Journal of Theoretical and Applied Information Technology
15th December 2020. Vol.98. No 23

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

THE INTEGRATED TECHNOLOGY DESIGN TO GUIDE THE BLIND PERSON TO NAVIGATE SAFELY

HUTHAIFA A. AL_ISSA [1], MOHAMMAD QAWAQZEH [2], SAJA ABU-ZAIDEH [3], SHAMSUL ANUAR SHAMSUDIN[4]

[1, 2, 3] Department of Electrical and Electronics Engineering, Al Balqa Applied University, Jordan.
[4] Centre for Advanced Research on Energy (CARe), UniversitiTeknikal Malaysia Melaka, Melaka, Malaysia

E-mail: [1]alissahu@yahoo.com, [2]qawaqzeh@bau.edu.jo, [3]saja20xx@gmail.com, [4]shamanuar@utem.edu.my

ABSTRACT

It is very hard and dangerous for a visually impaired person to get out alone from home and to navigate around places without any help, he cannot go out without a companion who can count on him and trusting him. This led us to think deeply to solve this problem and make the life easier for blind and help them to move freely and go ahead like any ordinary people by using Internet of Things (IoT). This integrated technology tool will help the blind in their movement without any fear from colliding and fall through giving the blind person alerts when the sensors detect any danger reason like a wall or stairs. So disable society, and community empowerment is our ultimate goal.

Keywords: *Arduino, Gsm300, Speaker, LDR, Ultrasonic Sensor, Water Sensor, GPS.*

1. INTRODUCTION

According to a study, the number of blind people in the world in 2015 is 36 million, which is expected to triple by 2050 as a result of demographic growth and population aging. The study showed that 217 million people had mild or severe visual impairment in 2015, an increase of 35% over 1990, and 588 million were expected in 2050, according to the study, which collected 188 countries. There is a major barrier to visual movement is the need to learn how to interpret non-visual sensory signals [1].

Blind people need to learn how to move safely in their environment. For example, they must learn the techniques of finding obstacles on their way, how to detect depressions or stairways and they must also follow their location and their current place or direction depends on where they want to go. Frequently, for mobility aid carrying a stick with white color or even a dog for guidance is commonly used by a blind person. The main objective of our integrated technology tool research is to contribute our awareness, knowledge, and services to support the mobility of blind and help them to navigate safely so we used different devices and advanced technologies. And finally, we developed a guidance system, by using appropriate sensors to detect and avoid obstructions while walking and giving a sound alert when the blind face any obstruction or any danger like a fire, and our system provides Global Position System (GPS) to help the blind people to know their location and their current place or direction depends on where they want to go and give them the direction using a map to arrive at their destination.

By using a design of integrated technology tool technology, a blind person can walk without anyone's help. This stick can help the blind man to overcome physical obstacles it detects the obstacle and gives a response by a warning sound. This integrated technology tool can also help a blind person from other obstacles like fire or water obstacles. Through this, the blind person can recognize the different obstacles that he faced. Also, this stick is connected to the internet so the location of a blind person can appear on the map so that the monitor person can know his location using a mobile application. Another advantage of an internet connection is that of communicating with a monitor person. In the case that the blind person faces any problem or loses in direction, he can send a text message to the monitor asking for help only by pushing the button. Our integrated technology tool is also equipped with remote control; the transmitter is used to make the stick send sound when the blind person lost his stick in distance at range 4m maximum. Finally, in the dark to make the people around him recognize the existence of a

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

blind person and then to reduce the accidents this stick is equipped with a smart lite.

2. HISTORY AND RELATED WORK

The white cane was introduced as a mobility tool after World War I [2]. a photographer suddenly became blind after an accident in 1921 and to make his stick more easily visible, he painted it with white color rather than black.

In 2014 [4] team of 7 students at the Egyptian e-Learning University of the Faculty of Computing and Information Technology has created the first device of its kind to help the blind to recognize and distinguish things around them and to coexist with the surrounding world without fear or risk, through a headset equipped with a camera called "X-Blindness", the device can identify people and objects as well as dealing with fixed and mobile cars, as well as distinguish between paper and silver currencies and classification, so that the visually impaired can do any cash transactions, and the device can enable the visually impaired to read any texts and written advertisements, So the device adds the ability to track and locate the visually impaired through an application on a mobile phone[4].

On March 7, 2016 [5], Toyota has reached a new device that eliminates many of the problems faced by the visually impaired. Toyota was able to reach a scientific discovery called "Project Blaid". On January 26, 2019 [6] finals of the Emirates Robotics and Artificial Intelligence Competition in the national competition, the smart intelligent guidance system for the blind (Smart Guide) was qualified for the finals and received an assessment rate (83.88%), an innovative Emirati project that helps the visibly impaired it is an innovative Emirati project that helps the blind independently to avoid obstacles that can be encountered, to locate places or objects and to move from one place to another, and to explore obstacles [6].

3. PROBLEM STATEMENT

Although technology is developing and growing these days very quickly, but so far there is no one has taken the advantage of this development to find an effective device that helps the blind person to be independent in movement. And we know the amount of limitation faced by blind people to do the simplest daily tasks. So, to allow the blind people to navigate easily and without the need for any helping hand, we used advanced technology to produce our integrated technology tool.

4. PROPOSED DESIGN

Figure 1 below is our integrated technology tool we can show the different input /output devices that used as represented on it. Our integrated technology tool consists of five sensors its name respectively is: two Ultrasonic sensors, water sensor, flame sensor, and LDR sensor, all these sensors used to sense different situations and make a different response. Also, our system has multi-output devices such as the speaker, buzzer, led, and mobile screen which presents a map. Also, the arrangement of the sensors used in the stick is shown in figure 1 below.

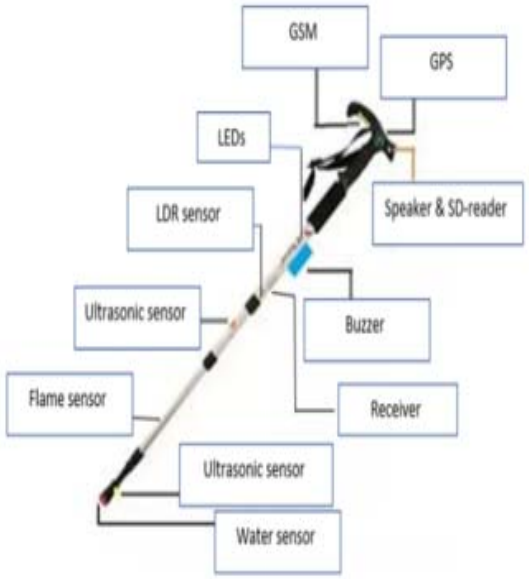

Figure 1: The integrated technology tool

5. SYSTEM DESCRIPTION

As shown in figure 1 above, two similar Ultrasonic sensors used the first one programmed to cover a range from 15-50cms. And the second used to detect and avoid the obstacles that close to the ground and its range cover from 3-15cms. Also, we used a switch and its main function to send messages and connect the blind person with the people responsible for him. One of the output devices we used is a buzzer which makes a different sound in each situation to alert the blind person about the presence of any obstacles so he can avoid hitting it.

The smart blind system consists of three parts: the first is responsible for connecting to the Internet and global site system, keeping the blind under permanent supervision, and communicating with the observer continuously to determine his location

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

in case of danger. This part is consisting of GPS, GSM, SD-reader, speaker, and button. The first part is shown in figure 2 below.

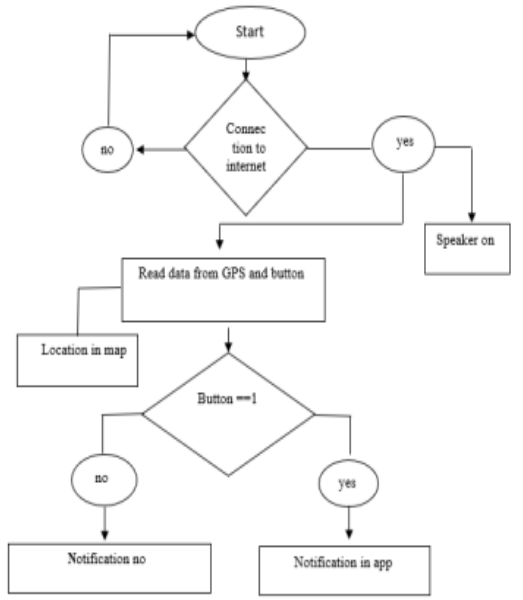

Figure 2: Operation of GPS & GSM

The second part consists of a set of sensors: fire-sensitive, space-sensitive, and light-sensitive. In the case of danger, such as a fire, the system alerts the blind by produce sound from the buzzer. The second part is shown in figure 3 below.

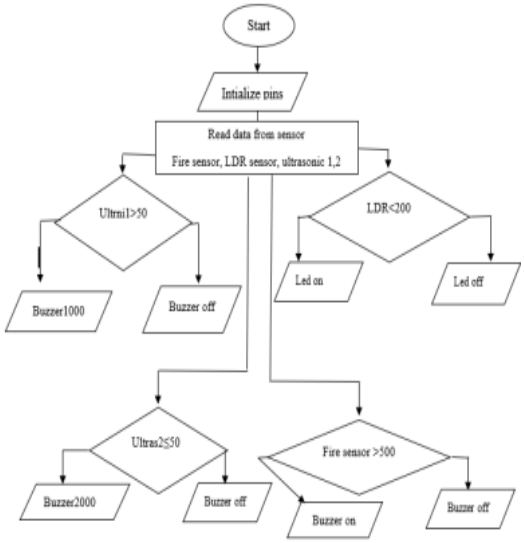

Figure 3: Operation of Sensors

The third part as shown in figure 4 below; consist of transmitter and button use it if the blind want to find the stick.

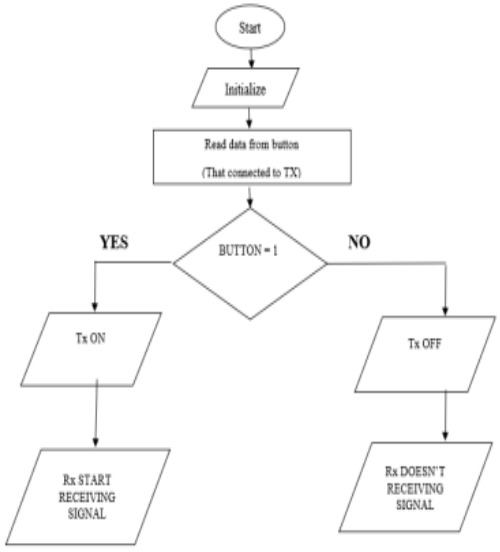

Figure 4: Operation of Remote Control

6. OPERATION OF SENSORS

All the sensors used, make the Stick do its perfectly, as shown in the figure 5 below.

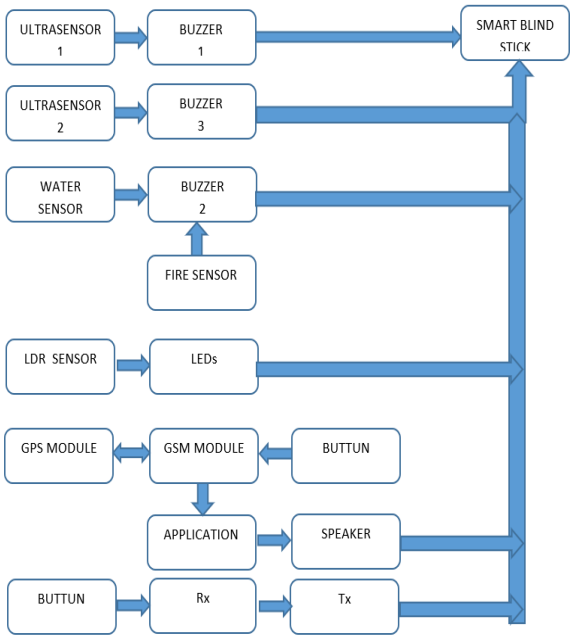

Figure 5: Block Diagram

We discussed the operations of these different sensors as follows in subsections:

6.1 Ultrasonic Sensor

Transducers are another name for the Ultrasonic sensor. The principle of its operation is using sound

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

wave, so the object or target are detecting using it. [7] as shown in figure 6, its main function is close to the principle of sonar or also radar [8]. Ultrasonic sensors determine the distance by using the time interval which is the difference between sending the sound wave signal and receiving back the echo from a target.

In general, the ultrasonic sensor consists of two parts, transmitter, and receiver. The transmitter emits the ultrasonic waves. The receiver detects the reflecting signals from the objects. The ultrasonic sensor work based on a principle called "The Time of flight" using the speed of sound. A range of pulses between (20 kHz to 200 kHz) is emitted by the sensor. When the pulse impacts an object and then reflected; therefore, the receiver of the sensor will be able to detect this signal. The time difference between the outgoing signal and the reflected signal known as (Δt) and the speed of sound at 20°c is equal to 343.5m/s [9]. The distance can be given according to the formula:

$$Distance = \frac{\Delta t}{2} * c \qquad (1)$$

Where c: speed of sound [9].

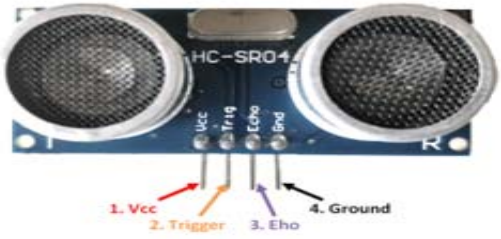

Figure 6: Ultrasonic Sensor

One of the most important sensors we used to make sticks. We used 2 of these sensors. The first Ultrasonic sensor, located in the middle of the stick, is used to detect forward obstructions. [10] [11], After detecting any forward obstacle the buzzer start produces a sound to alert the blind person. And then the blind can make a response to avoid any possibility of a collision by stopping or change his path. The other Ultrasonic sensor at the end of the stick called Ultrasonic sensor 2, it used to identify the lower obstructions such as staircase or stone.

6.2 LDR Sensor

It is a potentiometer, but its resistance change depends on the intensity of the light. Its resistance will be high during the night (in range M ohm), one of the challenging tasks for a blind person is walking in public places because there is not sufficient space to pass so we use the LDR sensor with LED. At night the led will bright and then when the blind walking any other people can recognize them easily [12]. [13]. LDR sensor shown in figure 7.

Figure 7: LDR Sensor

6.3 Water Sensor

The blind person can't recognize if there is any water on the floor if he wearing shoes, and the wet surface can cause slipping, to avoid slipping we provided the stick with a water sensor and we situated it at the end of our integrated technology tool. Water sensors sense the presence of water and then send a signal to the processor which will make the buzzer produce a sound to alert the blind person. [14][15] so the blind person will be more careful. As shown in figure8 below.

Figure 8: Water Sensor

6.4 Flame Sensor

Flame sensor as shown in figure 9 below. Also called a heat sensor, is sensing heat radiation from

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

long distances. In some cases blind person can't sense the heat easily, So to avoid any dangerous situations we provided the stick with this heat sensor to detect the presence of heat like fire or something burning and then inform the blind person by making the buzzer peep with different noise and the blind can avoid it early.

Figure 9: Flame Sensor

7 Prominent Techniques Used In Our Integrated Technology Tool

Many technologies can be used to develop smart sticks for the blind and can be linked together using IoT, the techniques used are sequentially found in the following subsections:

7.1 IoT

As shown in figure 10 below, IoT is to make all devices communicate with each other by connecting them to the internet. So, all these devices connected to the network are performing a giant network which is called IoT. And all devices within the network allowed to share data. And therefore, all devices sharing the experience of each other and learning from each other [18].

Figure 10: Connection of Multiple Devices [18].

Using IoT allows us to control all devices remotely by using sensors and the internet., thus the opportunities we get using IoT is to directly connect the world to the computer-based systems.

7.2 The SIM900 GSM/GPS

In this research, we used GSM/GPRS or Global System for Mobile communication/General Packet Radio Service; to connect to the Internet over the GPRS network. GSM is a digital mobile network that commonly used in the world [19] The SIM900 GSM/GPRS shown in figure 11 below [13].

Figure 11: The SIM900 GSM/GPRS [13].

7.3 GPS

In this research, we used the NEO-6M GPS or Global Position System receiver module, as shown in figure 12 below. GPS use the signals sent by satellites in space and ground stations on earth to accurately determine its position on earth. It receives information like latitude, longitude, altitude, etc. This module connects with Arduino through a particular protocol [20].

Journal of Theoretical and Applied Information Technology
15th December 2020. Vol.98. No 23

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Figure 12: The GPS Receiver Module [20].

In our research, this is one of the most important parts because it allows the monitor to follow the blind person and knows its location easily. So, via GPS we can follow the location of blind people and their current place or direction depends on where they want to go.

7.4 Blynk

Blynk is a simple mobile phone application for IOS and android we use it to open a map. Is provided with a digital dashboard we used it to build a graphic interface for our prototype[21]. The logo of Blynk shown in figure 13 below.

Figure 13: Blynk Logo

8 Other System Components

In this section, we will explain information about other basic pieces we used and explain its task.

8.1 Remote Control

The remote control used is a 433MHz RF transmitter and receiver.

8.1.1 Transmitter

As shown in figure 14 below, A transmitter is an electronic device that contains a precise oscillating circuit, So an AC carrier wave frequency creates using it. The signal prepared and sent by the transmitter to an antenna, its wave tuned at 433MHz, So the signal wave radiates out into the atmosphere by transmitter [22].

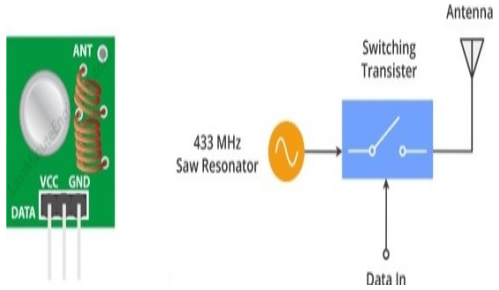

Figure 14: Transmitter Modules And Its Block Diagram [22].

8.1.2 Receiver

The receiver module as shown in figure 15. An antenna captures the desired carrier wave that is present in the atmosphere. Then the receiver separates the desired carrier wave with its information and then isolates the carrier wave from the information signal. It prepares it for output to a device, such as a display screen or speakers [22].

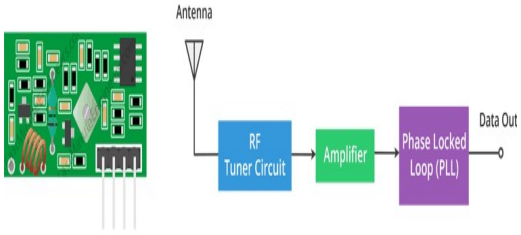

Figure 15: Receiver Modules and Its Block Diagram [22].

In this research, we use the remote control to find a stick, assume the person loses his stick so by remote which already has carried by the blind person. He presses on the button of Tx. Rx exists on the stick and it released a sound generated by a buzzer so the person will follow the direction of the sound to find it. The maximum range which we can find the stick around (10-15) m, because RF can get through the walls.

8.2 Buzzer

As shown in figure 16, It is a small crystal that operates by applying a particular frequency that generates a particular sound [23]. In our system we use many buzzers, each one of them specializes for a particular sensor. We programmed each buzzer on a different frequency to make each buzzer have a

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

different sound from the other buzzer. The reason why we use the buzzer because blind people GOD give them the capability to distinguish different sounds more than others.

Figure 16: Buzzer

8.3 Speaker and SD-Reader

To play good quality audio the digital speaker module is used, and It can be used to act as a buzzer, all that done using a potentiometer to control the volume output [24]. We use the SD card reader, to read the memory card that we used to record the sound that will appear from the speaker. This sounds to identify the tracking of the blind person such as, go on right, go on left and go straight. SD-reader and speaker shown in figure 17, 18 respectively.

Figure 17:SD-Reader Module

Figure 18: Speaker module

9 Results

The proposed system presents a helpful concept to provide a smart electronic tool for visually impaired people. figure 19 below shows the prototype and the whole pieces used. We fixed the various pieces and sensors on the stick, giving each piece the most suitable place at the stick to do its function perfectly.

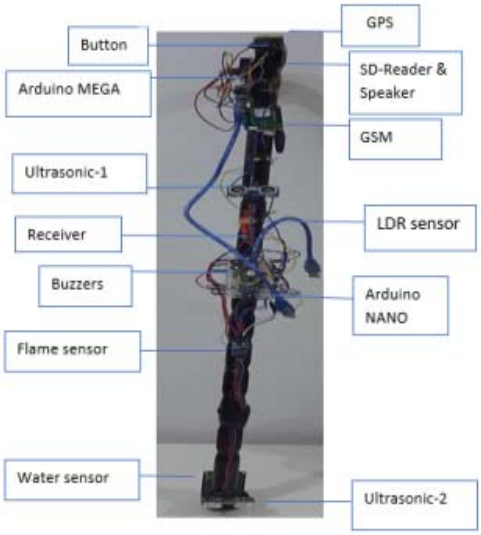

Figure 19: Our Integrated Technology Tool.

The results are divided into three parts, and it will be discussed briefly in the following subsections:

9.1 Result Based on the Internet Connection

A stick guide model represented for a visually impaired person to guide in their way, which consists of a GPS and GSM modules along with different sensors. To start using the stick, the user must put the SIM-Card on SIM900 GSM/GPRS modules first; to configure Internet connection over the GPRS network. Once the Internet connection begins, the GPS receiver is ready to receive the

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

signal from the satellites and locate the stick, and the location appears on the map on the monitor of the person who is often from the blind person's family. When the blind person starts going to the specified location, he starts receiving directions from the speaker. These directions are stored in memory and are read using SD-Reader. The process of tracking and display the location on the map is done using an application that is compatible with Arduino and the name of this application is "Blynk", which is found on Google store.

All the part mentioned here like GPS, GSM, Speaker, and SD-Reader are connected to each other to exchange data via their protocols, these pieces are connected to Arduino-MEGA, and they located at the top of the stick as shown in Figure 20 below, and this is the most suitable place for these pieces. For example, the GPS antenna is placed at the top of the stick to receive the signal from the satellite without any obstruction.

Figure 20: The Top Part of Our Integrated Technology Tool.

Also, this stick is supplied with a button that helps the blind person to communicate with his monitor if he needs helping only by pressing on it. When using this button, a text message which contains “help me" as shown in figure 21 below, will arrive at the monitor through the application then the monitor can determine the location of the blind person.

Figure 21: A Message Asking For Help In The Application.

9.2 Result Based on Sensor Reading

As mentioned previously, we have used five sensors: two ultrasonic sensors, a water sensor, a flame sensor, LDR sensor. Each of these sensors is connected to a buzzer that generates an alert sound, and each buzzer is programmed to output a different sound from the other, to be distinguished by the blind person. So that the buzzers are used to make a sound when the blind near any object.

When the blind person starts to walk, if we assume that he faced an obstacle ahead on his ways like a wall, a tree, or even other people as shown in figure 22 below. Then the ultrasonic-1 which is in the middle of the stick detects the forward obstructions by calculating the distance, and then directly the buzzer will start generating a sound to alert him.

Figure 22: Detect Forward Obstruction Using Ultrasonic-1.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Despite the fronted obstructions, the blind person may face obstructions below the ground level as shown in figure 23 below. So, the Ultrasonic-2 located at the end of the stick, detect scarps like the sidewalk, hole, stairs, etc.. It works the same as the principle described previously. And directly the buzzer will start generating different sounds with different frequencies.

Figure 23: Detect Obstructions Below The Ground Level Using Ultrasonic-2.

So, using these sensors make the stick detects the obstacles which help the blind to move safety. Suppose that the water detected in the street or from the rain can cause sliding on the floor. water sensor lying at the end of the stick as shown in figure 24 below is responsible for determining if there is a hole filled with water. After that, a sound from the buzzer will generate to alert the person of the presence of water.

Figure 24: Detect Water Using A Water Sensor.

Suppose that the fire detected by a photodiode as shown in figure 25 below, which can detect the presence of fire by fumbles the fire frequencies which is equivalent to infrared radiation (300G-430T) Hz. So if the heat radiation detects by the sensor, then the sensor will send an electrical signal to the controller and thus buzzer start alarming to alert the person of the presence of fire. This sensor is really important to protect the person from a dangerous accident.

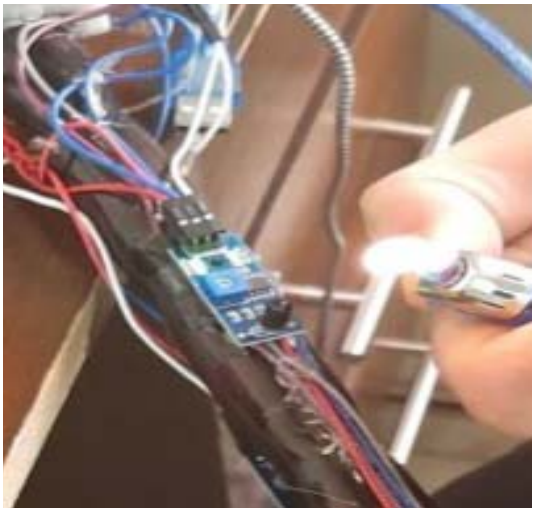

Figure 25: Detect Fire Using A Fire Sensor.

Another feature of this stick keeps the blind safe from the accident is using smart lite, which is a LED with LDR sensor. This sensor measures the intensity of the light to distinguish night from day and dark places from bright places. In this research we use LDR; because in the dark, sticks cannot be distinguished from the street, which may lead to problems for the blind person so we will use this sensor to if the place is dark, then the LED in the stick will light the sticks, as shown in figure 26 below.

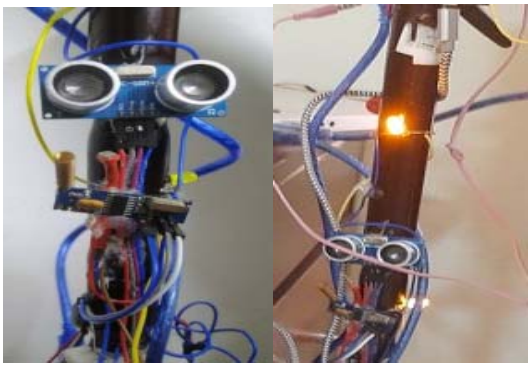

Figure 26: Workable LDR sensor.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

9.3 Result Based On Remote Control

In the case the stick fell from the hand of a blind person, or if the blind person forgets where he placed a stick or even the stick was lost in a range not exceeding 4m. Then the blind person can press a button in the remote control, which makes the stick produce a sound help the blind find it. The remote control is shown in figure 27 below.

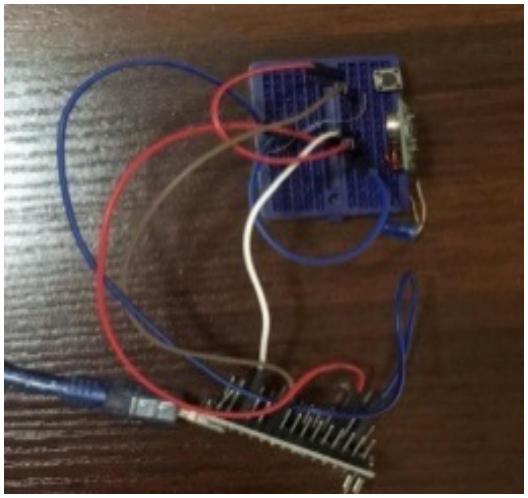

Figure 27: Remote Control.

10 Conclusion And Future Work

The blind stick is a stick designed for blind people to improve the navigation, by helping the blind people to know their location and their current place and give the monitor the location of a blind person using a map. Also, a blind person can send a message to the monitor using the application if he lost his direction or if he faces any danger.

Future work includes image processing to enhance an image such that identify persons and things i.e. coins, traffic signs …etc., and the ability to make a call. These are our ideas now and we will think to make an idea more creative. Hoping for our research to be more and more useful for those people.

REFRENCES:

[1] Tulip Mazumdar. (2017). BBC News. Health Global blindness set to 'triple by 2050.

[2] Wikipedia, the free encyclopedia.(White_cane).

[3] Philip strong. (2009). the history of the white cane. http://www.acb.org/tennessee/white_cane_history.html.

[4] Samir El-Seoud 1, Islam Taj-Eddin1, Naglaa Seddiek2 , Pauline Ghenghesh2 , Mahmoud El-Khouly3. (2014). The Impact of E-Learning on Egyptian Higher Education and its Effect on Learner's Motivation: A Case Study. Vol.2 No.3. pp. 179-187

[5] Michael Martines. (2016) Toyota creates device to help blind people move around. The Detroit News.

[6] GoDubai Editorial Team. (2019). 1,500 UAE Students to Step Up Their Game Competing at the Artificial Intelligence and Robotics (AIR) Series Competition. Dubai press releases.

[7] Kanagaratnam, Kajatheepan, "Smart Mobility Cane: Design Of Obstacle Detection", EE 4BI6 Electrical Engineering Biomedical Capstones, 2009.

[8] Mohd Helmy Wahab, Amirul A. Talib, Herdawatie A. Kadir, A.Noraziah, Roslina M. Sidek, "Smart Cane: Assistive Cane For Visually-Impaired People", IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 4, No 2, July 2011.

[9] A. F, A. NADA, M. A, and S. MASHALI, "Effective Fast Response Smart Stick for Blind People," no. April, pp. 5–11,2018.

[10] J. Borenstein and Y. Koren, "Obstacle avoidance with ultrasonic sensors," IEEE Journal on Robotics.

[11] B. Johann and Y. Koren, "Real-time obstacle avoidance for fast mobile robots," IEEE Transactions on systems, Man, and Cybernetics, vol. 19, no. 5, pp. 1179-1187, 1989.

[12] Vipasha and P. Abrol, "Design of Traffic Flow based Street Light Control," International Journal of Computer Applications, vol. 72, no. 18, pp. 32-37, 2013.

[13] 1Shashank Chaurasia and 2K.V.N. Kavitha. (2014)." AN ELECTRONIC WALKING STICK FOR BLINDS".

[14] P. Keeton, "Personal Injuries Resulting from Open and Obvious Conditions," University of Pennsylvania Law Review, vol. 100, no. 5, pp. 629-648, 1952.

[15] S. Lam Po Tang and G. K. Stylios, "An Overview of Smart Technologies for Clothing Design and Engineering.," International Journal of Clothing Science and Technology, vol. 18, no. 2, pp. 108-128, 2006.

[16] R. G. Millikan, "Biosemantics," The Journal of Philosophy, vol. 86, no. 6, pp. 281-297, 1989.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[17] R. Elghanian, J. J. Storhoff, R. C. Mucic, R. L. Letsinger and C. A. Mirkin, “Selective.

[18] Shubham Sinha.(2019) Introduction to Internet of Things:IoT Tutorial with IoT Application. Training in top technology.

[19] Maine, k.;Devieux, C.;Swan,P. (November 1995)." Overview of IRIDIUM satellite network".WESCON'95.IEEE.P.483.

[20] Bradford W. Parkinson and James J. Spilker (Eds)."The Global Positioning System: Theory and Applications" ISBN 9997863348 American Institute of Aeronautics and Astronautics.

[21] https://store.arduino.cc/usa/arduino-nano.

[22] F. Egan, William (2003). Practical RF System Design. Wiley-IEEE Press . ISBN 978-0-471-20023-9.

[23] "Piezo System: History of Piezo electricity", www.piezo.com . Retrieved 2015-07-12.

[24] https://www.trossenrobotics.com/digital-speaker-module.aspx.