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Smart Blind Stick

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Abstract: Blindness is a medical term that refers to the state of being completely blind in both eyes. However, the term blindness is frequently used in a relative sense to refer to visual impairment or low vision. The conventional blind stick assists the blind, as well as visually impaired persons, in recognise the dangers of falling. However, many difficulties can occur in connection with the environmental awareness of the blind. This project will focus more on the problems on the pathway, such as drain, object on path and hanging object. Thus, the Smart Blind Stick enables blind people to communicate effectively with the environment in everyday work situations. This project aims to identify obstacles in front of the user using ultrasonic sensor, track the user's location using GPS, and send location or emergency messages to guardians using GSM. It also focuses on aspects that provide cost-effective and efficient navigational help. This system has ultrasonic sensors HC-SR05, microcontrollers, GPS NEO6MV2 and SIM900 GSM. The system consists of two different parts: a slave transmitter and a master receiver. The sensor component identifies obstacles such as hanging objects, object on path, and drains, while the GPS module determines the location of the user and sends them to the guardian through message. The output of this project is a buzzer as the first warning and audio as the second warning for obstacles detection and an emergency message to the guardian. For the buzzer, the triggered distance for the drain is 90 cm to 120 cm, object on path from 150 cm to 200 cm, and hanging object is 140 cm to 180 cm. Below these distances for each obstacle, the audio will be given to the user as the second warning. To summarise, the purpose of this project is to achieve all of the previously stated objectives. This project can be improved by using Blynk programmed, which can turn the Smart Blind Stick into an IoT project and add a vibrator for further convenience and versatility.

Keywords: Smart Blind Stick, Obstacle Detection, Emergency Message

1. Introduction

Individuals who are visually impaired now experience severe vision impairments that make independent travel impossible [1]. As a result, they must use a variety of techniques and tools to assist them in their movement. An orientation and mobility specialist help blind or visually impaired people navigate safely and comfortably using their other senses [2]. Numerous technologies utilising signal

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processing and sensor technology have been developed recently to improve the mobility of blind people. The documentation classifies sonar feedback (infrared or ultrasonic signals) into two different categories. The radar system uses an ultrasonic system [3] to detect obstacles as stationary and moving objects. These devices operate similarly to the radar system. The wave moves and determines the distance between the human and the obstacles. However, all existing systems alert the blind person that an object exists before or next to them at a certain distance. Object information can provide additional information to enhance space manifestations and blind memory [4].

To overcome limitations, the work provides the blind with visually impaired mobility a simple, efficient and adaptable electronic guide, regardless of whether they are outside or indoor. A PIC microcontroller allows obstacles to be coded using a system with three simple ultrasonic sensors built into which all reflected data may be collected and combined. The slave data as a transmitter is delivered to the master as a receiver through Bluetooth. A buzzer and audio from a speaker will be added to the project, ensuring the blind receives an ultrasonic signal. The user is alerted and can avoid obstacles. When there is an emergency, the user can press the button for an emergency; the stick will send to the emergency contact number already specified in a GSM module the location of a user detected by GPS.

Even with help, such as traditional sticks, it can be challenging to navigate a visually impaired person on their way without accident, sometimes inconvenient and perhaps inaccurate, so that obstacles are not avoided. Therefore, a user system to prevent unwanted incidents will be developed in this project. Initially, an ultrasonic sensor operates on a stick when an obstacle, like hanging object, object on path, or a drain, appears. The received data will be recorded and converted into audio as the user's output, following the buzzing within a specified distance. In the voice recording device, the audio is first recorded. The Smart blind stick also has GPS and GSM to display the exact location with an emergency button to ensure the guardians know the user's condition.

With moving objects within 0 cm to 180 cm, the Smart Blind Stick can be detected and notified. In addition, the Smart Blind Stick may also send the location to the number on the GSM when users press the emergency button. This project aims to detect obstacles facing the user using the ultrasonic sensor and track the user's location using GPS and send the location and emergency message to the guardian using GSM. The project aims to provide a disabled person with an Arduino-based obstacle stick that allows blind persons to recognise obstacles using an ultrasonic sensor and DFPlayer audio. The blind person will be warned about their surroundings and obstacles. For visually impaired people, a GSM-GPS module is also attached. The user sends a message to the guardian by pressing the emergency button.

1.1. Previous research work

1.1.1. Smart Walking Stick for Blind Person [5]

A walking stick, complete with a raspberry p, an RF module, a USB camera, a headphone, rain sensor, and an ultrasonic sensor is included in the study. The raspberry pi is the central controller of the system. The raspberry pi allows the ultrasonic sensor to detect the distance between objects continuously. The ultrasonic sensor determines the distance to reach and reflect an object by the time it takes ultrasonic waves. If an obstacle is within 50 m of the ultrasonic sensor, a signal is given to the raspberry pi. The raspberry pi then activates the connected USB wired camera. When the camera is activated, it captures the image across it. At the same time, the image captured is sent to the raspberry pi. The image dataset is stored on raspberry pi and contains many examples of various obstacles. The raspberry pi is connected to a headphone, allowing voice communication. As soon as the comparison identifies the object, the user is notified via headphones. Other than that, if the rain sensor detects water, the buzzer is activated. These features enable blind people to move around freely.

1.1.2. Smart Blinding Stick with Holes, Obstacle and Ponds Detector Based Microcontroller [6]

The method presented in this paper is illustrated in Figure 1. A device that can help blind people walk safely is the focus of this study. The stick is constructed using a blind stick with four legs, an Arduino microcontroller, and three sensors. Additionally, the three buzzers, one vibrator motor, and three LEDs on the stick serve as an output to notify the user. The first method proposed involves placing a measured angle of approximately 40° with the ultrasound sensor on a suitable blinding stick to detect a hole or stair in front of the blind at a distance of about 48 cm to protect the user from falling and causing injury. The second one uses a moisture sensor implanted in the first leg of the four-legged stick to monitor the degree of land soil moisture in front of the blind and alerts the user when the degree reaches a preset value that could cause their feet to be immersed. In order to prevent an accident, the third sensor is constructed by mounting another ultrasonic sensor on the stick and activating a warning if an obstacle, person, or wall is within 50 cm of the user.

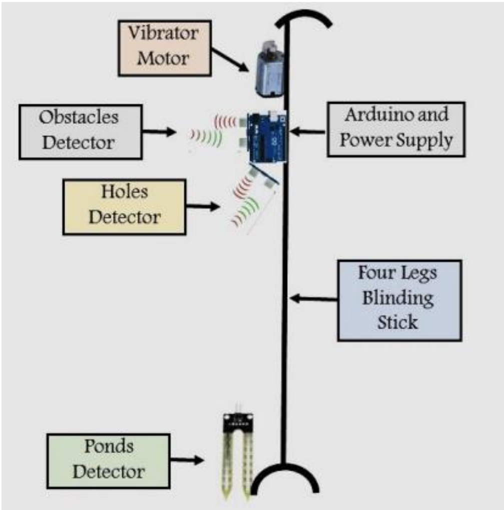

Figure 1: Smart Blind Stick system proposed

A small group of blind and visually impaired people who visited the medical centre, Merjan Medical City, Babylon, tested the device. As a result, as shown in Table 1, the number of tests and percentage of tests performed on blinds at the hospital. In addition, the estimated distance from holes and obstacles, as well as the soil moisture degree, are further clarified.

Table 1: Number and percentage of successful tests

Device Jobs	Number of tests	Measured degrees	Number of succeeded tests	Percentage of succeed tests
Holes	16	46.5 Cm	12	75%
Obstacles	16	0.5 Cm	16	100%
Ponds	12	1000	10	83.33%
Average percentage of succeed of the tested device				86.11%

2. Materials and Methods

2.1. Materials

- Ultrasonic sensor

A method for sensors that precisely determines the distance between the sensor to the object without physical contact. The ultrasonic sensor is a VCC, echo, trigger, and ground interface transducer with four pins. The transmitter and the receiver are two main sensor components, where the ultrasonic signal has previously been utilised to turn the ultrasonic signal into an electrical signal. The sensor HC-SR04 is used to calculate distances particularly. It supplies accurate information about measurements and delivers about 3 mm of precision (resolution). There can be a slight difference between the predicted distance and the actual distance. It is particularly efficient since the target object is precisely measured, and it mainly works with sound waves.

The time it takes for this wave to return is proportional to its distance. If the trigpin is left high for 10 µs, the longer it takes, the wider the distance. These waves move at the speed of sound, resulting in an 8-cycle sonic burst obtained from the ECHO pin. The ECHO pin is still triggered when these waves bounce to their destination, as indicated in Figure 2 [7] and a clear basic ultrasonic working concept in Figure 3. This sensor is primarily intended for use with Arduino to measure the required distance. By measuring the distance between the sensor and the object, the sensor determines the time between the sensor output by the transmitter and its connection to the receiver. The distance can be calculated using the following formula [8]:

$$Distance, D = \frac{VT}{2} \qquad Eq. 1$$

Where L is the distance from the obstacle, T is the time it takes for the round trip signal to trigger, and V is the sound speed. The division by 2 is because the measured time is for the entire signal transmission (round trip).

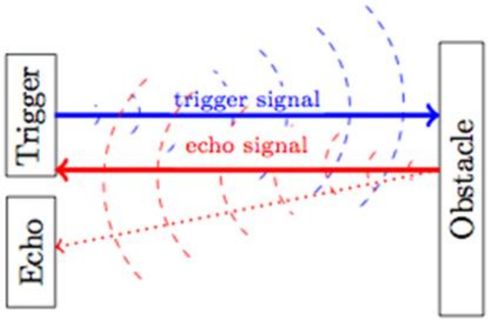

Figure 2: Ultrasonic sensor wave from sensor to the object

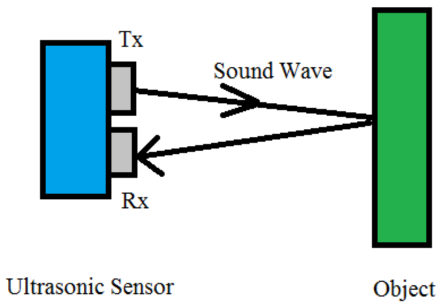

Figure 3: Fundamental ultrasonic sensor working principle

• GPS and GSM module

GPS trackers operate on the same concept. However, instead of displaying information from the system, the microprocessor calculates their location and transmits the completed data to an internet server via the global GSM cellular network. The server offers a platform where end users can connect and view the current and previous device's historical path, speed, and warnings. Both of these data are subsequently transferred over the internet to a desktop programmed or a smartphone utilising the iPhone or Android app on an end-user device, as seen in Figure 4 [5].

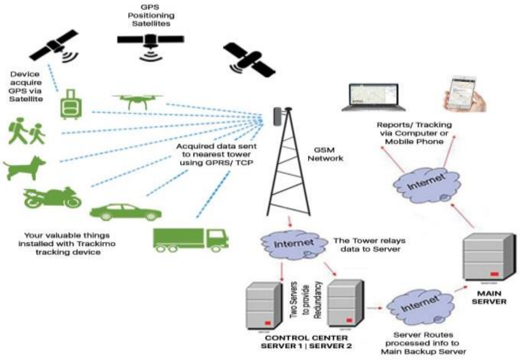

Figure 4: GPS tracker feature with the GSM

2.2. Architecture design

Figure 5 presents the overview of the system design for the system. There are various components in this system: ultrasonic sensors, microcontrollers, GPS NEO6MV2 and SIM900 GSM. The system is made up of two parts: slave transmitter and master receiver. There are three sensors used for detecting barriers for the slave section, such as a hanging object, object on path and drain, and a buzzer for the output at the slave. In addition, DFPlayer, speaker, switch, push-button, GSM, and GPS modules are available for the master. The GPS detects the user's location, and GSM sends the location detected through a message to the guardian. The audio will play when the stick detects the obstacles within the distance that have been set in the program. For the microcontroller, the Arduino UNO and Arduino MEGA are used. Therefore, the data that the ultrasonic sensor obtained then transfers to the buzzer at the slave and audio at the master through Bluetooth as a notification for the user.

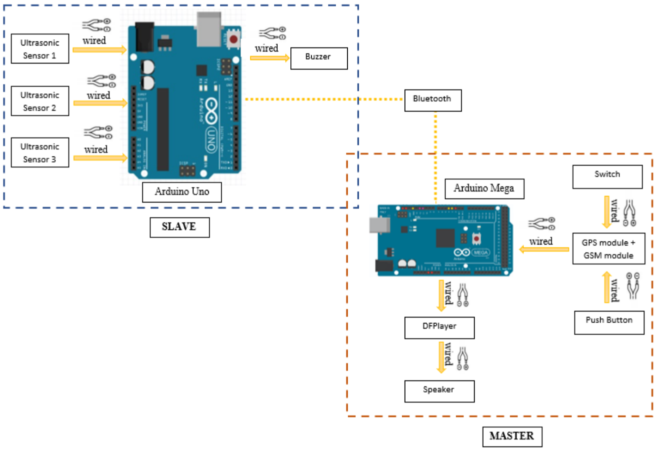

Figure 5: Block diagram of the system

The proposed system's operating flow begins when an obstacle in front of the user is detected by the ultrasonic sensor, which is described in detail below. The data is then stored in the Arduino UNO before the buzzer is triggered if the obstacle is identified within the distance range. For example, the buzzer will sound when the sensor detects a drain between 90 cm and 120 cm, an object on the path between 150 cm and 200 cm, or hanging object between 140 cm and 180 cm. The data in the slave is transmitted to the master, which is Arduino MEGA through Bluetooth when the distance is below this. The data will be stored in the microcontroller before releasing the audio to alert the user.

Furthermore, the master also includes GSM and GPS for locating the user. This function is used when an emergency occurs. To activate the system in the master, the switch is pressed first. GPS will then connect to the satellite and detect the location. Simultaneously, GSM will be activated and ready.

If the user is in an emergency, user must push the emergency button, at which point the GPS will locate the user, and the GSM will send a message to the guardian number. The guardian then receives the message (see Figures 6 and 7).

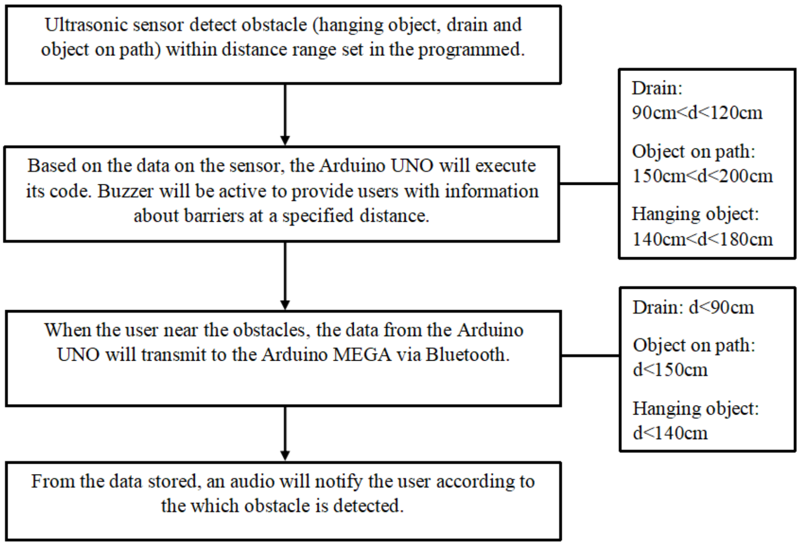

Figure 6: The operational flow of the system for the ultrasonic sensor

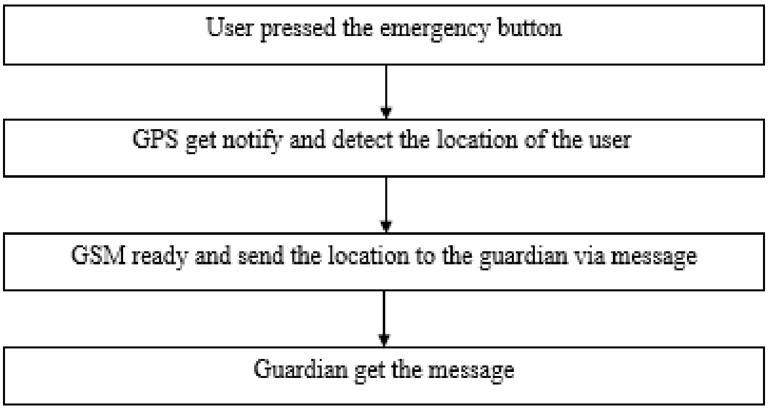

Figure 7: The operational flow of the system for the GPS and GSM

3. Results and Discussion

3.1. Results

Figures 8, 9, and 10 illustrate the complete prototype. The master box is attached to the user's waist using a belt, while the slave box is attached to the stick. The three sensors mounted on the slave box have the task of detecting obstacles at their distances. Sensors are placed in an inclined position at 40˚ and 50˚ angles for drain sensors and hanging objects to allow the sensor to detect obstacles accurately. Four wheels were put at the bottom of the Smart Blind Stick to maintain the sensor angle while the Smart Blind Stick was in use. In addition, the system also sends emergency messages to the guardian of the user. When an emergency occurs, the user can push the emergency button, and the GPS module tracks the user's location and sends them to the GSM module. Arduino helps to transmit GSM messages with a user location in case of an emergency. This section is placed on the belt, and the user uses it. This makes pressing the emergency button easy for the user.

Figure 8: Overview of Smart Blind Stick project

Figure 9: Master box is placed on the user's waist

Figure 10: Slave box is placed on a stick

As illustrated in Table 2, each sensor detects obstacles using a different range of distances. As a result, any obstacle within that range will be identified. A buzzer (first warning) or audio output (last warning) can be produced depending on the range set in the coding

Table 2: Result of obstacle detection tests

Obstacle	Output	Wave Distance	Warning Type
Drain	Buzzer	90 cm - 120 cm	Early warning
	Audio “Drain detected”	<90 cm	Too close/ danger
Object on path	Buzzer	150 cm - 200 cm	Early warning
	Audio “Object on path”	<150 cm	Too close/ danger
Hanging object	Buzzer	140 cm - 180 cm	Early warning
	Audio “Hanging object”	<140 cm	Too close/ danger

People with visual impairments may experience a variety of difficulties in an unfamiliar environment, or they may experience a serious illness and want to notify their parents or friends as soon as possible. Help and support for visually impaired people are usually needed. In an emergency, the primary application for tracking blind people is Google Maps. As a result, the system is tested as the user roams in an open space. Figure 11 illustrates a message received by the guardian when the emergency button is pressed. The message contains a short message such as “HELP, I NEED EMERGENCY” and a link to the user’s location to alert the guardian. Latitude and longitude are shown in Figure 12.

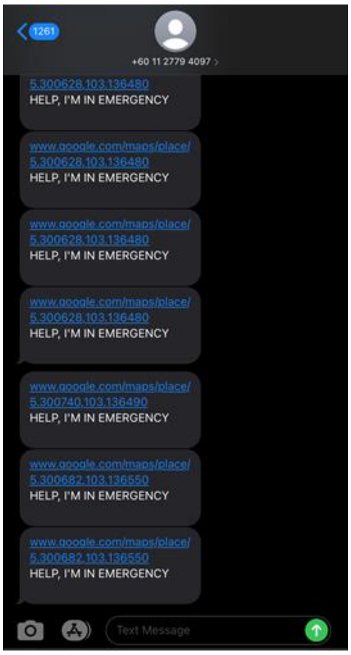

Figure 11: Screenshot of message send by user after pressing the emergency button

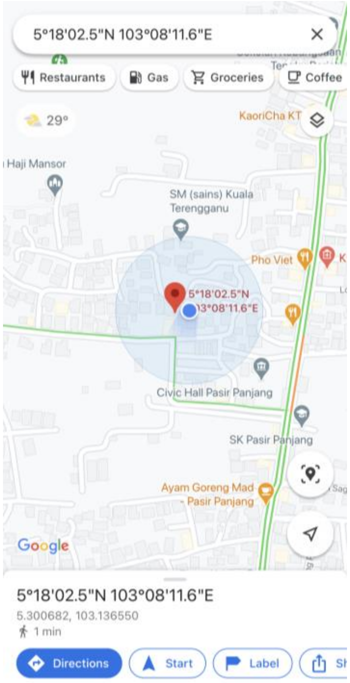

Figure 12: Location that detected by GPS

3.2. Discussions

Based on the data already provided, this Smart Blind Stick can be compared to the findings of [6]. In terms of prototype design, the author utilised an Arduino, two ultrasonic sensors, a moisture sensor, three LEDs, three buzzers, and three vibrator motors. It detects obstructions, ponds, and holes. The first sensor is a moisture sensor placed into the front leg of the stick to identify ponds or wet sections of the soil. The four-legged stick is also needed since all sensors must reliably detect values when the stick is placed at 90° angles on the ground. The suggested method uses a moisture sensor to read soil moisture. Upon reaching 1000, the buzzer, vibrating motor, and blue LED switch are on. Alternatively, it turns them OFF in the other degrees. When someone or an obstacle is within 100 cm of the blind, a buzzer will sound and a motor will vibrate, alerting users. Also, if the stick is facing a wall within a few centimetres, a yellow LED will turn on. A third sensor, a hole sensor, is placed at roughly 40°. If the sensor is set at 56 cm, there should be no hole on the road to the distance of the sensor (based on the 38 Cosine Law). So, the sensor should not exceed 74 cm. Table 1 shows the number and percentage of successful blind tests in the hospital, as well as the number and percentage of successful test results in this study. The paper also explains the device's measurement of holes and obstacles, as well as soil moisture level.

For this Smart Blind Stick, it is divided into two parts in this project: a slave box and a master box. Three sensors on the slave detect drains, objects in the path, and objects hanging below head level. It also has a buzzer as the initial output to warn the user early. This smart blind stick can also send the user's location and send a short message to the guardian. This is provided in the master box containing GPS, GSM and speakers as a second output when the sensor detects an obstacle. For users to avoid obstacles in advance, the project provides two warnings. It uses a four-wheel toy car instead of four leg sticks to maintain the same angle as in [6] for drain detection and hanging objects. From these results, it can be concluded that the Smart Blind Stick helps blind persons locate obstacles. According to Mohammed Azher Therib's suggestion, the GSM and GPS module is being used in the project to send emergency messages to the guardian and to provide the guardian with the user's position.

4. Conclusion

Overall, the aim of this project is therefore to meet all of the objectives indicated previously. This project aims to identify obstacles in front of the user, track users with GPS, and send their location and emergency message through GSM to the guardian. Smart Blind Stick is an ultrasonic sensor, GPS Navigation Sensor Detection, and GSM Module project. While this system can work and implement all the requirements, many improvements are needed to make the project efficient. This project can be enhanced in the future by positioning the sensor in a more convenient location for the sensor to detect particular obstacles. Aside from that, there are various future recommendations where this blind stick can be utilised as an IoT based project using the Blynk application. A vibrator may also be attached for ease of operation and versatility.

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References

[1] N. Donaldson, "Visually impaired individuals' perspectives on obtaining and maintaining employment.," *Diss. Abstr. Int. Sect. B Sci. Eng.*, vol. 79, no. 1-B(E), p. No-Specified, 2018, [Online]. Available: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=psyc15&NEWS=N&AN=2017-54456-005

[2] Carmen Willings, "Orientation & Mobility Specialist - Teaching Students with Visual Impairments," *Teaching Students with Visual Impairments*. https://www.teachingvisuallyimpaired.com/orientation--mobility-specialist.html (accessed Jun. 24, 2021)

[3] A. Biswas, S. Abedin, and M. A. Kabir, "Moving Object Detection Using Ultrasonic Radar with Proper Distance, Direction, and Object Shape Analysis," *J. Inf. Syst. Eng. Bus. Intell.*, vol. 6, no. 2, p. 99, 2020, doi: 10.20473/jisebi.6.2.99-111

[4] C. M. Tyng, H. U. Amin, M. N. M. Saad, and A. S. Malik, "The influences of emotion on learning and memory," *Front. Psychol.*, vol. 8, no. AUG, 2017, doi: 10.3389/fpsyg.2017.01454

[5] D. Sathya, S. Nithyaroopa, P. Betty, G. Santhoshini, S. Sabharinath, and J. Ahanaa , M, "Smart walking stick for blind person," *Math. Appl. Sci. Comput.*, vol. 118, no. 20, pp. 4531–4536, 2018

[6] M. A. Therib, "Smart blinding stick with holes, obstacles and ponds detector based on microcontroller," *J. Univ. Babylon*, vol. 25, no. 5, pp. 1759–1768, 2017, [Online]. Available: https://www.iasj.net/iasj?func=article&aId=132299

[7] S. Heenkenda, A. Mohammed, D. Chamara, and V. Senthooran, "An Assist System for Visually Impaired People to Recognise Massive Obstacles (Within one meter)," *Int. J. Sci. Eng. Res.*, vol. 9, no. 10, pp. 795–800, 2018, [Online]. Available: http://www.ijser.org

[8] Adnan Aqeel, "Introduction to HC-SR04 (Ultrasonic Sensor) - The Engineering Projects," *The Engineering Projects*, Oct. 05, 2018. https://www.theengineeringprojects.com/2018/10/introduction-to-hc-sr04-ultrasonic-sensor.html (accessed Jun. 29, 2021)