International Journal of Research in Engineering, Science and Management
Volume-3, Issue-7, July-2020
journals.resaim.com/ijresm | ISSN (Online): 2581-5792

Design of an Audio Aid for Indoor Navigation for the Blind

Priyanka Koli[1], Alfiya Mukadam[2], Monika Rathod[3*], Santosh Tamboli[4]
[1,2,3]*Student, Department of Information Technology, Vidyalankar Institute of Techology, Mumbai, India*
[4]*Professor, Department of Information Technology, Vidyalankar Institute of Techology, Mumbai, India*
*Corresponding author: monika311099@gmail.com

***Abstract*: In this paper, we present a smart glass for visually impaired people to overcome their traveling difficulties. It can detect obstacles using ultrasonic distance sensor. It is also able to track the position of an individual in an indoor environment for this the college campus is considered. It tends to bring innovation in the way a disabled person travels independently. The visually impaired have difficulties in accessing various facilities. it is not easy for disabled person manoeuvre to the different location, due to the discriminatory manner buildings were built. Visually impaired people would have to faced difficulties while finding bus stops, which causes inconvenience for people with impaired vision, walking impairment. Sometime impaired people don't get the proper location and they might reach somewhere else. This android system will help disabled people to find them way on their own just by speaking up on the phone. This android application asks for the desired place where the person wants to reach and navigate by speech to the person. If the student is visually impaired the map can save all details about the college and guide the student by navigating to reach till college, classroom floor, library, etc.**

***Keywords*: Google App Engine modules, Google API, Ultrasonic sensor, NodeMCU, Smart glass, Visual impairment.**

1. Introduction

From last few years the number of visually impaired people is growing. According to the World Health Organization (WHO) report, 253 million people are visually impaired. Among them, 36 million peoples are completely blind and 217 million peoples have low to moderate vision impairment [1]. We present a unique design of smart glasses for visually impaired people that can be used to perform multiple tasks with in the very low cost. The device can easily guide visually impaired people and be able to give proper direction. This application is specially designed for the visually impaired person. visually impaired people would face difficulties in finding bus stops and stations because not every bus stops and stations have guiding tracts. Traveling or navigating/walking in a crowded street can be challenging. Because of this, many visually impaired peoples will prefer to travel with a sighted friend or family member when they are navigating unfamiliar places. This application will help blind people to navigate. They can also store the place where they visit daily. For example, if the visually impaired person is a student then he/she would save the college map. The person can find various part of the college like canteen, library, etc. this application speaks to navigate the visually disabled person.

2. Indoor Navigation Technologies

There are various technologies and techniques used for navigating through indoor spaces. Description and comparison amongst them can be done for choosing the best one for our use case [2].

A. RFID

Indoor positioning using RFID [Radio Frequency Identification] has been selected as one of the indoor wireless location technologies, and it has rapid development. Advantages of RFID technology are for positioning, such as light weight, low cost and identification of multiple tags. RFID indoor positioning systems contain two main components: 1. Transponder (attached to objects/people) 2. A reader. In a passive RFID system, the power source is the Locator node [3]. Locator node transfers radio- frequency energy to the transponder at a short distance known as remote-coupling. Then the Locator node captures ID and data from the transponder and forward the data for processing. Complexity increases while installing the tags because installation of tags everywhere is practically not feasible. The tags can also get damaged or corrupted, hence fixing them is the time consuming and tedious process. There is one more barrier for implementing RFID for indoor navigation systems is transmission power of tags.

B. Beacons

Indoor navigation with beacons has some advantages for projects that are obsessed to high accuracy and wish to incorporate with Apple devices. Indoor navigation with beacons when utilized in every procedure which is client based, such as airline passengers who provide an accuracy up to 1 meter and are using an app-based platform [4]. Tracking of persons or goods which are server based (beacon tracking) could even be realized using appropriate receiver hardware for example Cisco, infsoft Locator Node. To establish such a system, the beacon is connected to the asset which needs to be tracked by the person or to be carried out to be located. While tracking with well-established Bluetooth Low Energy i.e.

Bluetooth 4.0, accuracy of some meters is offered by beacons, the new Bluetooth 5.1 standard gives some new perspectives of accuracy within the range. However, beacons incur huge costs.

C. *Bluetooth (IEEE 802.15)*

Bluetooth works in the 2.4-GHz ISM band. The gross bit rate is lower up to 1 Mbps than WLAN, also the range is shorter than WLAN typically 10–15 m. Bluetooth is a "lighter" standard. Also, it is a highly ubiquitous i.e. embedded in phones, personal digital assistants known as PDAs and supports several networking services in addition to IP. Bluetooth tags are transceivers of small sizes. As any Bluetooth device, each tag consists of a unique ID. This ID is useful for getting the location of the Bluetooth tag. Example of a Bluetooth tag is the Blue Tags tag. In small scale systems of locations, Bluetooth technology is used, such as in warehouses or in single rooms. Biggest advantage of Bluetooth indoor positioning technology is the small size device and easy to integrate the PC, PDA and mobile phones, so it is easy to popularize [4].

D. *Ultra-Wideband*

There are some advantages in the industrial environment of Indoor navigation with Ultra-wide bands. 1. The accuracy is 10-30 cm, which is considerably better than working with Wi-Fi (5- 15 meters) or beacons (1-3 meters). 2. Height differences can be measured accurately. 3. Latency time is very low (position request up to 100 times/second). Infsoft Locator Tags are required for the client-based installation. Transmission of their position takes place directly to the smartphone - either via Bluetooth or via a USB dongle which is directly plugged into the smartphone. There is an app installed on the smartphone which contains a digital map for determining and displaying the current position. However, this technique requires appropriate components and is the best solution and thus it is the most suitable for special industry applications. Compared to UWB, Wi-Fi or BLE, this is costly.

E. *Augmented Reality*

Augmented Reality [AR] is a rapidly expanding market, in demand from entertainment apps and games to custom business solutions. Now, AR indoor navigation is in high demand but still the current state of technology is far from perfection. Beacon technology is used in the known indoor navigation solutions and only leverage Augmented Reality is used for visualizing routes. But Augmented Reality is also useful for gaining more accurate data related to the user's position [5]. For now, robust mobile apps having maps and built-in GPS are used to determine outdoor positioning and used for outdoor navigation. In day-to-day life many smartphone owners regularly use such navigation apps as part of their routine. But still the situation is not well developed and more complicated when it comes to indoor navigation, such as the location of the particular classroom in the college, finding what floor a user is positioned on.

F. *Google API*

The Maps API is helpful for gaining data about places and accurate locations. Google API makes it easy for the user to access the maps. It returns the data about longitude/latitude location, or return data about an address

3. Proposed System

The proposed model comprises ultrasonic sensors mounted on spectacle along with an earpiece and NodeMCU [6]. Three ultrasonic sensors are placed on the left side, front side and right side of the wearable device for obstacle detection [7]. In this way, an obstacle can be detected from three sides. When an obstacle comes near to the blind within the range of 5 meters, the sensors measure the obstacle distance and send the value to the microcontroller NodeMCU.

The android application is developed using Android Studio with JAVA as a programming language. Proposed system is accessed by one entity namely, User. The User needs to speak the desired place. If the place is fed in the application, then it starts navigating it. If the place is new the system searches and navigates the place and helps the user to reach the desired destination. Users can also come to know the depth details about the particular place.

The application becomes friendly with new users as well as old ones. It helps explorers who visit new places. It provides navigation details and helps to reach the destination. As this application uses speech to text, visually challenged people can also make use of the application.

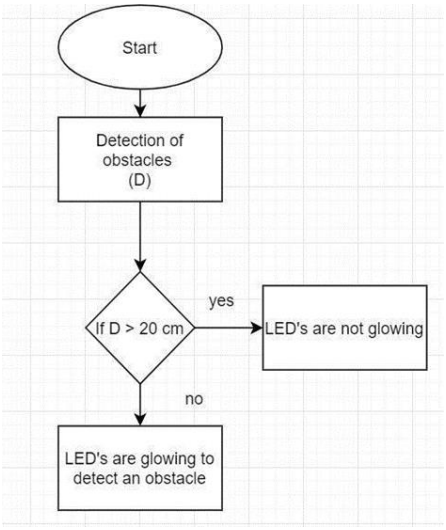

Fig. 1. Hardware model workflow

A. *Proposed features of the system*

Load Balancing: Since the system will be available only the admin logs, the load on servers will be limited to some amount of period of admin access.

Easy Accessibility: Records or information can be easily accessed when required and can store other information respectively.

User Friendly: The application will be giving a very user friendly approach for all users.

Efficient and reliable: Maintaining all databases over servers and information will be accessing according user requirement without any maintenance cost, it will be more easy and efficient as compared to manually storing all the users or customers data on the in physically in the record books.

4. System Design

In hardware design, we use three ultrasonic sensors mounted on the wearable device along with three LED's which are connected to NodeMCU. The NodeMCU is powered by an external battery and the communication takes place using air as a medium using the ESP8266 Wi-Fi module connected using a local internet connection.

In software design, we have designed an android application which is installed on the user's mobile phone. This android application is supplied with navigation information using Google API. It also provides an indoor navigation inside the college campus using a custom defined map of the college's internal structure.

A. Hardware Design

Ultrasonic sensors are used for detection of obstacles which occur in a way, LED to glow as per the direction of the obstacle, a central processing unit comprising of NodeMCU which takes the information from the sensor about the obstacle distance and processes the information according to the coding done and sends the output through the LED, power supply is given to central processing unit and which distributes the power to components which connected to system. The ultrasonic sensors are used because ultrasound is a strong point, the energy consumption of slow waves propagating in the medium relatively far distance [7]. Therefore, often it is used to measure the distance over a big length. At the same time, ultrasounds are used to detects object in the dark, dust, smoke, electromagnetic interference, toxic and other harsh environments. It has a certain ability to adapt, with a wide range of application. As shown in Figure 1, the ultrasonic sensors check whether the reflecting distance is greater than 20 cm or not, if no then LED's glow to indicate an obstacle.

B. Software Design

The Project application is loaded in Android Studio [8]. We used Android Studio for Design and coding of the project. We used SQL Server for create and maintain all databases, in that we create tables and stored record of project. We used SQL Server for create and maintain all databases as shown in Figure 2, the application interacts with Google API for getting location information which is updated frequently.

The user feeds in the desired location in a speech format which is then converted into text by the application and is then processed to give instructions to the user for navigation for both outdoor and indoor (custom defined college campus) spaces.

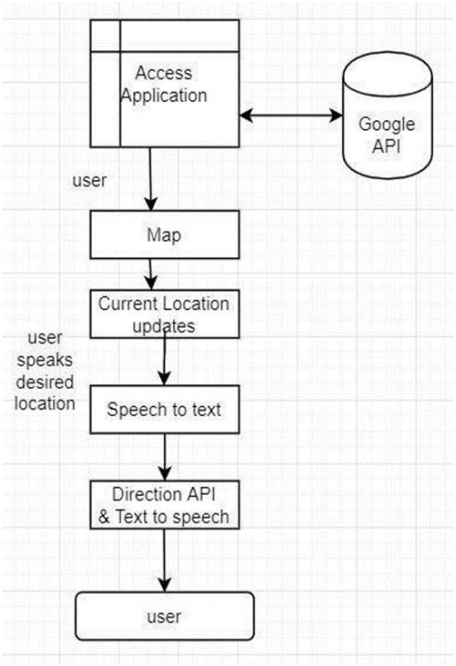

Fig. 2. Software model workflow

- *Map:* It updates the current location; User will speak the desired location. If the location is already saved then it will navigate the person, but if the new location it goes to google place API. System then reply to location details and call Direction API and navigate user. If the user reaches its destination, then it speaks about the place and asks for more detail of the place.
- *Speech to Text:* User based speech is converted to text by the application and sent to the Google API for processing.
- *Text to Speech:* Application speaks up the place details and navigation.
- *Places Search:* User could simply search for places around them and get the details from the application. We have tested both the modules rigorously; the obstacle detection module detects the obstacles perfectly. While the application module is efficient and user-friendly.

5. Result

We have tested both the modules rigorously; the obstacle detection module detects the obstacles perfectly. While the application module is efficient and user friendly. For demonstration purposes the application is incorporated with a "Mocking facility", which enables the testing of the working of the application.

6. Conclusion

This paper presents a unique smart wearable device for visually impaired users, which can help them to travel anytime avoiding any kinds of obstacle indoor and outdoor environment. Our proposed device is more comfortable and less expensive. User friendly Ultrasonic sensors are used in this device because

they are small in size, light in weight, and require less power consumption. Although our proposed model responds quickly, it cannot detect the ground level object. Future research work will include (I) making the wireless system and (II) implementing image recognition to get the information of obstacles.

References

[1] M. R. Miah and M. S. Hussain, "A Unique Smart Eye Glass for Visually Impaired People," 2018 International Conference on Advancement in Electrical and Electronic Engineering (ICAEEE), Gazipur, Bangladesh, 2018, pp. 1-4.

[2] T. Moder, C. R. Reitbauer, K. M. D. Wisiol, R. Wilfinger and M. Wieser, "An Indoor Positioning and Navigation Application for Visually Impaired People Using Public Transport," 2018 International Conference on Indoor Positioning and Indoor Navigation (IPIN), Nantes, 2018, pp. 1-7.

[3] F. De Cillis et al., "Hybrid Indoor Positioning System for First Responders," in IEEE Transactions on Systems, Man, and Cybernetics: Systems, vol. 50, no. 2, pp. 468-479, Feb. 2020.

[4] A. Satan, "Bluetooth-based indoor navigation mobile system," 2018 19th International Carpathian Control Conference (ICCC), Szilvasvarad, 2018, pp. 332-337.

[5] G. Gerstweiler, "Guiding People in Complex Indoor Environments Using Augmented Reality," 2018 IEEE Conference on Virtual Reality and 3D User Interfaces (VR), Reutlingen, 2018, pp. 801-802.

[6] S. Sunitha, “Distance Measurement using Ultrasonic Sensor and NodeMCU,” International Research Journal of Engineering and Technology, vol. 4, no. 6, pp. 1794-1797, June 2017.

[7] R. Agarwal et al., "Low cost ultrasonic smart glasses for blind," 2017 8th IEEE Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON), Vancouver, BC, 2017, pp. 210-213.

[8] M. C. Pérez et al., "Android application for indoor positioning of mobile devices using ultrasonic signals," 2016 International Conference on Indoor Positioning and Indoor Navigation (IPIN), Alcala de Henares, 2016, pp. 1-7.