International Journal of Education, Science, Technology and Engineering

Original Research Paper

Smart Cane based on IoT

Faiz Bin Abdul Ghani[1], and Asnazulfadhli bin Zariman[1]

[1] *Department of Computing, Faculty of Arts, Computing and Creative Industry, Universiti Pendidikan Sultan Idris, Malaysia.*

Article history
Received:
13.03.2019

Revised:
11.04.2019

Accepted:
30.05.2019

*Corresponding Author:
Faiz Bin Abdul Ghani
Email:
faizsmart99@gmail.com

Abstract: Generally, blind people use a traditional cane (known as white cane) for moving from one place to another. Although, white cane is the international symbol of blindness, it could not help them to detect place and to avoid obstacles. In this paper, we represent a model of walking stick for blind people. It consists of GPS module, GPS Antenna, Arduino, ultrasonic sensor and buzzer. This stick can detect place and obstacles. Position detection part is done with GPS module and GPS antenna. Ultrasonic sensor is used for detecting obstacles. Here, the buzzer produces two types of sound. When the blind reaches to his destination, buzzer buzzes continuously. When the blind faces any obstacles, buzzer buzzes with interruption. By discovering these two types of sound, blind can be confirmed about his destination and also can avoid obstacles in front of him. The whole system is designed to be small, light and is used in conjunction with the white cane so that it could ensure safety of the blind.

Abstrak: Umumnya, orang buta menggunakan tongkat tradisional (dikenali sebagai tongkat putih) untuk bergerak dari satu tempat ke tempat lain. Walaupun, tongkat putih adalah simbol kebutaan antarabangsa, ia tidak dapat membantu mereka untuk mengesan tempat dan untuk mengelakkan rintangan. Dalam makalah ini, kita mewakili model tongkat untuk orang buta. Ia terdiri daripada modul GPS, Antena GPS, Arduino, sensor ultrasonik dan buzzer. Tongkat ini dapat mengesan tempat dan halangan. Bahagian pengesanan kedudukan dilakukan dengan modul GPS dan antena GPS. Sensor ultrasonik digunakan untuk mengesan rintangan. Di sini, buzzer menghasilkan dua jenis bunyi. Apabila orang buta sampai ke destinasinya, buzzer berbunyi terus menerus. Apabila orang buta menghadapi sebarang halangan, buzzer berhembus dengan gangguan. Dengan bantuan kedua-dua jenis bunyi, orang buta boleh disahkan mengenai tujuannya dan juga boleh mengelakkan rintangan di hadapannya. Keseluruhan sistem ini direka dalam saiz yang kecil, ringan dan digunakan bersama tongkat putih sehingga dapat memastikan keselamatan orang buta.

Keyword: Arduino, Buzzer, GPS Antenna, GPS Module, IoT, GSM.

1. Introduction

Visually impaired persons have difficulty to interact and feel their environment. Physical movement is a challenge for visually impaired persons, because it can become tricky to distinguish where he is, and how to get where he wants to go from one place to another. To navigate unknown place, a visually impaired person needs to bring a sighted family member or friend for support [1]. Over half of the legally blind people in the world are unemployed because limited on the types of jobs they can do. They are relying on their families for mobility and financial support.

Their mobility opposes them from interacting with people and social activities. In the past different systems are designed with limitations without a solid understanding of the non-visual perception. Some of the systems are only for indoor navigations and has no hurdle detection and determining location feature in outdoor environment. Researchers have spent the decades to develop an intelligent and smart stick to assist and alert visually impaired persons from obstacles and give information about their location.

Over the last decades, research has been conducted for new devices to design a good and reliable system for visually impaired persons to detect obstacles and warn them at danger places [2]. There are some systems which has some deficiencies.

A Navbelt was developed by [3], an obstacle avoidance wearable portable computer which is only for indoor navigation. Navbelt was equipped with two modes, in the first one the system information was translated to audio in different sounds. One sound for free for travel direction and other for blocked, it was difficult for the person to differentiate the sounds. Other problem was the system would not know the user momentary position. Further, a stick for distance measurement using infrared sensors, have introduced by [4] which is a complex and time-wasting process. The stick has different vibration modes for different ranges which is difficult for a blind to differentiate, it needs time for training. The stick informs the person clearly at dangerous stage which conveys less information and safety. The stick has no location and positioning features. Another research, [5] proposed an interactive guide system for indoor positioning, which can't detect the obstacles and hurdles. The system is not suitable for the outdoor activities. Further, in a research by [6] developed a design to provide its user location-based services, for instances navigational guidance which connect to a personal digital assistant with Bluetooth headphones and it was called iCane. Another research that developed by [7] built a prototype of a stick, called a Radio Frequency Identification Walking Stick.

In paper [8] only focus on the Differential Global Position System (DGPS). Further the papers [9] [10] offer visual SLAM techniques to address the problem of visual impaired persons. This project aims to design and implement of an intelligent and cheap stick with Global Positioning System (GPS) for the visually impaired peoples, which will detect the obstacle and hurdle in the path and also determine the position and location through GPS coordinates.

2. Smart Cane

Smart Cane has been generated through a problem statement has been identified. The problem statement that has been identified here is through the stick that I use. This is what I come up with because of the fact that in the present time the blind people in Malaysia can be said to be the majority, so I have this opportunity to create useful objects for the blind. This will make the blind easier to walk by telling the barrier with a distance of 1m. In addition, in a time full of this sophisticated technology I thought of putting GPS with GSM to tell the guard or parents where the blind was.

With the existence of Smart Cane this can help solve the problem faced by the blind. This is because it helps the blind to walk by telling the distance. In addition, this can also be help blind people tell where they are via GPS.

Communication with the user is an observation conducted on 10 Sample people close their eyes are mostly made up of students of the University of Education Sultan Idris (UPSI). Through their joint communication, it was found that This Smart Cane is appropriate and stipulated with the objective, purpose, function, problem statement, scope and module as stated. Most of them think that Smart Cane is has the potential to go further and explore more deeply.

Among the constraints that arise in the implementation of Smart Cane are design constraints with various sensors providing slow feedback. Therefore, Smart Cane needs to be measured to measure the maximum angle of detecting the barrier. In addition, the constraints arising during the implementation of Smart Cane are when items obtained easily damaged.

Therefore, this should be done with caution. At the same time, GPS component problems are damaged. In addition, measuring the distance between obstacles is a constraint until it starts with 0.5m, 1.0m, 1.5m, 2.0m, 2.5m, 3.0m. In addition, constraints arising after the implementation of Smart Cane are weaknesses that cannot be affected by water. This tool cannot be affected because components in Cane Smart are very sensitive and easily damaged. So, it is necessary to create a prototype for Smart Cane.

The rational for Smart Cane is expected to make the system on time coming soon can be improved especially in terms of prototype design and can be adopted by the parties concerned especially for the blind. It is also expected that implementation of this tool can be completed and repaired at a time come in.

Implementation of Smart Cane is to facilitate parties which creates job opportunities with these tools generates income and facilitates the blind to buy them through direct parents or guardians in certain stores such as pharmacy safer to make it easy to refer back. These tools also make it easier for blind people to walk and know the distance between user and user-friendly.

Smart Cane has two modules of the first, this Smart Cane module developed is intended to facilitate the users especially blind people to walk easily and also tell where the location of the blind is. It's also will help generate revenue for this Smart Cane developer opening career and potential opportunities to a higher level. These tools enable blind people to know the distance between the obstacles and also tell the location where they are. For example, blind people walk around and hear buzzer sounds so blind people know from distance 1m there are obstacles and also in the event of anxiety the blind will push the button the emergency to tell where it is.

At the same time, GSM helps to send messages in the form of coordinates so the guard or parents will push the message and will continue to Google Maps. In addition, the second module is to help developers get increase income and can sell through online and directly. This book is developed because of the thoughtful ideas need to be shared and released into reality for the benefit of the blind.

The target audience for Smart Cane is a blind person in general. This is because they can facilitate the journey of the blind. The number of users, especially the blind is limited as they have visual impairment and Malaysian citizens.

3. Designing Process

The second stage is designing process. Smart Cane was designed via the IOT Design Methodology. Through this method, the information collected has been successfully developed by comparing with regular sticks. In addition, diagrams such as Chart Diagrams and Case Diagram Use have been designed to ease the development of this IOT to ensure that the development process is more organized and runs smoothly. Through the build process, the coding that has been used to make this IOT is C ++. This code was also created using a software called Arduino IDE. In this phase also, Smart Cane starts construction by recycling items. Lastly, after IOT is ready to run and Smart Cane is fully built, IOT can finally be used. Then tested whether ultrasonic and motor at Smart Cane can be accessed via phone via GPS with GSM.

The propose system design of the smart stick, as shown in Figure 1.

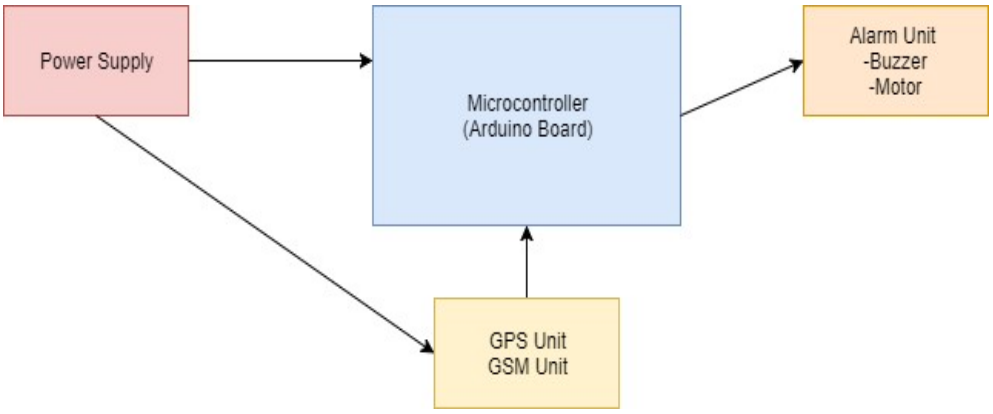

Figure 1. System Architecture

The Arduino integrated system keeps the person informed about the obstacles lying ahead. Such aid gives user more knowledge about the environment and enables them to make decisions much more quickly, thus allowing them to move around more confidently and effectively. The cane may be used in the nearby environment may be in a park, at work, at home, and while a long journey. The designed assisted device helps a visionless person to anticipate the surrounding using the sensor and vibrations

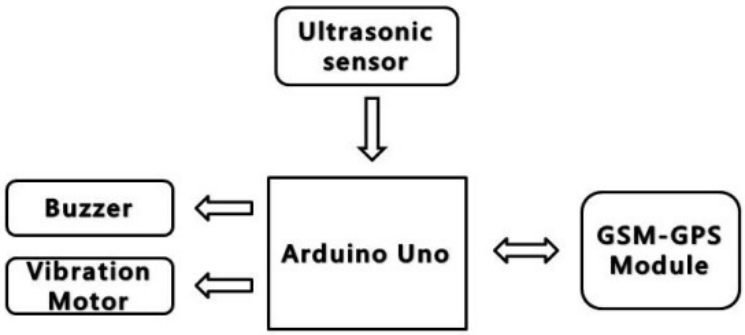

Figure 2. Function of Smart Cane

3.1. Ultrasonic Sensor Module

Ultrasonic sensor is used, as, it is less affected by target materials or by colour, it is capable of detecting objects within a range of 4 meter. These ultrasonic sensors are designed to resist external disturbances such as vibration, infrared radiation, ambient noise, and EMI radiation. The sensor used is a SRF-04. It requires a short trigger pulse and it provides an echo pulse. Ultrasonic waves are emitted from the module and bounce back when hits an objects and obstructions in the path of the user. The output of the sensor provides change in voltage with respect to the distance of the obstacle. Also potholes can be detected using this system.

3.2. Adruino Uno R3 Microcontroller

Arduino can control the environment by receiving input signals (Digital/Analog) and can effects its surroundings by controlling lights, relays and other devices. The microcontroller on the board is programmed using Arduino software.

The control sub-system consists of an Arduino Board having an ATMEGA328P microcontroller merged in it. Arduino is an open-source single board microcontroller, heir of the open-source Wiring platform, thus helping in designing electronics projects easily. The hardware consists of a simple open hardware design for the Arduino board with an Atmel AVR processor and on-board input/output support. The software consists of a standard programming language compiler and the boot loader that runs on the board. The sensor output is provided to an Arduino which calculates the distance based on the program. The obtained value is compared with the fixed value and a vibratory pattern of different intensities is generated.

3.3. Vibrator Motor

A vibration motor is used in the system design, which vibrates with three different intensities depending on the distance from the obstacle. If the obstacle is very near then intensity of the vibration will be very high. Intensity of the motor decreases as the distance of the obstacle increases. A vibrator motor is included to enhance the overall feedback for the person who receives the warning against obstacles closeness in different formats of vibrations.

3.4. Buzzer

A low frequency piezo buzzer is used to indicate that the obstacle is very close to the person and there might be a chance of collision. A buzzer is used along with the vibration motor as an alerting the user in crowded areas. A transducer (converts electrical energy into mechanical energy) that typically operates a buzzer is in the lower portion of the audible frequency range of 20 Hz to 20 kHz. This is accomplished by converting an electric, oscillating signal in the audible range, into mechanical

energy, in the form of audible waves. Buzzer is used in this research to warn the blind person against obstacle by generating sound proportional to distance from obstacle

3.5. GSM-GPS Modem

It provides reliable positioning, navigation, and timing services to civilian users on a continuous world basis freely available to all. For anyone with GPS receiver, the system will provide location with time. The GPS based blind device with user input interfacing get alert the blind person when reaches his destination by voice.

When the GSM modem receives a message, the microcontroller will process the message with the keyword saved in it. Then, it will get the location of the stick from the GPS modem and transmit the location to the GSM modem in order to respond to the sender. In case of an emergency, the user of the stick can press the emergency button the microcontroller to access the location from the GPS modem and transmit the location to the GSM modem which will send a SMS messages to the saved number in the system.

4. Implementation

In this research, development and implementation Smart Cane was built using C++ coding. These codes have been built with using software like Arduino IDE.

The device that alerts the user to obstacles in their path is the vibration motor. The motor is housed in the cane, and is connected to the Arduino. The Arduino analyzes data from the ultrasonic sensor, and it is this data that is sent to the vibration motor in the form of a corresponding PWM duty cycle. Depending on the number of pulses, the vibration motor receives varying amounts of power, which causes the vibration motor to spin at differing speeds. These speeds very discretely instead of continuously, so that a given range of distances will correspond to one vibration intensity. Additionally, each distance will also correspond to a certain delay between vibrations, with greater distances having greater delays.

The obstacle detection circuit consists of an ultrasonic sensor interfaced to the Arduino Uno Board. The sensor detects the presence of obstacles in each direction and then the range of the barrier is calculated. If the distance is within <100cm then the vibration of the motor will vibrate with the highest intensity and also the buzzer will be switched on. If the distance above of 100cm then the vibration motor intensity will be less.

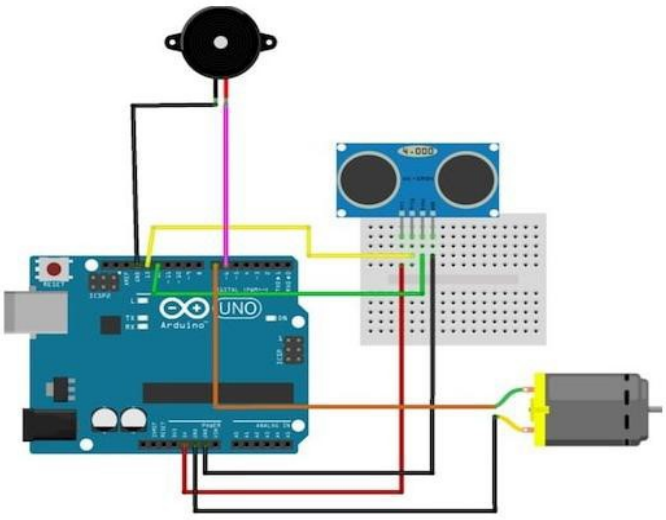

Figure 3. Interfacing the Arduino

The pothole detection system consists of an ultrasonic sensor and a buzzer interfaced with the Arduino Uno. The working of this circuit is based on the assumption that the height of the ultrasonic sensor mounted on the stick will remain constant in case of a plain path. But if there occurs any

noticeable increase in its height from the ground above a certain threshold level then the buzzer will start buzzing. This will help the visually impaired person in detecting a pothole or a staircase ahead.

The GSM_GPS module is used in emergency situation. This module receives the information from the GPS satellite in NMEA format and transfers the latitude and longitude information as SMS message to a predefined mobile number in case of emergency.

Arduino Interface shown in Figure 3 while the GPS-GSM Module shown in Figure 4

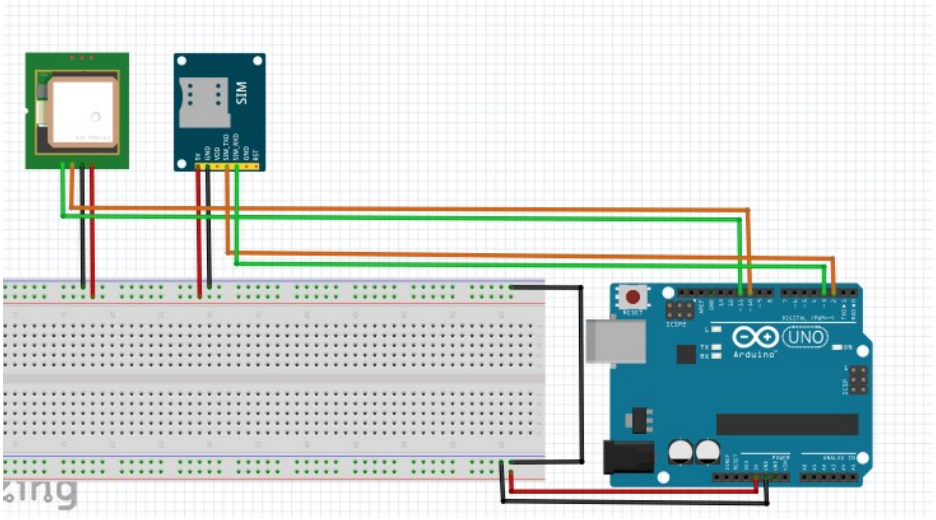

Figure 4. GPS-GSM Module

5. Testing

At this stage, information gathering has been implemented with Determine a certain distance by measuring the measuring tape from 0.5m, 1.0m, 1.5m, 2.0m, 2.5m, 3.0m.

Smart Cane is nearing its goal and aims at the development of this IOT. The blind can push the switch to bring the world to life. Blind people need to guide the stick to detect. At the same time, ultrasonic with motor. Blind people can also tell their location on GPS with GSM. This IOT improves its function primarily in security. GPS will provide coordinates and at the same time GSM serves to send sms to guardians or parents in coordinates.

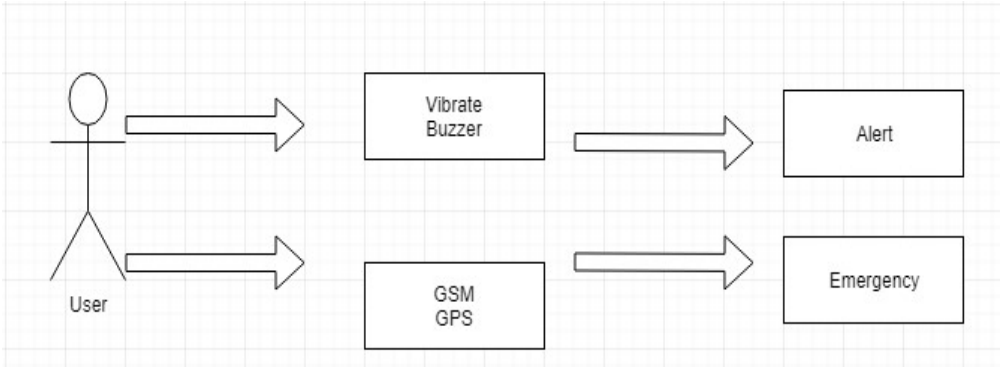

Figure 5. Use Case

The Smart Cane Project has the first 2 modules, modules for distortion between barriers and sound and vibrations. Second, the module uses GPS with GSM to monitor the blind from harm. IOT has been developed to help the blind to be able to use anywhere and anytime with Smart Cane.

Based on the analysis and results of the research, it shows that most respondents are completely satisfied with this system as it really helps the blind as well as not worrying about guards or parents

on behalf of the blind. In line with the technological developments in the world, this IOT system is beneficial to humans.

5.1. Strength

Some of the strengths that can be seen in this research, namely:

1. Can prevent obstacles at a distance of 1m up to 3m
2. Tells the location where the blind is located
3. Reduces the fears of guardians or parents of the blind.

5.2. Weakness

The system has weaknesses, such as:

1. This material cannot be affected by water
2. The fall will result in compound damage

6. Conclusion

This paper discusses walking sticks for blind and visually impaired. This wood can help its users to be verified about their destination as well as to avoid any front obstacles in the way they walk. Work procedures and system limitations are also discussed.

With the proposed architecture, if built most accurately, the blind will be able to move from one place to another without the help of others, leading to increased autonomy for the blind.

Built-in smart wood incorporated with a variety of sensors will help navigate the roads while walking and worrying about people if there is any sign of danger or difficulty being detected. The developed prototype provides good results in detecting obstacles at distance in front of the user; it will be a real blessing to the blind.

At the same time the global positioning system (GPS) can be connected with a balloon for navigation, so that people can know the current position and distance from the destination that will be notified to the user through voice commands.

References

[1] M. Pinto. (2017). Smart Cane for Visually Impaired. American Journal of Intelligent Systems, Vol. 7 No. 3. pp. 73-76. DOI: 10.5923/j.ajis.20170703.07.

[2] Sung Jae Kang. (2001). Development of an Intelligent Guide-Stick for the Blind, Proceeding of the IEEE international Conference on Robotics & Automation.

[3] S. Shoval, J. Borenstein, Y. Koren. (1994). Mobile robot obstacle avoid anceina computerized travel aid for the blind, *Proceeding softheI EEE International Conference on Robotics and Automation*, May 1994.

[4] S. Innet, N. Ritnoom. (2008). An Application of Infrared Sensors for Electronic White Stick. *International Symposium on Intelligent Signal Processing and Communication Systems*, Bangkok, Thailand.

[5] J. Na. (2006). The blind interactive guide system using RFID based indoor positioning system, Lecture Notesin Computer Science, Springer Publications, Vol. 4061, pp.1298-1305.

[6] Tsung-Hsiang Chang, Chien-Ju Ho. (2018). *i*Cane – A Partner for the Visually Impaired, National Taiwan university.

[7] Saaid, M.F.; Ismail, I.; Noor, M.Z.H. (2009). Radio frequency identification walking stick (RFIWS): A device for the blind. *In Proceedings of the IEEE 5th International Colloquium on Signal Processing & Its Applications*, Kuala Lumpur, Malaysia, 6–8 March. pp. 250–253.

[8] Madad A. Shah, Sayed H. Abbas, Shahzad A. Malik. (2010). The Performance Evaluation of DGPS Data Correction Links in Dynamic Environments, Australian Journal of Basic and Applied Science, 4(6): 1449-1458.

[9] J. M. Sáez, F. Escolano, and A. Peñalver. (2005). First steps towards stereo- based 6DOF SLAM for the visually impaired, in *IEEE Conf. on Computer Vision and Pattern Recognition* (CVPR), San Diego, USA.

[10] V. Pradep, G. Medioni, and J. Weiland. (2010). Robot Vision for the Visually impaired in CVAV110, in IEEE *International Conference on Computer Vision and Pattern Recognition* (CVPR), San Francisco, CA, USA.