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RF and RFID based Object Identification and Navigation system for the Visually Impaired

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***Abstract*—The proposed model taps into the acoustic abilities of a Visually Impaired Person(VIP). An RFID based system is used to help the VIP identify any particular object of his need. In addition to RFID module, an Ultrasonic sensor is used to avoid obstacles and to provide various feedback for pinpointing the object. A series of acoustic actuators is used to trigger the required navigation for the VIP. The model uses two-way localization, one using acoustic stimuli and the other using RFID. The proposed model provides an affordable solution to the existing problem of lack of sophisticated technological assistance to the VIPs.**

Keywords*—Blind Assistance, RFID, Blind navigation, Object Identification*

I. Introduction

VIPs confront a diversity of problems in their day to day life. They do need some sort of assistance for movement from one place to another, and an outdoor navigation system. Most of the time this issue creates a dependence of VIPs on sighted people. At the same time, VIPs need an indoor navigation system for object identification in a number of situations, as discussed in section [V]. Taking into account the good acoustic abilities and memory of a VIP [6], we propose a portable Blind-Assistance system for safe and smooth navigation of VIPs.

II. Literature Review

Two types of systems are proposed to address blind-assistance: a) with sensors mounted on a cane [1], [2], and b) with sensors mounted on a head module or glasses. The latter type mostly makes use of cameras and Artificial Intelligence (AI) technology. Such systems make use of image processing techniques, as proposed in [3]. One such proposed systems makes use of a single image and processes the spatial depth of the objects around the user, but this system is quite different from what we seek to do because the result does not necessarily identify the object [4]. Another report [5], proposes a system which converts virtual reality into audio reality using image processing.

The information embodied in cues like inter-aural time differences (ITDs) and inter-aural level differences (ILDs) allows listeners with normal hearing to locate sound sources on the horizontal plane [6]. This is called Source Localization. VIPs are particularly good at Sound Localization and this ability has been utilized in different research areas for VIPs, for example in [7]. It has also been found that VIPs have a greater memory capacity and fidelity [8]. We exploit these abilities of the VIP in our proposed system.

III. Materials Used

The entire model has been divided into four parts depending on the place they need to be present. They are as follows:

A. Hand Module

- *RFID Reader:* A standard MFRC522 type. The RFID is connected to the MCU via the SPI Protocol. The RFID reader serves the purpose of pinpointing the object the VIP has requested for.
- *Braille Keypad:* The keypad serves as the interface between the VIP and the MCU.
- *Vibrator:* Haptic feedback is provided using this

B. Head Module

- *Ultrasonic Sensor*: Obstacle avoidance.
- *Main Buzzer:* for audio Cues

C. Center Band

- *Microcontroller Unit (MCU):* Manages other peripheral and maintains the database
- *RF Transmitter:* A RF Transmitter serves as the connect between the wall module and the MCU. Based on the database, the transmitter sends appropriate signals to the wall module which in turn, turns on the corresponding buzzer. It is worth noting that only one transmitter is required to control up to 1024 buzzers within a range of 100m as different receivers can be contacted wirelessly by varying the Address bits ($AD_{7\text{-}0}$) of the encoder chip paired with the transmitter (HT12E).
- *Encoder Chip:* The RF transmitter transmits data serially using PCM. The state of four data bits is encoded into serial communication and is fed to the transmitter. Additionally, there are 8 address bits which can control target receiver. To set the state of buzzers corresponding to the sector, the address bits and data bits have to be set correctly. HT12E encoder is used for this purpose.
- *Power Source:* A 9V battery source is used.

D. Wall Module

- *RF Receiver*: The receiver receives the signal from the transmitter present with the MCU and accordingly sets the relevant buzzer high or low. A single unit of RF receiver can only control four buzzers.
- *Decoder Chip:* Similar to encoder chip present in the center band, a decoder chip is required to decode the signals received from the receiver and then change it

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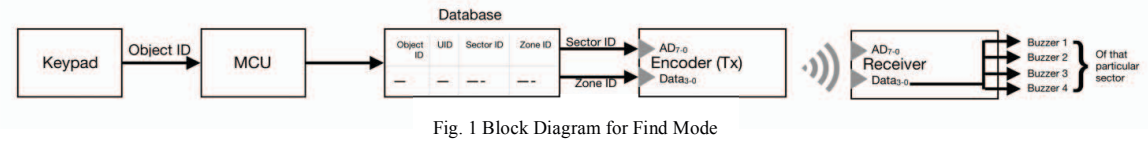

Fig. 1 Block Diagram for Find Mode

accordingly to high or low data bits to control zonal buzzers.

- *Zonal Buzzers:* These buzzers serve as the indicator for presence of object in the area. (Many objects can be present in that area)
- *Power Source:* This power source can be a 9V battery or an SMPS (Switched Mode Power Supply).
- *RFID Tags:* These tags are stuck to the objects giving them UID (unique ID) so that they might be recognized when needed.

IV. Method

A. Mapping

The entire area is divided into sectors and these sectors are further divided into zones

- ***Sectors****:* As mentioned above, the RF transmitter can control 256 receivers using a single transmitter and encoder chip but each unit of RF receiver can only control a maximum of four buzzers. To help the MCU decide which receiver to transmit to, entire area is divided into sectors wherein each sector is controlled via one RF receiver. Each sector is allotted a sector ID to help the MCU map correctly.
- ***Zones****:* Each sector is divided into four zones wherein each zone is recognized by its corresponding buzzer. Zone number (or Buzzer number) divided four gives the sector number.

A database is maintained which has fields which help locating the object (Refer Fig. 1)

B. Modes of Operation

To increase the usability of the proposed system, various modes have been programmed which can be setup by the VIP by entering different unique numeric patterns.

- ***FIND mode****:* The find mode is enabled by the VIP when he wishes to locate an object. The flow of find mode is as follows: (Refer Fig. 1)
  - The VIP enters a code which triggers the FIND mode (a numeric code)
  - A feedback is given to the VIP confirming the setting up of the mode and that an object ID is expected next.
  - The VIP enters the object ID, the corresponding ID is identified by the UID of the tag placed on it. This UID is mapped onto various stages to trigger the corresponding buzzer. The buzzer is activated by looking up in the database to determine which sector and zone the object is in and then corresponding receiver address is fed to the address pins of the encoder chip ($AD_{7\text{-}0}$) and then corresponding data pins are set to make the right buzzer sound.
  - As soon as the zonal buzzer is activated the VIP needs to follow the source of the sound. Meanwhile, ultrasonic sensor and the main buzzer would help him avoid obstacles present en route. The moment he is 30 cm away from the source, the main buzzer stops sounding indicating that the object is just in front of the VIP and this also turns off the zonal buzzer. The vibrator vibrates signaling the VIP to hover his hand above the shelf.
  - Getting feedback from the ultrasonic sensor that the shelf is 30 cm away, the search function of RFID activates. As the VIP hovers his hand above the objects, the UID received from the reader is checked if it is the requested object's UID. As soon it matches, a distinct sound and vibration pattern alerts the VIP that the requested object is just below his hand. He, then, picks it and the find mode is deactivated until further input from the VIP.
- ***Entry Mode****:* Using this mode, the VIP can enter new objects into the database. VIP can enter new object into the database using this mode.
- ***Outdoor Mode****:* The VIP can activate this mode if he wishes to go outdoor and does not need object identification. In this mode, only Ultrasonic Sensor works and obstacle avoidance is done.

Hash (#) serves as the reset button which sets the system into idle state until a code is entered.

V. Conclusion and Future Scope

The model was tested on 5 blindfolded persons and performed well and the subjects located the item of choice with 96% success rate. The model can be used in places where object placement plays an important role for example in shops, hypermarkets, stores etc.

VI. Acknowledgement

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VII. References

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