Contents list available at: https://journals.ekb.eg/
Sohag Journal of junior Scientific Researchers
journal homepage: https://sjyr.journals.ekb.eg/
ISSN 2735-5543

*Article*

# Navigation Guide for the Blind and Visually Impaired People using the Global Positioning System

Hedra Saleeb*, Mohamed Hassan, Fatma Ismail, Amany Hassan, and Rasha Kassem

Electrical Department, Faculty of Technology and Education, Sohag University, Sohag 82524, Egypt
*Corresponding author: hedra_mahfouz@techedu.sohag.edu.eg

**Article info.**

**Citation:** Saleeb H., Hassan M., Ismail F., Hassan A., and Kassem R. (2023). Navigation Guide for the Blind and Visually Impaired People using the Global Positioning System *Sohag Journal of Junior Scientific Researchers*, Vol. **3** (*2*). 48-56.

https://doi.org/10.21608/sjyr.2023.297617

**Received**: 26/02/2023
**Accepted**: 30/04/2023
**Published**: 01/06/2023

**Publisher's Note:** *SJYR* stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

**Abstract**

The blind and visually impaired people represent a special segment of society where they suffer from a lack of independence, especially in movement, due to the presence of many obstacles, as they find it difficult to recognize objects in their path. To solve this problem, blind and visually impaired people resort to using the white stick, which allows them to perceive the surrounding environment within the limits reached by the stick. In this research, a smart stick has been developed using an (Arduino) chip to help them by locating the current location of the holder in case of his long absence by using a Global Positioning System (GPS). As for avoiding obstacles, it is done using ultrasonic sensors, and blind people are alerted through audio clips to help them navigate and choose the appropriate path. Blind people can also send an SMS text message of their current location to a specified phone number of a relative in case they need assistance using the Global System for Mobile Communications (GSM). Finally, the proposed structure was experimentally validated by the results of the experimental work obtained from the prototype built and implemented in our laboratory.

**Keywords:** Blind Visually Impaired, Navigation Systems, Global Positioning System (GPS), Global System Mobile (GSM).

## 1. Introduction

People with disabilities have received a lot of attention in recent years. This interest is due to the growing conviction in different societies that persons with disabilities, like other members of society, have the right to live and develop to the fullest extent their abilities and energies enable them. Changing the societal view of these individuals and shifting from considering them an economic burden on their societies to considering them as part of the human wealth (koley & Mishra, 2012). It is necessary to develop this wealth and benefit from it to the maximum extent possible. This led to integrating the blind and visually impaired segment within the technological development and keeping pace with this technology to improve their lives for the better and harness it to serve them and meet their needs and help them move so that they can rely on themselves and feel independent and self-centered (Ameer 2010). Employing technol-

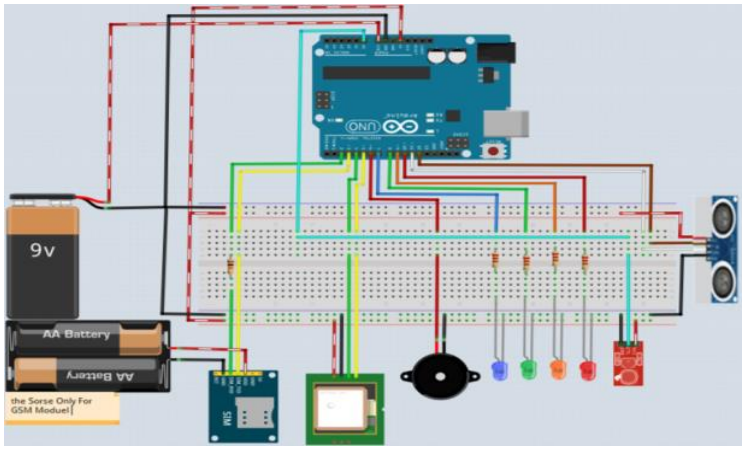
ogy in the lives of the blind leads to facilitating their affairs with the least effort and least effort, often at the lowest cost because they represent a special segment of society that should not be ignored (Moulton et al., 2009).

The blind and visually impaired suffer from some of the challenges and difficulties they face in society, as they move from one place to another, and this leads to a feeling of lack of independence. They also face many obstacles and obstacles that stand in their way, such as colliding with things, stumbling and falling, or crossing the road in the middle of cars and other obstacles that force them to seek help from others (Loomis, J. M., 2001). Although most blind people use the traditional (white) stick to help them move around, it does not make them self-reliant in reaching their destination, and it may not be useful sometimes in avoiding obstacles because it detects the presence of the obstacle after reaching (Borenstein 1997).

The main objective of this research is to develop a smart stick for the blind and visually impaired using (Arduino) chip technology and ultrasonic sensors to help them navigate by determining the current location of its holder using GPS. It also detects obstacles in the path in which the blind person moves and alerts him ahead of time through voice commands. In addition, the blind person can send a text message with his current location to someone from his relatives in case he needs help using GSM.

## 2. Materials and Methods

Figure 1. It shows the components of the electronic stick design in the form of a long black stick, but it provides the blind with ultrasonic vibrations that he feels under his hand when it hits a specific obstacle in its path. It can also detect obstacles in all directions at a distance of five meters. The ends of this stick are made of lead. And it is equipped with a water sensor that provides attention through a bell to alert, and in order to be able to distinguish between the ultrasonic sensor alarm and the water sensor, we used the LSD1820 to hear a recorded sound that there is an obstacle in front of it and use the bell with the water sensor to give a ringing alarm so that it can differentiate between each of the two sensors. And because the safety of every blind person is important to us, we added a tracking device for the blind, which is a GPS and a Subscriber Identity Module (SIM), so that in the event of his absence for a long period, any member of the family can send a message to the stick, and the SIM works by sending a message with the location to the sender via GPS.




(**a**) (**b**)

Figure 1. Navigation system for the blind and visually impaired using GPS. (a) The block diagram of the navigation device; (b) A final design of the navigation device.

## 3. Results

### 3.1. Arduino

Arduino as shown in Figure 2, is an open-source software and hardware program in which you can simply control the hardware and perform a large number of functions based on the integration of programming and hardware with the inputs of your choice so that the outputs achieve the goals you want.

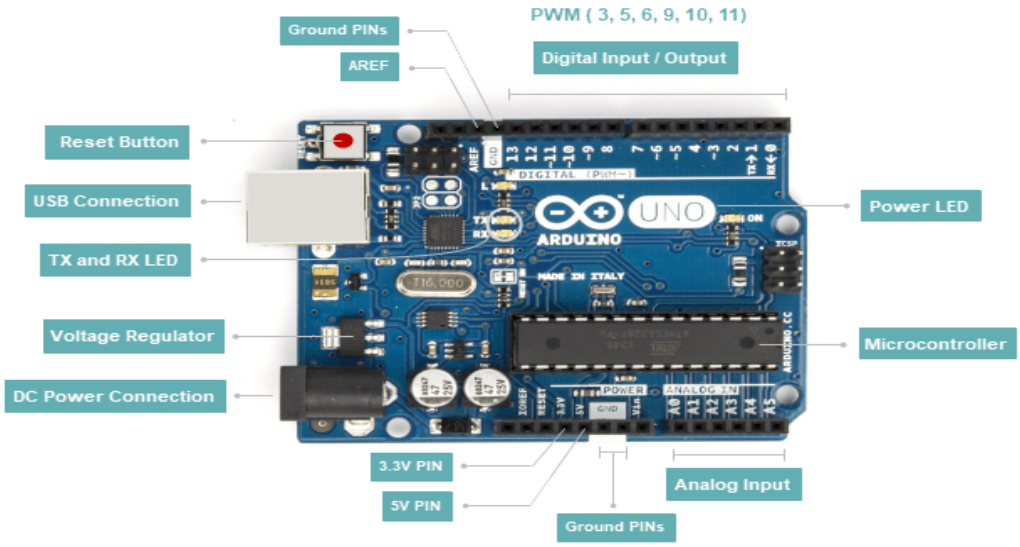
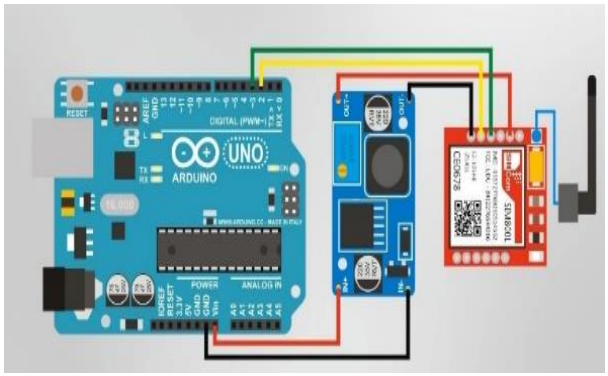



Figure 2. Shows the Arduino configuration.

### 3.2. Global System for Mobil Communication

GSM is a mini modem as shown in Figure 3, its function is to send SMS text messages, make or receive phone calls and connect to the Internet through GPRS, TCP/IP. And for the first time, the unit supports quad-band SIM800L GSM/GPRS, which means it works pretty much anywhere in the world.


Figure 3. Shows the GSM configuration.




```
#include <SoftwareSerial.h>
SoftwareSerial GSM(3,2);

void setup()
{
  Serial.println("START GSM .... ");
  GSM.println("AT");
  upGSM();
  GSM.println("AT+CMGF=1");
  upGSM();
  GSM.println("AT+CSQ");
  upGSM();
  GSM.println("AT+CCID");
  upGSM();
  GSM.println("AT+CMGS=\+021025576379\"");
  GSM.print("helo mohamed / 1 GSM");
  upGSM();
}

void loop()
{
  upGSM()
}

void upGSM()
{
    delay(500);
    while (Serial.available())
    {
      GSM.write(Serial.read());
    }
    while (GSM.available())
    {
      Serial.write(GSM.read());
    }
}
```

(**a**) (**b**)

Figure 4. A method of connecting the GSM module to Arduino Uno. (a) The block diagram of the electric circuit; (b) Software code.

3.3. Global Positioning System

GPS as shown in Figure 5, is one of the most widely used Global Navigation Satellite Systems (GNSS) around the world. Its function is to determine the geographical location, time and speed with an accuracy of up to 30 cm.

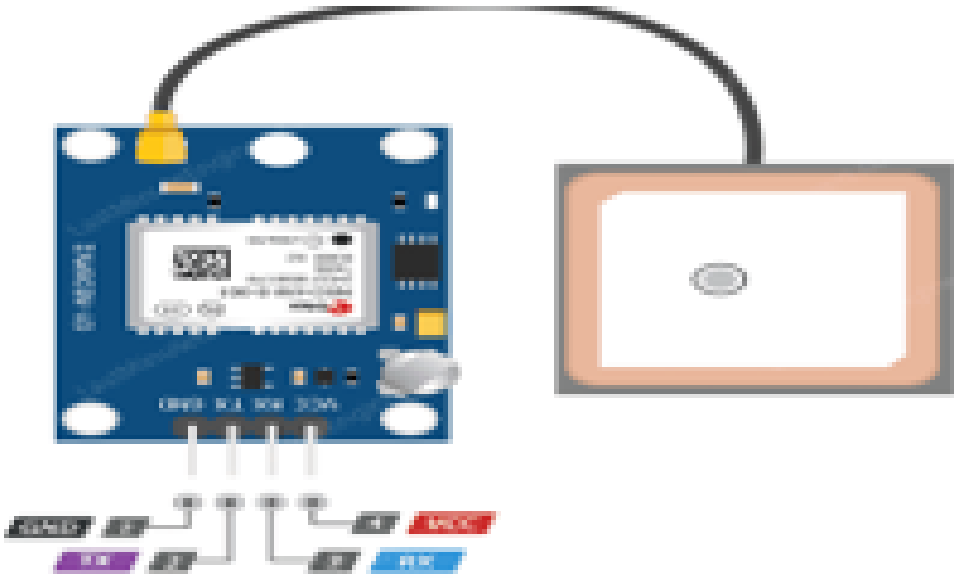
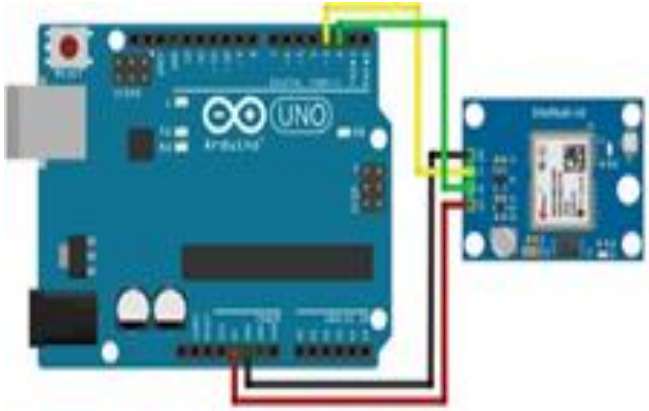


Figure 5. Shows the GPS NEO-6M configuration.




```
void loop()
{
}

void displayInfo()
{
  Serial.print(F("Location: "));
  if (gps.location.isValid())
  {
    Serial.print(gps.location.lat(), 6);
    Serial.print(F(","));
    Serial.print(gps.location.lng(), 6);
  }
  else
  {
    Serial.print(F("INVALID"));
  }

  Serial.print(F("  Date/Time: "));
  if (gps.date.isValid())
  {
    Serial.print(gps.date.month());
    Serial.print(F("/"));
    Serial.print(gps.date.day());
    Serial.print(F("/"));
    Serial.print(gps.date.year());
  }
  else
  {
    Serial.print(F("INVALID"));
  }

  Serial.print(F(" "));
  if (gps.time.isValid())
  {
    if (gps.time.hour() < 10) Serial.print(F("0"));
    Serial.print(gps.time.hour());
    Serial.print(F(":"));
    if (gps.time.minute() < 10) Serial.print(F("0"));
    Serial.print(gps.time.minute());
    Serial.print(F(":"));
    if (gps.time.second() < 10) Serial.print(F("0"));
    Serial.print(gps.time.second());
    Serial.print(F("."));
    if (gps.time.centisecond() < 10) Serial.print(F("0"));
    Serial.print(gps.time.centisecond());
  }
  else
  {
    Serial.print(F("INVALID"));
  }

  Serial.println();
}
```

(**a**) (**b**)

Figure 6. A method of connecting the GPS module to the Arduino chip. (a) The block diagram of the electric circuit; (b) Software code.

3.4. Ultrasonic Sensor

The distance sensor as shown in Figure 7, measures a large distance from the sensor by reflecting the ultrasonic wave. The sensor sends an ultrasonic wave (Trig) to be shocked and reflected back to the sensor (Echo).

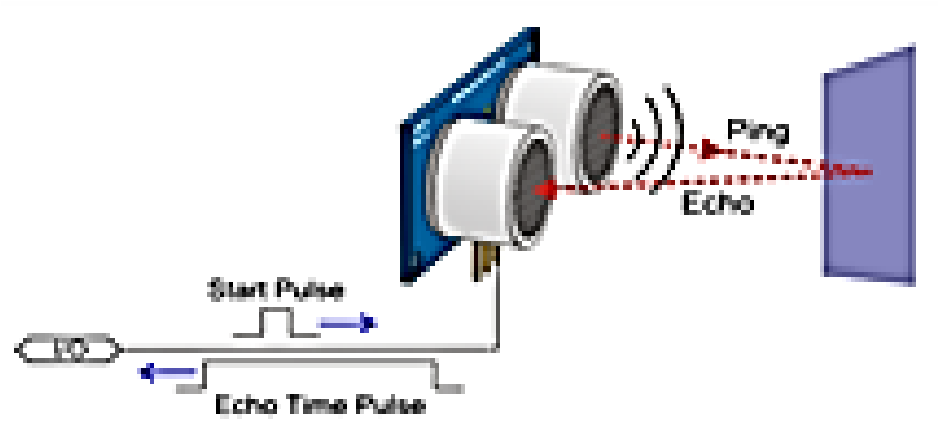
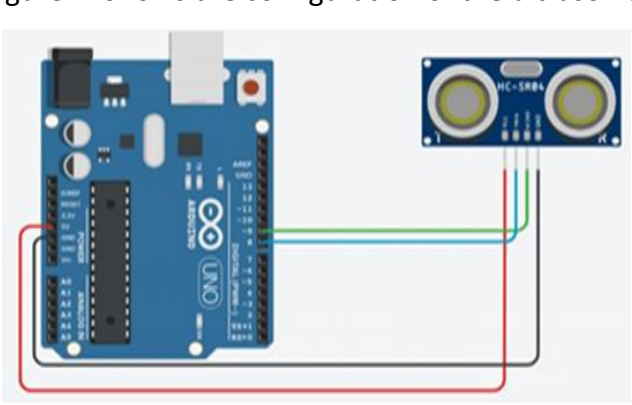



Figure 7. Shows the configuration of the ultrasonic sensor.



(**a**)

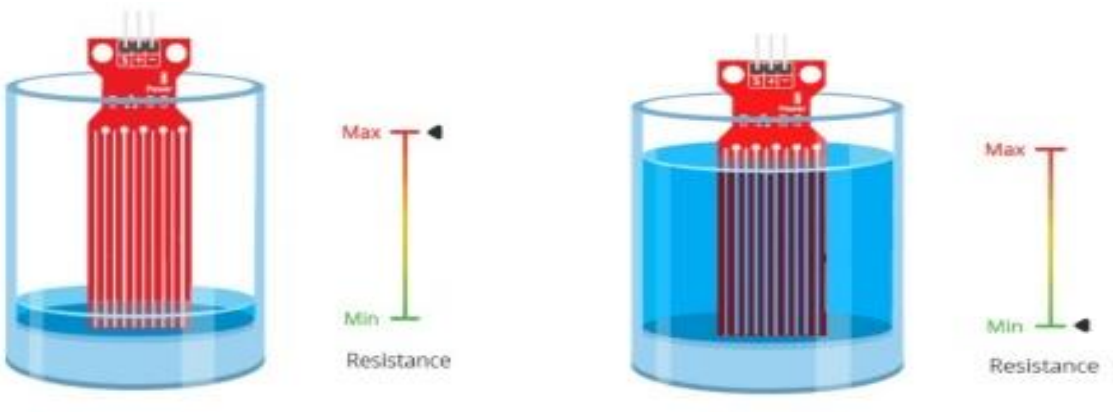
```
void loop()
{
  digitalWrite(trig,LOW);
  delayMicroseconds(2);
  digitalWrite(trig,HIGH);
  delayMicroseconds(10);
  digitalWrite(trig,LOW);
  distance = pulseIn(echo,HIGH);
  distance1 = distance/58.2;

  Serial.print("Altra Sonc ...");
  Serial.print("     ");
  Serial.print(distance1);
  Serial.println("  cm");

  if (distance1 < 50)
  {
    digitalWrite(pazzer,HIGH);
    digitalWrite(green_led,HIGH);
    digitalWrite(pley_Adio,HIGH);

  }
  else
  {
    digitalWrite(green_led,LOW);
    digitalWrite(pazzer,LOW);
```

(**b**)

Figure 8. A method of connecting the ultrasonic sensor to the Arduino chip. (a) The block diagram of the electric circuit; (b) Software code.

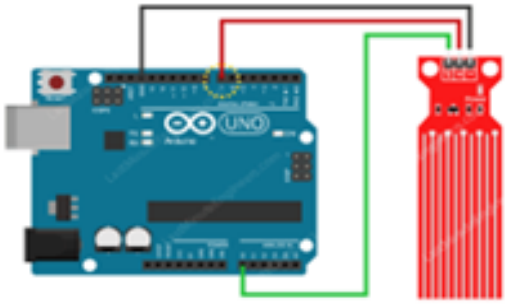
3.5. Water Level Sensor

The water level sensor as shown in Figure 9, is a device used to detect the water level inside tanks. It is recommended to power the sensor from 3.3V to 5V. Please keep in mind that the analog output will vary depending on the voltage supplied to the sensor.




(**a**) (**b**)

Figure 9. Shows the configuration of the water level sensor. (a) minimum water level sensor; (b) maximum water level sensor.



(**a**)

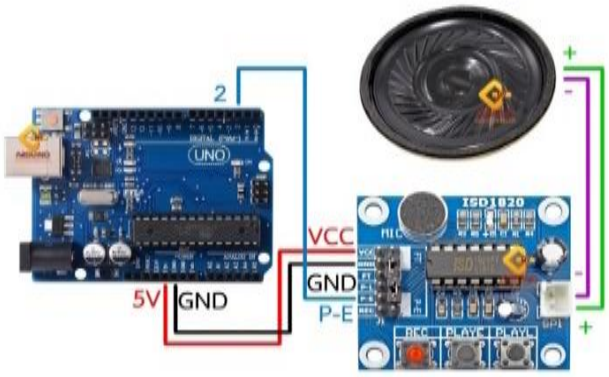
```
void levelsensor()
{
  int x = 0 ;
  x = digitalRead(wotersensor);
  if (x > 0)
  {
    digitalWrite(pazzer,HIGH);
    digitalWrite(blow_led,HIGH);
    digitalWrite(pley_Adio,HIGH);

  }
  else
  {
    digitalWrite(blow_led,LOW);
    digitalWrite(pley_Adio,LOW);

  }
```

(**b**)

Figure 10. A method of connecting the water level sensor to the Arduino chip. (a) The block diagram of the electric circuit; (b) Software code.

3.6. Sound Recording Module (LSD1820)

The sound recording module as shown in Figure 11, is a device that records audio clips. It is triggered when a pulse is given and transmitted to the loudspeaker using signals or frequencies outside the sound group. The desired sound can be recorded, and all or a small part of the sound can be output using the speaker.




(**a**)

```
void setup()
{
  pinMode(PE, OUTPUT);
}

void loop()
{
  int PE = 2;
  digitalWrite (PE , HGIH);
  delay (500);
  digitalWrite (PE , LOW);
  delay (500);
}
```

(**b**)

Figure 11. A method of connecting the sound recording module to the Arduino chip. (a) The block diagram of the electric circuit; (b) Software code.

## 4. Discussion

Figure 12 shows the experimental setup circuit for a navigation system for the blind and visually impaired, consisting of an Arduino control unit with GPS, an ultrasonic sensor, batteries, and a battery charger adapter. The experimental results of the proposed control system showed good stability and better network performance of the proposed navigation system.

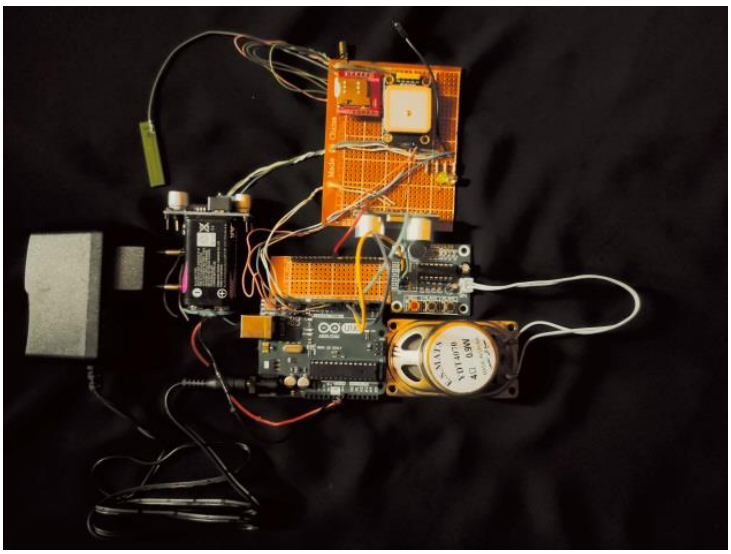


Figure 12. Shows the experimental setup circuit for a navigation system for the blind and visually impaired.

Figure 13 represents the duty cycle versus output power regulation characteristics of a new prototype navigation system for the blind and visually impaired under the symmetrical fixed-frequency PWM control strategy. Figure 13 shows the validation of the experimental results, which were very consistent with the simulation results using the Arduino controller.

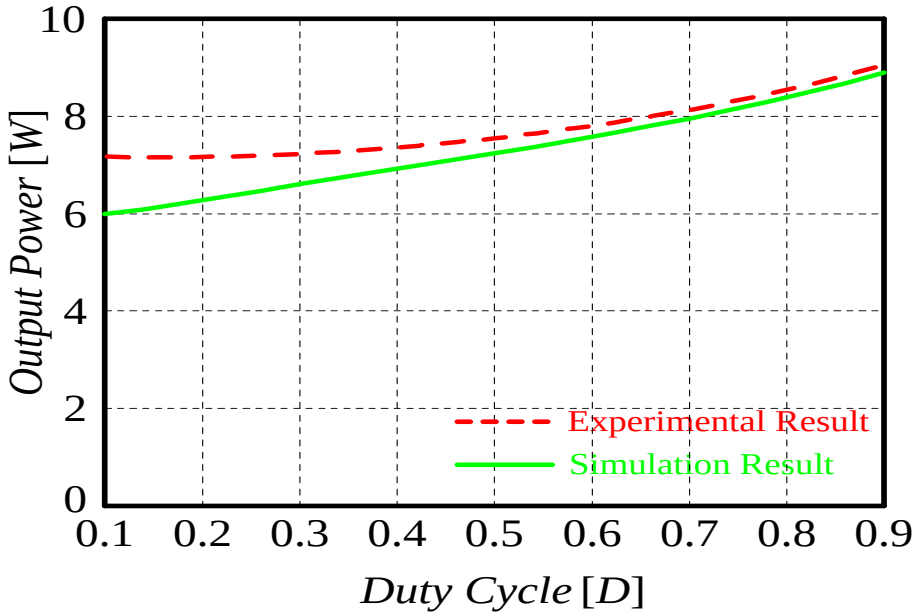



Figure 13. Duty factor vs. input power and peak voltage characteristics.

In this research, a low-cost, very easy-to-use, as accurate as possible navigation system was developed that helps blind people navigate around camps and cities. This is done by developing the white stick by designing an electronic circuit consisting of an Arduino microcontroller. We have used an ultrasonic sensor to detect obstacles instead of a white stick, but it provides the blind with ultrasonic vibrations that it feels under its hand when it hits a specific obstacle in its path. It can also detect obstacles in all directions at a distance of five meters. The ends of this stick are made of lead. It is equipped with a water sensor that provides attention through a buzzer for an alert, and to be able to distinguish between an ultrasonic sensor alarm and a water sensor, we used the LSD1820 to hear a recorded sound of an obstacle in front of it and used the buzzer with the water sensor to give a ring alarm so that it could distinguish between both sensors. And because the safety of every blind person is important to us, we have added a tracking device for the blind which is GPS and Subscriber Identity Module (SIM). So that in the

event of his absence for a long time, any family member can send a message to the stick to determine his location. If a blind person needs assistance, the wand enables him to send an SMS text message to a phone number previously registered in the wand system of a relative using GSM. This message contains his current location, which is determined using GPS. Satisfactory results were obtained after trying the stick, as the blind man became able to avoid obstacles while walking by following the voice directions until he reached the desired destination safely.

**Appendix A**

Table 1. List of Abbreviations.

| Acronyms | Description |
|---|---|
| GPS | Global Positioning System |
| GSM | Global System Mobile |
| SIM | Subscriber Identity Module |
| GNSS | Global Navigation Satellite Systems |
| SMS | Short Message Service |

**References**

koley, S. & Mishra, R. (2012). Voice-operated outdoor navigation system for visually impaired persons. *International Journal of Engineering Trends and Technology*, *3*(2), 153-157. https://ijettjournal.org/archive/ijett-v3i2p217

Ameer H. Morad, (2010). GPS talking for blind people. *Journal of Emerging Technologies in Web Intelligence*, *2*(3), 239-243. https://doi:10.4304/jetwi.2.3.239-243

Moulton, B., Chaczko, Z. & Pradhan, G. (2009). Voice operated guidance systems for vision impaired people: investigating a user-centered open-source model. *International Journal of Digital Content Technology and its Applications*, *3*(4), 60-68. http://hdl.handle.net/10453/10592

Loomis, J. M., Golledge, R. G. & Klatzky, R. L. (2001). GPS-based navigation systems for the visually impaired. *In: Barfield, W. & Caudell, T. eds Fundamentals of wearable computers and augmented reality. Mahwah, NJ: Lawrence Erlbaum Associates*, 429-446. https://psycnet.apa.org/record/2001-16260-013

Borenstein, J. (1997). A computerized travel aide for the active guidance of blind pedestrians. *Proceedings of the IEEE International Conference on Robotics and Automation, Albuquerque*, NM, Apr. 21-27, 1283-1288.

*مقال*

## الملخص العربي

### دليل التنقل للمكفوفين وضعاف البصر باستخدام نظام تحديد المواقع العالمي (GPS)

هيدرا صليب*، محمد حسن، فاطمة إسماعيل، أماني حسن، رشا قاسم

قسم الكهرباء، كلية التكنولوجيا والتعليم، جامعة سوهاج، سوهاج 82524، مصر
*المؤلف المختص: hedra_mahfouz@techedu.sohag.edu.eg

يمثل المكفوفين وضعاف البصر شريحة خاصة من المجتمع حيث يعانون من عدم الاستقلالية خاصة في الحركة، وذلك لوجود العديد من المعوقات حيث يجدون صعوبة في التعرف على الأشياء في طريقهم. لحل هذه المشكلة يلجأ المكفوفون وضعاف البصر إلى استخدام العصا البيضاء التي تسمح لهم بإدراك البيئة المحيطة ضمن الحدود التي تصل إليها العصا. الهدف من هذا المشروع هو تطوير العصا البيضاء وجعلها أكثر فاعلية ومنح المكفوفين وضعاف البصر المزيد من الاستقلالية في حريتهم في الحركة. في هذا المشروع، تم تطوير عصا ذكية باستخدام شريحة (Arduino) لمساعدتهم من خلال تحديد الموقع الحالي لحاملها في حالة غيابه لفترة طويلة باستخدام نظام تحديد الموقع العالمي (GPS). أما عملية تجنب العوائق فتتم باستخدام أجهزة الاستشعار فوق الصوتية (Ultrasonic)، ويتم تنبيه المكفوفين من خلال مقاطع صوتية لمساعدتهم على التنقل واختيار المسار المناسب. يمكن للمكفوفين أيضًا إرسال موقعه الحالي في رسالة نصية إلى رقم هاتف محدد خاص بأحد أقاربه في حالة احتياجهم إلى مساعدة باستخدام النظام العالمي للاتصالات المتنقلة (GSM). أخيرًا، تم التحقق من صحة الهيكل المقترح تجريبيًا من خلال نتائج العمل التجريبي الذي تم الحصول عليه من النموذج الأولي الذي تم بناؤه وتنفيذه في مختبرنا.

**الكلمات الأساسية**: المكفوفين وضعاف البصر، أنظمة الملاحة، نظام تحديد المواقع العالمي (GPS)، النظام العالمي للهاتف المحمول (GSM).