MOBILE BASED NAVIGATION SYSTEM FOR BLIND

Prof. Supriya S. Thombre#1, Prof. Smita R. Kapse#2, Prof. Nilima Jichkar#3, Prof. Preetee K. Karmore#4

#1-#3 Assistant Professor, Yeshwantrao Chavan College of Engineering, Nagpur, #4 Assistant Professor, Dr.Babasaheb Ambedkar College of Engineering & Research, Nagpur

Abstract: More than 285 million people in the world are visually impaired. They cannot move independently. They required some assistance for navigation. The proposed system helps them to navigate by their own. The system will detect the obstacle and it will generate the audio message for them about any obstacle. It will guide the visually impaired person for navigation.

IndexTerms - **Navigation, visually impaired, navigation using RFID tags, blind person, audio-based navigation system.**

I. INTRODUCTION

1.1 Overview

More than 285 million people in our world are visually impaired [1]. They cannot move independently without any external assistance. There are various systems available for outdoor navigation which works with the help of satellite signals. But these systems cannot be used for navigation in an indoor environment because of blockage of satellite signals. In this Chapter, we have introduced various flaws which are present in the existing indoor navigation systems like inaccuracy, cost, etc. [2]. To overcome these flaws, we have proposed a system which uses RFID technology for indoor navigation. The advantages, scope and goal of the proposed system is also explained in this Chapter.

Blind people always suffer in an unknown environment without any external or physical assistance. There are few existing systems or technologies designed which focuses on independent mobility of the blind or visually impaired people. These systems are very costly, difficult to operate, highly inaccurate and thus unsuitable for public use. Also, there is no availability of sales, marketing or servicing of existing systems in developing countries [2].

The proposed system is designed to overcome some flaws like an unaffordable cost and complex design in the existing system. The system focuses on a visually impaired persons who are usually out of the big company's scope of development ideas. The system can be easily installed, maintained and can be carried from one place to another easily. Moreover, it is a cost-effective system that can be afforded by a common man.

The proposed system focuses on independent mobility of a blind people who suffer in an unknown environment without any external or manual assistance. This system uses Radio Frequency Identification (RFID) to achieve an objective of identifying certain paths for user navigation. The proposed system on the user side includes an RFID reader module with an integrated micro-controller (Arduino Uno), RF trans-receiver for transmitting the tag's information. The server side includes RF trans-receiver for receiving the tag's information for wireless communication between the server and the user. RFID passive tag network is installed on the path for the path identification. The information regarding the directions associated with the Tag ID is stored in the database on the server. The RFID reader reads the tags and transmits the data wirelessly to the smartphone. These in turn scan the received Tag ID in the database and respond to the user through voice command. In this way, the user will navigate in indoor environments.

Table 1.1: Comparison with Existing Systems

Existing System	Concept	Limitation
Talking Signs	Network of transmitters installed on the walls (or poles) at strategic locations.	Large no. of transmitter units have to be installed which adds to a high setup cost.
Cricket Sensors in Indoor Localization	Ultrasound modules mounted on ceiling in regular intervals, it uses Sonar Technology to identify the position.	Although very efficient, it is very highly priced
Devices using Gyroscopic Compass	Use of compasses and gyroscopes and sensors to determine position and orientation of the user.	Affected by changes in environmental temperature, magnetic fields and it is Expensive.

II. LITERATURE SURVEY

Several techniques have been used to get the location of indoor environment such as radio signal triangularization, radio signal emitter or signal fingerprinting [5].

Amongst the existing technique, RFID technology is one of the new ways in tracking the location in indoor environments. RFID tag and RFID reader are the main component of the tracking system. Active and passive tags are the two types of RFID tag. The type of the RFID tag selected in tracking the location depends on the usage [6]. Active tag is used to read the distances of hundred feet and more. It may have other sensors that can use electricity for power. Because of its several advantages it is used for tracking the location [7] [8] [9] [10]. Active tag suffers the issue of battery replacement, installation, maintenance and per unit cost. Whereas passive tags are cost effective and easy to deploy so passive tag replaces an active tag [10] [8]. False negative, occur when a reader fails to read out a tag in its detection range. When an RFID tag reads by RFID Reader, the false negative may occur during tracking object. To handle false negative in the indoor RFID tracking system false negative algorithm has been used [11]. There are different techniques that can be used in RFID technology for finding the path to track the location. In [12], RFID tags are placed at landmark points of the walking route. Color sensor installed on the tip of a white cane senses the colored navigation line and the system informs the user through vibration, in this way system track the location. In above the user direction cannot be detected. To overcome this issue, Liu Jing and Po. Yang, author proposed the system that embeds the RFID tags into a footpath [13].

This RFID tag can be read by an RFID reader with cane antenna and track the location which uses a shortest path algorithm. For finding the shortest path, the Simultaneously Localization and Mapping (SLAM) localization algorithm is used [13].

Another method to track the position of RFID tag is Swift Communication Range Recognition (S-CRR). It tracks the position of RFID tags in very short time, but its disadvantage is that the mobile robots stop to search RFID tags accurately after some time. The System proposed by Emi Nakamori et al. used Continues Moving Communication Range Recognition (CM-CRR) to overcome the disadvantage of S-CRR [6]. Emi Nakamori used RFID technology without Wi-Fi, but there was a problem of multipath detection. This shortcoming was overcome by Chi-Yi Lin et al. [7]. In the proposed system by Chi-Yi Lin the RFID reader is mounted on the ground floor, staircase and first floor. The user carries an RFID tag and mobile phone. The RFID readers deployed in the building receive RF signals of the active RFID and then send the Receive Signal Strength Indication (RSSI) values to the positioning engine through Zigbee interface. It focuses on the capability of the seamless positioning handoffs between floors, but it needs to carry multiple devices to track the location. Another technique to track the location without carrying multiple devices is by using active tag and wireless sensor network. It uses two localization algorithms SA-LANDMARC and SA-SVR [8]. To overcome the disadvantages of active RFID tags such as battery replacement, cost, installation, etc. passive RFID tag was introduced. The first passive RFID tag-based system has been developed that is Kaman filter, aiming at estimating the RFID reader position based on instantaneous RSSI measurement received from the tag about reader [14].

There are several tag detection algorithms as described below:

2.1 Particle Filtering Method

Particle Filter (PF) method is used for tracking indoor RFID tag. The system uses a PF to combine RFID data from the RFID system and image data from the webcam or accurately identifying the position of the vehicle by using the particle filter method [15]. Particle filters represents a probability distribution over the state (location, scale, etc.) of the object being tracked as a set of weighted particles which represents a possible instantiation of the state of an object. Bayesian filtering equation is used for propagating weighted distribution through time which can determine the trajectory of the tracked object by taking the particle with the height weight or the weighted mean of the particle set at each time step. The set of particles contains more weight at locations where the object being tracked is more likely to be. [16].

2.2 Trilateration Positioning Method

This method is used to determine the position of the tag or reader using range information. In this, a new algorithmic approach for passive RFID localization in indoor environment is used. It is based on elliptical trilateration and fuzzy logic [18]. By using trilateration which is the determination of absolute or relative locations of measurement of distances, the three fixed points is needed to determine an indoor position. The distance between Access Points (Ap) & mobile device needs to be

calculated first which will help to provide an area of localization. Signal measurement techniques like a Received Signal Strength (RSS), Time of Arrival (ToA) of radio signals from transmitters or Time Difference of Arrival (TDoA) of several radio signals is used for providing the distance. It can also be provided by Triangulation method and by using measurement of arriving signal angle. The Wi-Fi trilateration method is used for indoor positioning and provides low accurate localization [20].

2.3 Real Time Location System (RTLS) Algorithm

The identification and tracking the location of objects within a building or other contained area is done in real time [21]. RTLS is more efficient than others as the numbers of iterations required are less, it also provides the security bonding, the guarantee of data packet delivery is given.

Real-Time Location Systems (RTLS) are used to track and identify the location of objects in real time using: "Nodes" or "tags" attached to, or embedded in the objects tracked, and "Readers" that receive and process the wireless signals from these tags to determine their locations.

RTLS systems may perform passive or active (automatic) collection of location information. A closely related term is "Intelligent Positioning System (IPS)" which continuously determines the position of an object in real-time in a given physical space. Many wireless technologies are used to establish the communication between tags and readers. Most popular ones include Wi-Fi, GPS, Infrared, Bluetooth, and active and passive RFID systems [22].

In this chapter, we discussed about the existing indoor navigation system. The detailed description of indoor navigation system using RFID technology is described in the following chapter.

III. WORK DONE

3.1 High Level Design

Figure 3.1 depicts the high-level design of the proposed system by six different blocks.

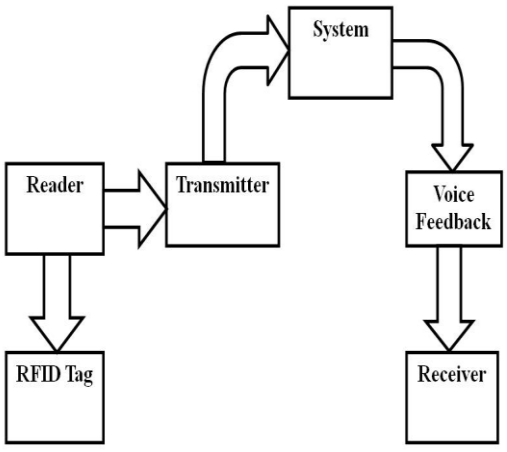

Fig 3.1: high level design of proposed system

3.1.1 Block 1: RFID Tag

An RFID tag comprises of a microchip. This microchip contains identifying information and an antenna that transmits the data wirelessly to an RFID reader. At the most basic, the chip will contain a serialized identifier or license plate number which will help to identify that item uniquely [5].

3.1.2 Block 2: RFID Reader

RFID Reader is also called as interrogators. They convert radio signals from the RFID tags into a form that is passed on to controllers, which understand those signals and make use of it. Fixed readers are set up to create a specific interrogation zone, which are tightly controlled. In order to communicate, RFID tags and readers have to be tuned to the same frequency. RFID system uses many different frequencies, but the most common and widely used RFID Reader frequency is 125 KHz. There are active or passive type of RFID reader, the type of reader we choose depends on the type of RFID Tag [5].

3.1.3 Block 3: Transmitter

This part of the system is to be mounted on navigating system. The goal of this element is to send signals, which is by RFID Reader to the server, which in return will give voice feedback to the user [5].

3.1.4 Block 4: System

It stores the database of registered RFID tags and its corresponding text message. It gives the voice command to the user according to the RFID tags detected by the RFID Reader [5].

3.1.5 Block 5: Voice Feedback

SAPI (Speech Application Programming Interface) is used to convert text message to speech command. This speech command is given to the user via the earphone or speaker to help him to reach his desired destination safely [5].

3.1.6 Block 6: Receiver

This is a device that the user will carry. The goal of this element is to catch the emitted signal from the transmitter. On receiving the signal, the device should send a voice signal so that the user knows that it is permissible to travel safely [5].

3.2 Modules

There are four modules in the proposed system. They are:

3.2.1 Module 1: Detecting the RFID tags

The very first step is to detect the RFID tag by the RFID Reader. These tags are installed in the path of the blind man. The RFID Reader is attached to the white cane/hand glove, which is being held by the blind man [28].

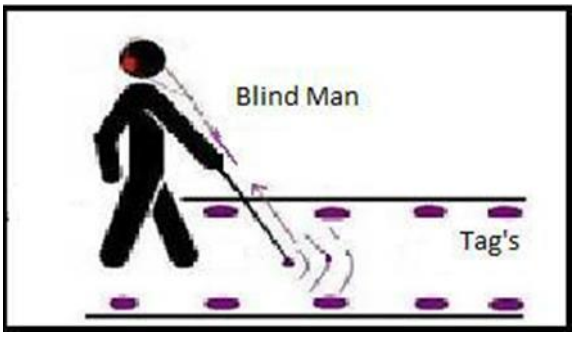

Fig 3.2: Detection of RFID Tag

In this module, the main components used are RFID Tags & RFID Reader

3.2.1.1 RFID Tags

An RFID tag comprises of a microchip. This microchip contains identifying information and an antenna that transmits the data wirelessly to an RFID reader. At the most basic, the chip will contain a serialized identifier or license plate number which will help to identify that uniquely [6]. There are varieties of RFID tags with a variety of capabilities. The key words include:

"Read-only" versus "read-write"

Data can be encoded on tags in three ways:

Read-only tags contain data such as a serialized tracking number, which is pre-written into them by the tag manufacturer. These are cheapest tags because they cannot have any additional information included. Any updates to that information would have to be maintained in the application software that tracks tag's movement and activity.

"Write once" tags enable a user to write data to the RFID tags only one time. This may include an identification number, etc.

Full "read-write" tags allow new data to be written to the RFID tags as needed and re-write over the original data.

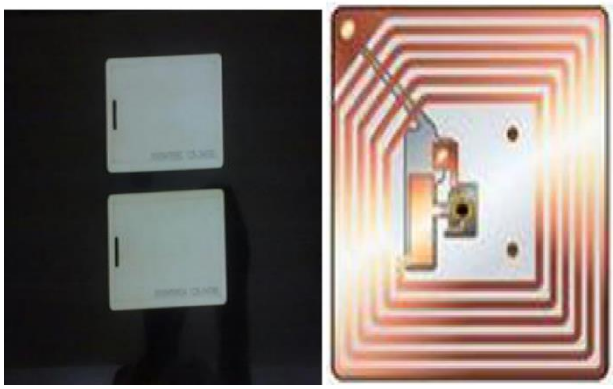

Fig 3.3: RFID Tags and its internal structure

3.3.1.2 RFID Reader

The reader is also called as interrogators. The RFID reader reads the tag ID information from RFID tags and transmits it to an RF transmitter. They convert radio signals from the RFID tags into a form that can be passed on to controllers, which can understand those signals and make use of it. The most common and widely used RFID reader frequency is 125 KHz. Reader functions [31]

Remotely power tags.

Establish a bidirectional data link.

Inventory tags, filter results communicate with networked server(s).

Can read 100-300 tags per second.

Readers (interrogators) can be at a fixed point such as Entrance/exit and at the point of sale.

Readers can also be mobile/handheld.

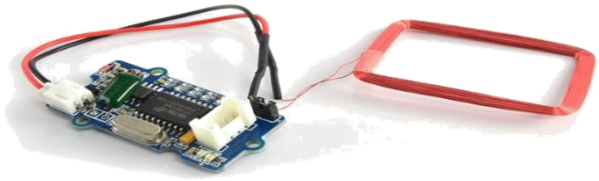

Fig 3.4: RFID Reader

3.2.2 Module 2: Transmitting RFID tag's ID through signals to the receiver

In this second module, the RFID tag which is read by the RFID reader is transmitted to the microcontroller (Arduino Uno).

3.2.2.1 Arduino Uno

Arduino is an open source microcontroller which can be easily programmed, erased and reprogrammed at any instant of time. Introduced in 2005 the Arduino platform was designed to provide an inexpensive and easy way for hobbyists, students and professionals to create devices that interact with their environment using sensors and actuators. Based on simple microcontroller boards, it is an open source computing platform that is used for constructing and programming electronic devices. It is also capable of acting as a mini computer just like other microcontrollers by taking inputs and controlling the outputs for a variety of electronics devices. It is also capable of receiving and sending information over the internet with the help of various Arduino shields, which are discussed in this paper. Arduino uses a hardware known as the Arduino development board and software for developing the code known as the Arduino IDE (Integrated Development Environment). Built up with the 8-bit Atmel AVR microcontroller's that are manufactured by Atmel or a 32-bit Atmel ARM, these microcontrollers can be programmed easily using the C or C++ language in the Arduino IDE. Unlike the other microcontroller boards in India, the Arduino boards entered the electronic market only a couple of years ago and were restricted to small scale projects only. People associated with electronics are now gradually coming up and accepting the role of Arduino for their own projects. This development board can also be used to burn (upload) a new code to the board by simply using a USB cable to upload. The Arduino IDE provides a simplified integrated platform which can run on regular personal computers and allows users to write programs for Arduino using C or C++.

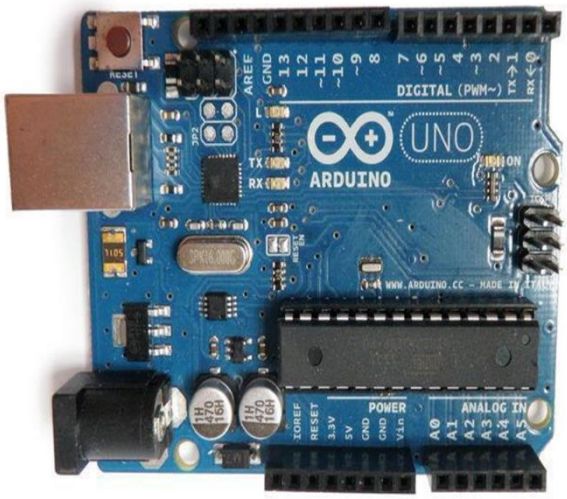

Fig 3.5: Circuit diagram for Arduino UNO.

3.2.3 Module 3: Receiving RFID tag's ID by nearest Receiver and pass on to the Smartphone

In this third module, the information corresponding to the detected tag is transmitted to the android smartphone via Bluetooth.

3.2.3.1 Bluetooth Module

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle.

Fig 3.6: Bluetooth module chip.

3.2.4 Module 4: Server provides voice feedback to the user

In this fourth module, the message received by the smartphone is heard by the visually impaired person as an audio message. The received text message is converted to audio via txt-to-speech functionality present in the mobile application.

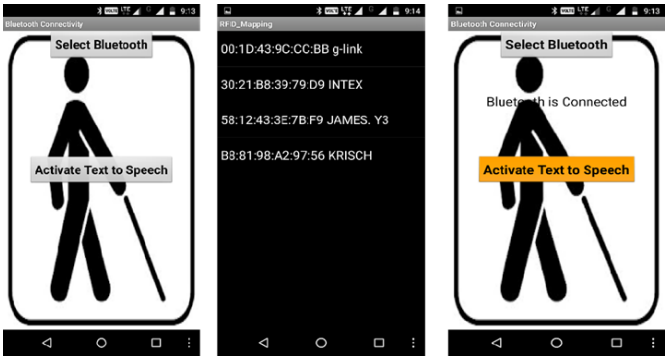

Fig 3.7: RFID Mapping Application.

3.3 Implementation

The figure below shows the implementation of how the blind person can navigate in the indoor environment without any external assistance [37].

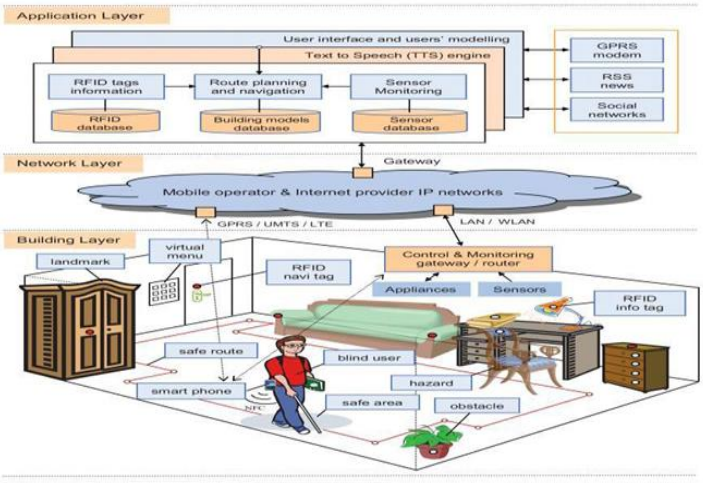

Figure 3.8: Blind Man Navigation in the Indoor Environment

The figure 3.8 shows an indoor environment that is a house on the path of which the RFID tags are mounted. There is a white cane/hand glove in the hand of the blind person. As shown in figure 3.9 on the hand glove is our RFID reader, which will read the RFID tag's ID. When a blind person enters the room with the cane/glove in his hand the RFID reader will read the tag's ID and accordingly there will be a voice feedback from the smartphone. The blind person will have earphones plugged in his ears. The tag's information is stored in our database. The blind person will get navigated as per the voice feedback. For voice feedback, Text-to-Speech functionality is used available in the application. The hardware is connected to the application via Bluetooth.

3.6 Result and Discussion

We have proposed the navigation system for indoor environments. The concept of RFID technology is being used to navigate blind people in indoor environments. The different location tracking algorithm has been discussed.

The proposed system on the user side includes an RFID reader module with an integrated microcontroller, RF transceiver for transmitting the tag's information. The server side includes Smartphone for receiving the tag's information for wireless communication between the smartphone and the user. RFID passive tag network is installed on the path for the path identification. Tag ID's are stored on the database. The RFID reader read the tags and transmits the data wirelessly to the smartphone. These in turn scan for the received tag ID in the database and respond to the user through voice command. The directions are heard by the visually impaired person as an audio message which guides him to move forward.

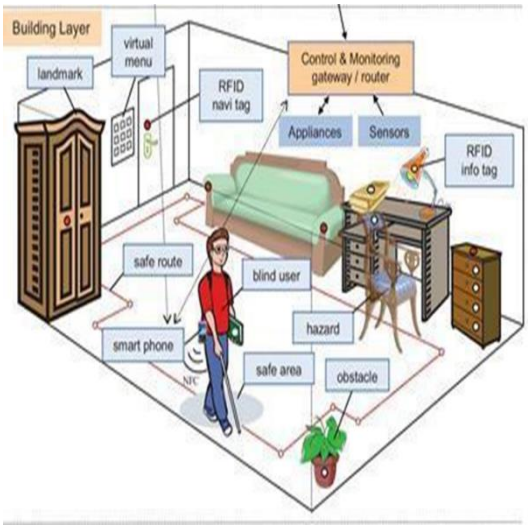

Fig 4.1: Navigation of Blind Man in the Indoor Environment using RFID

There are various existing systems available which uses the devices such as talking signs, cricket sensors, etc. which helps the blind man to navigate in indoor environment. The benefits of the proposed system are discussed below.

The setup cost is very less as compared to other existing systems.

The system is affordable to a moderate user in a developing country.

The system is not affected by environmental changes.

The system is highly portable and simpler.

The audio message heard by the user is loud and clear.

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