**TELKOMNIKA Telecommunication Computing Electronics and Control**
Vol. 22, No. 1, February 2024, pp. 175~181
ISSN: 1693-6930, DOI: 10.12928/TELKOMNIKA.v22i1.24972 

# Smart stick for blind people with wireless emergency notification

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**Article Info**

***Article history:***

Received Jan 17, 2023
Revised Oct 5, 2023
Accepted Oct 13, 2023

***Keywords:***

Arduino Nano
Gyroscope sensor
Smart stick
Ultrasonic sensors
Wireless

**ABSTRACT**

This effort develops and uses a smart stick to help blind individuals walk more safely and avoid hazards. This research paper involved to develop smart stick for blind people to help them to walk safely by avoiding obstructions, and at emergency conditions sent their location to person in charge like a doctor or relatives to help them accordingly. Three ultrasonic sensors are used in the proposed device's architecture to detect obstructions at three different heights, low, mid, and high obstructions using speaker to alert the blind person. An emergency message with the location of the blind person's phone is sent through a mobile app to the doctor or person in charge whenever the designed smart stick's emergency button is touched, or the stick is dropped down. The Arduino Uno platform, Bluetooth model, MPU-6050 3-axis gyroscope as a position sensor, and microSd card module has been used to effectively implement the stick. At the testing stage, the device gave good results. The user received notifications in the form of voice messages and vibrations from the smart stick when it detects things or obstacles in front of them. Additionally, even though they cannot directly activate it, the automated emergency condition has been detection and activated.



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## 1. INTRODUCTION

Blind people have difficulty interacting with their environment and feeling their environment, they have little contact with the environment, since sight is the most important part of human physiology, 83% of the information humans get from the environment is through sight. According to the World Health Organization, more than 40 million people worldwide are blind and another 250 million suffer from some form of visual impairment and, due to age-related diseases such as glaucoma and diabetes, these figures are in an increase [1]–[4]. Today, blind people use a white cane or a relative to help them detect objects while walking. As technology advances every day, we could use these technologies to help blind people by using a smart stick to easily detect obstacles.

In the past, the majority of blind people used dogs and sticks to navigate. The white cane's drawback is that information is only obtained by touching the items at the end of the stick. In order to solve the difficulties associated with using a stick, researchers have developed smart devices. These systems use infrared or ultrasonic sensors to detect various boundaries and vibrate to alert the user [5]–[7].

The suggested system in this research consists of Arduino, ultrasonic sensors, position sensor, Bluetooth module, and feedback is received via a speaker. Arduino is a microcontroller that can do every one of the estimations fastly and rapidly with incredible exactness [8], [9]. The ultrasonic sensor is utilized to distinguish the item toward the front of the individual by estimating the distance between the article and the stick. A position sensor is a device used for determining the linear or angular position of the stick. The speaker will help the visually impaired individual to hear how far an object is in front of him. In addition, the system is embedded with a Bluetooth module that sends a signal to the mobile app whenever there is an emergency condition which is activated either by pressing a button on the stick or with the position sensor [10]–[12]. The main oobjectives in this research paper are designing a smart stick using an Arduino Nano platform, ultrasonic sensors, position sensor, speaker, and Bluetooth module with a mobile app for an emergency condition, the second objective is implementing this design of smart stick that can find the distances with obstacles, detect objects in front, and track the blind's location in an emergency condition [13]–[18].

## 2. METHODOLOGY

Figure 1 shows the block diagram of smart stick system, this system includes three ultrasonic sensors. All these sensors are located in different direction and the purpose of these sensors is used to detect the obstacles (up, mid, down) and measure the distance by Arduino Nano platform according to the mathematical calculation explained in Figure 2. In this smart stick, all three sensors are located in front of the stick, but they are positioned and angled differently (Figure 2). The ultrasonic high is located at the top of the stick to detect objects that are high to the blind person. The ultrasonic middle is located at the middle of the stick to detect objects that are in the middle to the blind person and the ultrasonic low is located at the bottom of the stick to detect objects that are low to the blind person. Also, a speaker is used to alert the blind person. In addition, the stick also has an emergency button, whenever the button has been pushed or the position sensor detects that the stick is fallen a signal is sent through Bluetooth to the relative person in charge mobile app, and then the location is sent from the mobile app to the person in charge.

Figure 3 demonstrates the circuit design and the connection of the pins for each built-in component. The components in the figure are ultrasonic sensors [19], [20], Arduino Nano [21], [22] , Bluetooth module [23], MPU-6050 3-axis gyroscope and accelerometer [24], [25] as a position sensor, microSd card module, and battery. All of the power voltage common collector (VCC) and ground pins of the ultrasonic sensors are connected to +5 volt and ground pin on the Arduino. Each ultrasonic sensor has a trig and echo pin, the trig and echo for the ultrasonic high are connected to the D2 and D3 on the Arduino. For ultrasonic mid trig and echo are connected to D4 and D5 and for ultrasonic low, the trig and echo pins are connected to D6 and D7. The Bluetooth model has four pins which are VCC, ground, transmitting data pin (TXD), and receiving data pin (RXD). Both VCC and ground pins are connected to +5 volt and ground pins of Arduino, The TXD is connected to the RXD of the Arduino Nano, and RXD is connected to the TXD of the Arduino. For the the MPU-6050 3-axis gyroscope and accelerometer (position sensor), four pins are used, VCC and ground are connected to Arduino's VCC and ground, and serial clock (SCL) pin is connected to A5 of Arduino Nano, while serial data (SDA) pin is connected to A4 of Arduino Nano. The microSd module has 6 pins two of them is VCC and ground while chip select (CS), master out slave in (MOSI), master in slave out (MISO), and serial clock (SCK) pins are connected to D8, D9, D11, D12 of Arduino Nano respectively . The speaker has two pins and connected to Arduino. Lastly, the battery has two pins which are positive and negative, The positive is connected to the Vin on the Arduino and the negative is connected to the ground.

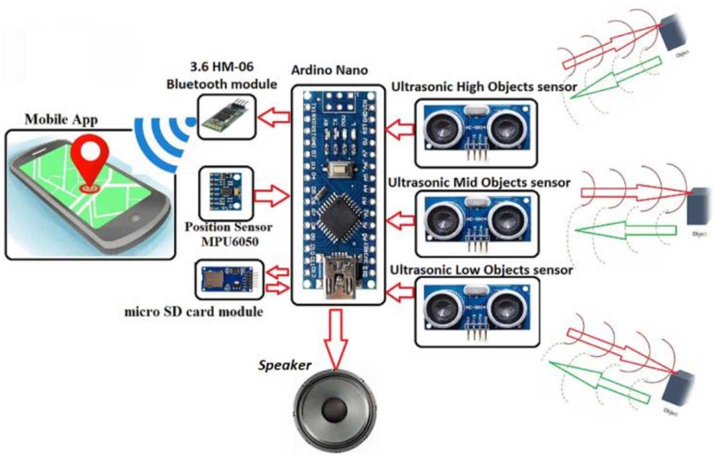


Figure 1. Block diagram of system

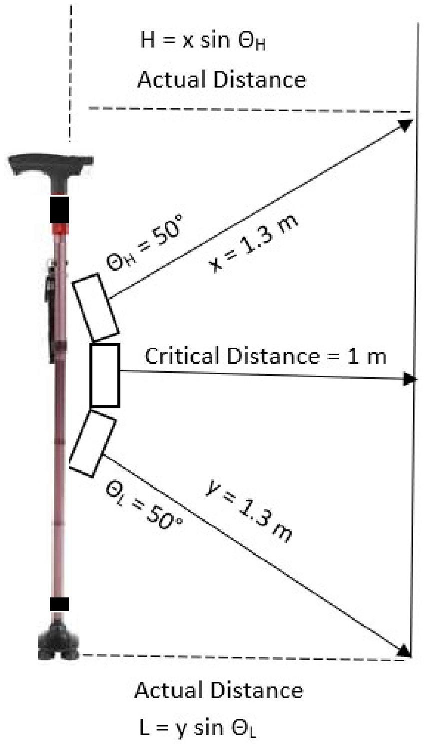


Figure 2. The circuit design and the pins connection of the system

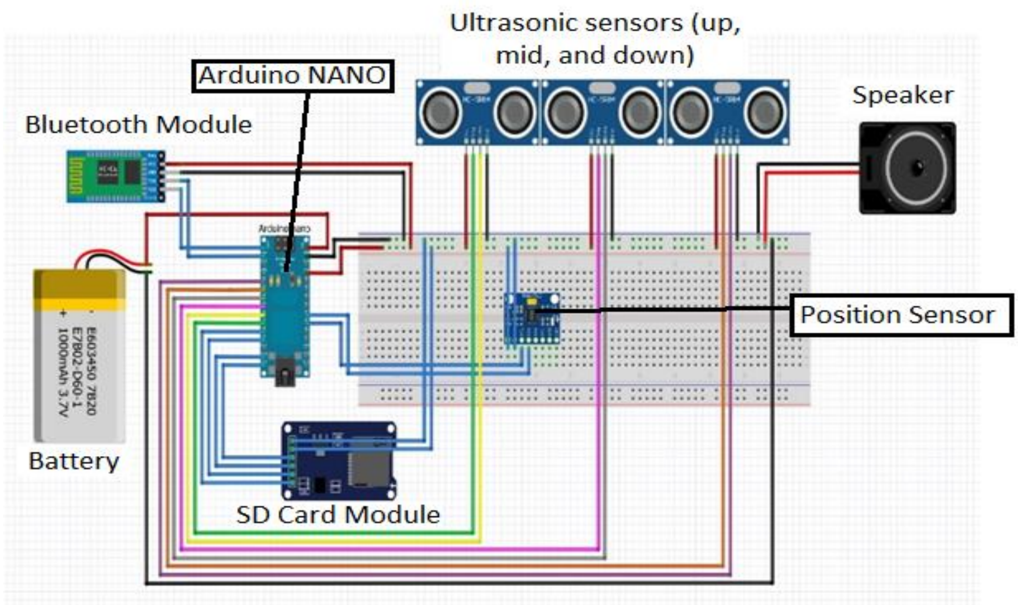


Figure 3. The circuit design and the pins connection of the system

Figure 4 shows the flowchart diagram, first, and after the system is ON, it checks the emergency condition by a push button or by position sensor, if the condition is yes then it will send the location from the mobile app to the emergency contact. If the condition is no it will start detecting an object, first the higher sensor checks for any object, then the middle sensor checks for an object, and finally the lower sensor checks for an object. Whenever any object is found by the sensors that are less than the threshold the speaker will alert the blind people of the distance of the object.

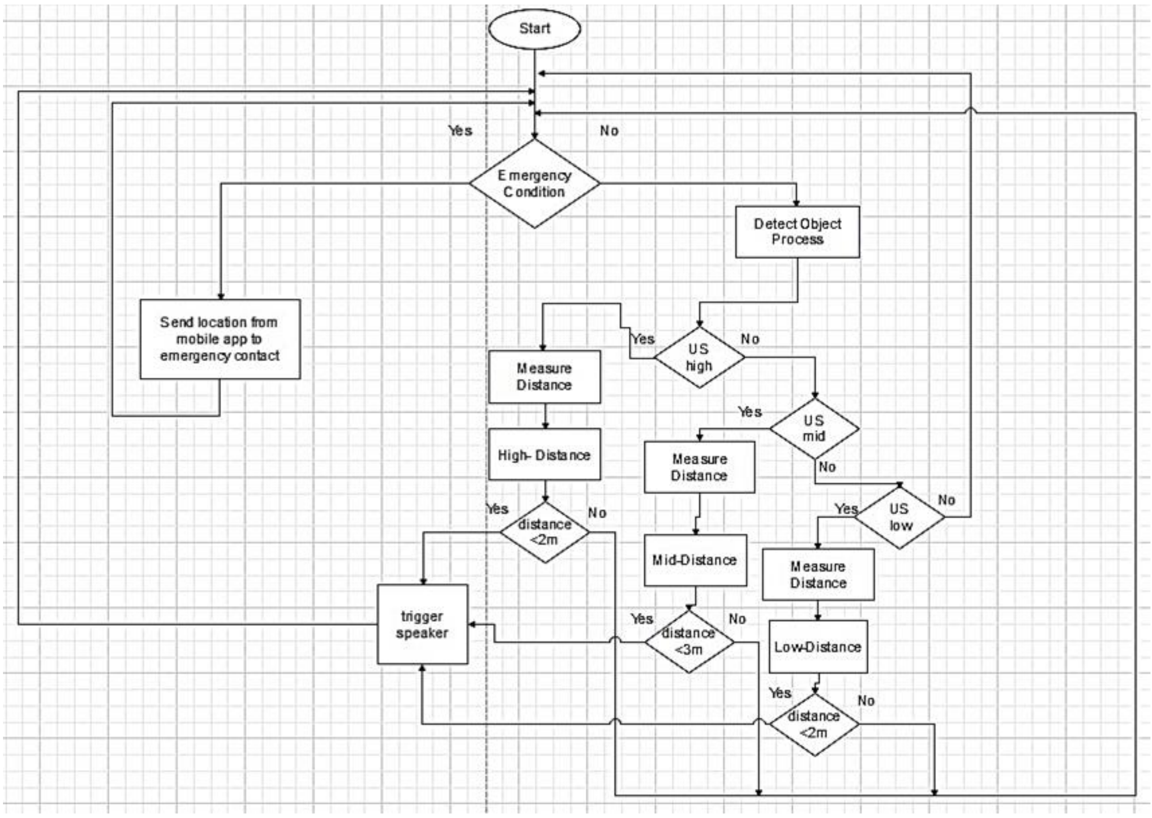


Figure 4. Flowchart of smart stick system

## 3. RESULTS AND DISCUSSION

Figures 5 illustrates the complete prototype. The master box is attached to the top of the stick, while the sensors box is attached to the bottom of the master box. The three sensors mounted on the sensors box have the task of detecting obstacles at their distances and levels. High and low sensors are placed in an inclined position at 50° to allow the sensors to detect obstacles at high and low levels. In addition, the system also sends emergency messages to the person in charge.

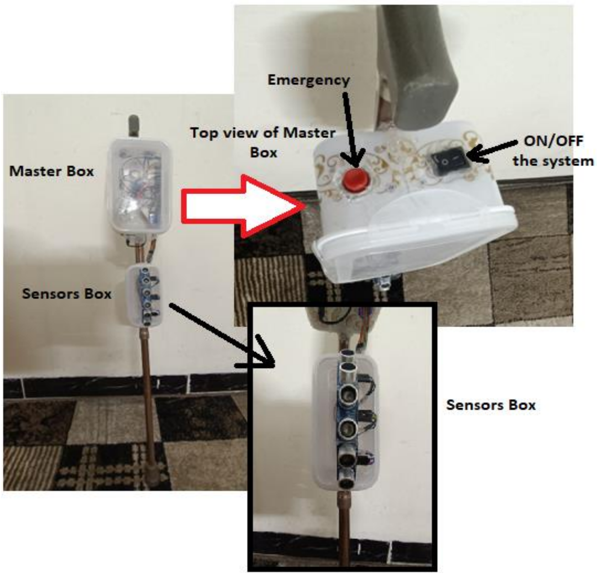


Figure 5. Prototype of smart stick system

When an emergency occurs, the user can push the emergency button, and a signal is sent to the smart stick app with a Bluetooth module. Arduino helps to transmit emergency signals with Bluetooth in case of an emergency. This section is placed on the top of the master box, and the user uses it. This makes pressing the emergency button easy for the user. As illustrated in Table 1, each sensor detects obstacles using a different range of distances. the range of the high and mid sensors is 100 cm while the low sensor is 70 cm to avoid detecting ground. As a result, any obstacle within that range will be identified. Audio output can be produced depending on the range set in the coding. Table 2 is a small part of testing the accuracy of the ultrasonic sensors, the testing is done more than what is shown in the table. The average error is -1 which makes the system accurate.

Table 1. Sensors range

| Sensor | Max distance measured |
|---|---|
| High | 1 cm–100 cm |
| Middle | 1 cm–100 cm |
| Low | 1 cm–70cm |

Table 2. System distance testing

| No | Measured distance (cm) | Sensors detected distance (cm) | Error (cm) |
|---|---|---|---|
| 1 | 1 | 1 | 0 |
| 2 | 5 | 4 | -1 |
| 3 | 15 | 14 | -1 |
| 4 | 25 | 25 | 0 |
| 5 | 35 | 33 | -1 |
| 6 | 45 | 44 | -1 |
| 7 | 55 | 53 | -2 |
| 8 | 65 | 64 | -1 |
| 9 | 75 | 74 | -1 |
| 10 | 85 | 83 | -2 |
| | Average error | | -1 |

Blind people may experience a variety of difficulties in an unfamiliar environment, or they may experience an emergency condition 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 smart stick application is used to connect to the mobile app through Bluetooth module and the app mobile interfacing shown in Figure 6. As a result, the system is tested as the user roams in an open space. Figure 7 illustrates a message received by the person in charge when the emergency button is pressed. The message contains a short message such as "EMERGENCY PLEASE HELP" and a link to the user's location to alert the person in charge. Latitude and longitude are shown in Figure 8.


Figure 6. Smart stick app

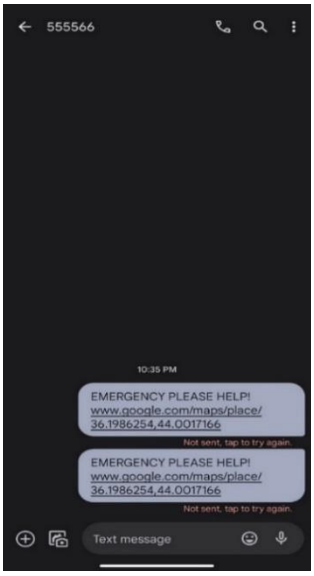


Figure 7. Message/emergency

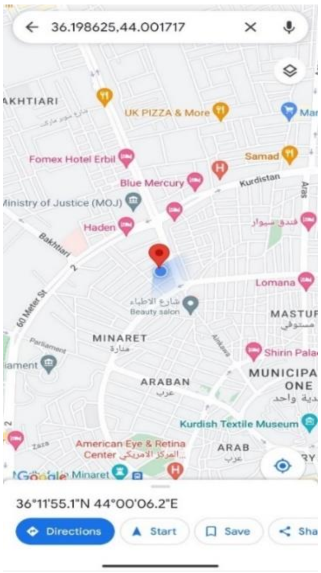


Figure 8. Location detects

## 4. CONCLUSION

The most accurate smart walking stick will enable blind individuals to move from one location to another without the assistance of others. It can also be viewed as a rudimentary method of granting blind people a sense of sight. The use of this stick lessens the visually impaired person's reliance on other family members and friends while out and about. The suggested integration of multiple functional components produces a real-time system that tracks the user's location and offers feedback, enhancing the security and safety of navigation. The smart stick detects objects or obstacles in front of the user and sends back alerts, in the form of voice messages rather than vibrations. Also, the automatic emergency condition detection in the stick will be useful while they can not activate it manually. The advantage of the system lies in the fact that it can be an affordable solution for a lot of blind people worldwide.

## ACKNOWLEDGEMENTS

Author thanks Tishk International University. In most cases, sponsor, and financial support acknowledgments.

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