstacle in forward direction, Obstacle in above direction

As shown in Fig 6b, if the obstacle is identified in the 2nd ultrasonic sensor present on the upside, then the vibrational motor present at the upside position vibrates and the VAS present on the upside produces an alert sound indicating the presence of an obstacle in the upside direction. As shown in Fig 7a, if the obstacle is detected in the 3rd ultrasonic sensor present on the right side, then the vibrational motor present on the right side vibrates and also the VAS present on the right produces an alert which indicates the presence of an obstacle in the right side.

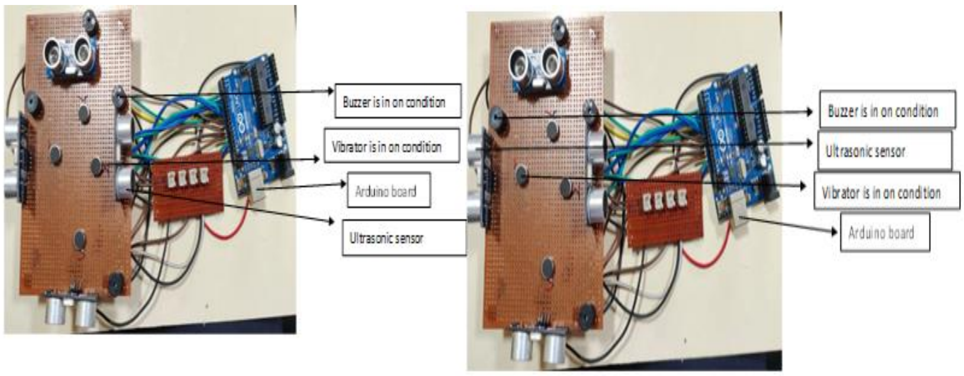

Figure 7. a, 7b. Obstacle in right direction, Obstacle in left direction.

As shown in Fig 7b, if an obstacle is detected at the 4th ultrasonic sensor present on the left side of the blind, then the vibrational motor present at the left side vibrates and also the VAS present on the left side produces an alert which indicates the presence of an obstacle in the left direction.

Thus, the entire working model of the smart shoe is explained here so based on this presence of an obstacle in either direction mentioned can be identified and based on the vibration caused by the vibrational motor and the alert from the VAS can convey the message to the visually impaired. As shown in the Fig 8, the prototype model is embedded with the GPS module in-order to pass the location of the blind on emergency conditions. Here SPI protocol is used with Arduino for communicating the location of the blind person with the care-taker.

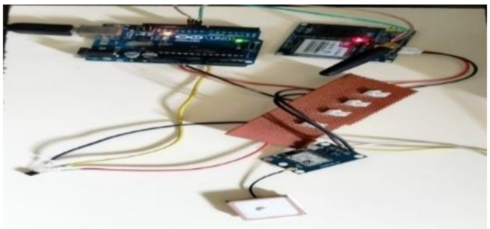

Figure 8. GPS module.

Once if the location of the blind people is transmitted to the care-taker the output of the location will be as shown in the Fig 9. The location of the blind person is communicated with the care-taker on emergency conditions (I. e the blind will be provided with a switch to transmit the location with the care-taker) in-order to make them feel free and to watch the current location of the blind person without being with them.

Figure 9. GPS location prediction.

4. Conclusion

In the olden days the blind people were suffering from the problem to walk independently in roads, so there was an invention termed as blind stick which is used for detection of object but as it can't sense the presence of obstacle in before there was an invention where there was an addition of ultrasonic sensor to detect the presence of object but this wasn't effective as taught because the stick can't be used in every locations where the blind travel so in order to solve this here is a IOT technology used in the shoe of a blind will help to them to walk independently in roads and which makes them to feel independent without depending on the help of others to walk. This helps the blind effectively as there are nearly 4 ultrasonic sensors combined with the vibrators and VAS which can predetermine the presence of object in all the directions when a blind walks in the road. Here there is a usage of both VAS and vibrators, because if the blind is also having earing-impairment then the vibrator's vibration is enough for him to detect the location of obstacle present. By the usage of GPS module, the blinds' location is transmitted with the care-taker for safety measures on emergency situations. The placement of the ultrasonic sensors on the shoe will be as: 2 ultrasonic sensors on the right shoe to detect the obstacle in the right and in the forward direction and 2 ultrasonic sensors in the left shoe for detection of obstacle in the upward and in the left direction of the blind person. The prototype model is to be done on the shoe in-order to make the product more efficient for the blind to use, but due to the size compactness the model is to be reduced to a smaller one and developed in the shoe in the future.

Author Contributions: Conceptualization, L.V. and R.D.; methodology, G.R., S.S., M.T.; software, G.R.; validation, L.V., G.R. and R.K.; investigation, R.K.; writing—original draft preparation, L.V., G.R.; writing—re-view and editing, supervision, L.V., G.R., S.S., M.T.;

Funding: This research received no external funding Institutional Review Board Statement: Not applicableInformed Consent Statement: Not applicable

Data Availability Statement: Not applicable

Conflicts of Interest: The authors declare no conflict of interest

References

1. P. Bhongade, S. Girhay, A.M. Sheikh, R. Ghata, S. Ambadkar and C. Dusane, "Internet of Things - Enabled Smart Shoes for Blind People," IEEE Delhi Section Conference (DELCON), New Delhi, India, **2022**, pp. 1-9.
2. S. Durgadevi, C. Komathi, K. ThirupuraSundari, S.S. Haresh and A. K. R. Harishanker, "IOT Based Assistive System for Visually Impaired and Aged People," 2nd International Conference on Power Electronics & IoT Applications in Renewable Energy and its Control (PARC), Mathura, India, **2022**, pp. 1-4.
3. R. Mishra, S.K. Pippal, Asif, A. Kumar, D. Singh and A. Singh, "Clear Vision - Obstacle detection using Bat Algorithm Optimization Technique," 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO), Noida, India, **2021**, pp. 1-5.
4. E. V. Nandalal, V. Anand Kumar, S.A., S.G. and S. A S, "Intelligent Multi-Utility Shoe for Visually Impaired Persons," 2nd International Conference on Smart Electronics and Communication (ICOSEC), Trichy, India, **2021**, pp. 1102-1108.
5. P. K. M., I.K.M., L.S., L.C.N. and P. U, "Real Time Assistive Shoe for Visually Impaired People," 6th International Conference for Convergence in Technology (I2CT), Maharashtra, India, **2021**, pp. 1-5.
6. M. Anisha et al., "Low-Cost Smart Shoe for Visually Impaired," Third International Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV), Tirunelveli, India, **2021**, pp. 1108-1111.
7. S. Rao and V. M. Singh, "Computer Vision and Iot Based Smart System for Visually Impaired People," 11th International Conference on Cloud Computing, Data Science & Engineering (Confluence), Noida, India, **2021**, pp. 552-556.
8. T. Chava, A.T. Srinivas, A.L. Sai and V. Rachapudi, "IoT based Smart Shoe for the Blind," 6th International Conference on Inventive Computation Technologies (ICICT), Coimbatore, India, **2021**, pp. 220-223.
9. U. Maheshwari, J.S.T., S.V.S. and S. P. R, "Sneak-Sight Shoes for the Visually Challenged," International Conference on Power, Energy, Control and Transmission Systems (ICPECTS), Chennai, India, **2020**, pp. 1-3.
10. R. Abi Zeid Daou, J. Chehade, G. Abou Haydar, A. Hayek, J. Boercsoek and J. J. S. Olmedo, "Design and Implementation of Smart Shoes for Blind and Visually Impaired People for More Secure Movements," 32nd International Conference on Microelectronics (ICM), Aqaba, Jordan, **2020**, pp. 1-6.

.