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SAFE NAVIGATION SYSTEM USING ULTRASONIC AND ZIGBEE TECHNOLOGY

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Abstract

This paper proposes to assist the visually impaired for their safe navigation. We are using the Zigbee technology to help them correctly identify their destination without any human guidance. It uses a SD card to store the map of the familiar and unfamiliar environments which helps the visually impaired upon their query through an alphanumeric keypad. We are proposing to use ultrasonic range finder to help them navigate freely without stumbling upon any obstacles. If it detects any obstacles it will send the signal to the microcontroller which will then activate the voice system to provide necessary assistance through the use of an ultrasonic rangefinder that hectically interfaces with the user via tiny vibrating motors mounted on the user's head. The idea behind this project was to construct a sixth sensory system that interacts with the body in an intuitive and user friendly fashion and enables the user to navigate without vision.

Keyword-- **SD card, Zigbee, Ultrasonic Range finder**

I. INTRODUCTION

According to a WHO study [1] in 2002, there were more than 161 million people with visual disabilities. More than 90% of them live in developing countries and most of them are below poverty line. Among the many challenges faced by the visually challenged persons are the constraints of independent mobility and navigation which stem from hazards in an unfamiliar indoor environment. Finding their location and the path to some other location inside the building can be quite a daunting task, especially when the environment is unfamiliar.

The main objective is to make them independent in this regard. Although several attempts have been made at making such systems, not many have been successfully deployed. Moreover, all systems currently in use are very expensive for the end-user (USD 200 onwards) and are therefore unsuitable for use in developing countries. Our system, on the other hand, is extremely cost-efficient (INR 2000 or less), easily scalable and user-friendly as it does not require the user to wear any complicated belts, sensors or any other gear. It includes setting up a mesh network of Zigbee nodes in the building for calculation of the user's position, a bi-axial geomagnetic sensor to determine user's orientation, a keyboard for the user to make queries, a voice-feedback system and a micro-controller to control them all and do the processing.

A prototype of an ultrasonic obstacle detector developed as a part of a navigation system for blind and visually impaired people is presented.

The detector, which employs a single ultrasound source and an array of microphones, determines the distance to the obstacle by measuring time between sending the pulse and receiving the reflected signal.

Using the phase beam forming technique, borrowed from hydro acoustics, to process the output signals of microphones, it determines also the direction from which the reflected signal is received, thereby locating the obstacle. The obstacle detector was subjected to a series of tests in order to verify its design and to assess its ability to detect a broad range of obstacles. Presented test results show that most obstacles can be detected and recognized, and that the tested obstacle detector provides complete coverage of the safety zone in front of the user.

In this we propose a system which can detect obstacles for the blind people. In this new system we increase the range of the operating device to about 40 to 240cm which is possible only through obstacle Sensors. Here we are using ultrasonic sensor for detecting the obstacle. Ultrasonic Receiver is placed in the spectacle. And the transmitter placed in the walking stick. When the obstacle detect the receiver receives the signal from the transmitter. And indicate by voice.

In this paper we outline the design for an indoor navigation system for the visually impaired. Our long-term goal is for a portable, self-contained system that will allow visually impaired individuals to travel through familiar and unfamiliar environments without the assistance of guides.

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The system, as it exists now, consists of the following functional components: (1) assistance for determining the user's position and orientation in the building, (2) a detailed map of the interior of the building, and (3) the user interface. By pressing keys on his/her mobile unit, directions concerning position, orientation and navigation can be obtained by the portable system that can prompt them acoustically over a text-to-speech engine.

II. System Design

Organization: The paper is organized as follows: in I part, we describe the Zigbee technology which is useful to guide the blind user to reach their desired destination without the help of others and in II part, we describe the work of ultrasonic sensor which indicates the presence of obstacles to blind user, and in III part, we describe our proposed vision system using ultrasonic and Zigbee technology. Finally, we conclude our paper in Section III.

III. Navigation System Using Ultrasonic And Zigbee Technology

In our proposed system, both ultrasonic and Zigbee technologies are used to indicate the presence of obstacles and to navigate in familiar and unfamiliar environments without the help of others. This system mainly uses Zigbee technology to help the blind people to navigate but in order to provide the blind with safe navigation, an ultrasonic sensor is incorporated in that.

A. Indoor navigation system using zigbee technology

The system uses a Zigbee-based location engine developed by Texas Instruments. Zigbee (IEEE-802.15.4) [2] is a low-cost, wireless mesh networking standard specially suited for embedded applications requiring low power consumption.

The system employs a network of Zigbee Nodes (Reference Nodes) deployed at various locations inside the building.

The building there is at least three. The user carries a similar Zigbee node (Blind node) as part of the system.

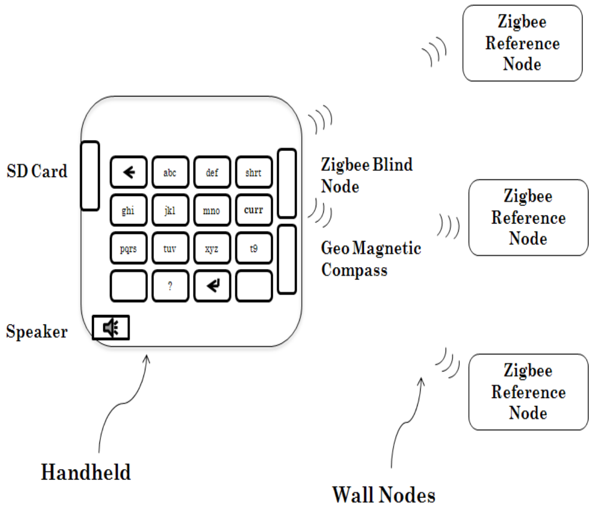

Fig.1 Schematic Diagram

In order to guide the user, the system has to find the position and orientation of the user with respect to reference node.

To find the position of user, Zigbee nodes are employed. The Reference nodes can be hard coded with their coordinates with respect to a pre-defined coordinate system. The Blind node uses **RSSI** (Received Signal Strength Indication) values of the radio signal from the reference nodes. These RSSI values are a measure of the power received, and hence the distance, and along with the trilateration technique [3] can be used to calculate the coordinates of the Blind Node.

A **bi-axial geo-magnetic sensor** [4] is used to calculate the orientation of the user with respect to the corridor and guide him/her accordingly. This means an electronic compass IC which calculates the direction in which the user points with respect to the north.

This system uses **SD Card** within which the map of the building is stored. The map file for each building can be transferred to the system whenever the user enters a new building using the Zigbee Nodes themselves. The system uses the Dijkstra's algorithm to find the best possible path from the user's current location to the destination location that the user has queried for.

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An **alphanumeric keypad** is used in the system. The blind user use this keypad to enter his/her queries. The user can enter or inform his/her requirement by pressing keys in keypad.

Each of the keys represents a location queried by the user. For example, elevator, rest room, exit door are some commonly queried destinations. The user can enter the destination name by using alphanumeric keys.

Each of the keys has a voice feedback which informs the user what he/she has entered.

For example, if the user wants to enter into office room, he/she has to press the key with probability which represents the office room. The voice system will give the feedback about the pressed key. After that it will guide the blind user to reach the office room.

The system generates sound output using a text to speech engine, made using a 10-bit DAC (Digital to Analog Converter) and at 16 KHz sampling rate. The sound files for output are stored on the memory card.

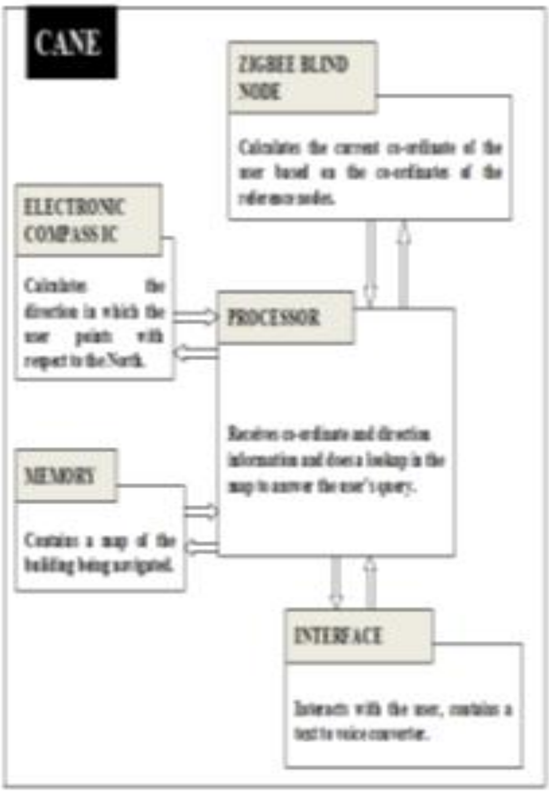

Fig.2 Zigbee nodes with microcontroller

Zigbee nodes are fixed in various parts of the building and one Zigbee node is interfaced with this system. User node will be addressed as the Blind node.

Other Zigbee nodes in the various parts of the building help the blind node to relatively determine the position and orientation of the user within the building. Map of the building or any kind of environment is stored in SD card or memory. Microcontroller controls and co-ordinates all the functions in the system.

Hence this system finds the position and orientation of user and provides the necessary directions to the user (i.e., guides the user) through a voice activated system whenever the blind user gives the query through the alphanumeric keypad.

B. Safe navigation system using ultrasonic technology

Numerous object detector systems are available. These employ the principle of “interrupted beam principle”. That is an object is sensed when the beam between the transmitter and receiver is interrupted. For this we need to align the transmitter and receiver in proper direction i.e. facing each other. This is complicated and requires severe maintenance on our part. This type basically provides whether there is some object or not, but no object recognition. Our “Ultrasonic Object detector” eliminates the above said problems effectively. Here Ping ultrasonic sensor is used. This sensor is based on the working principle of ‘echo ranging’ [5].

Fig.3 (Ping Ultrasonic Sensor)

Obstacle sensor (ping)

Object ranging is essential in many types of systems. One of the most popular ranging techniques is ultrasonic ranging. Ultrasonic ranging is used in a wide variety of applications including:

- Autofocus cameras
- Motion detection
- Robotics guidance
- Proximity sensing
- Object ranging

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This application note describes a method of interfacing PIC16CXXX microcontroller to the Polaroid 6500 Ranging Module. This implementation uses a minimum of microcontroller resources, a CCP module and two I/O pins. The two major components of the system are:

- Microcontroller
- Polaroid 6500 Ranging Module

Ultrasonic ranging entails transmitting a sound wave and measuring the time that it takes for the sound wave to reflect off of an object and back to the origin. The reflection time is proportional to the distance that the object is from the source. In this implementation, the sound wave is transmitted and received from the same transducer. Therefore, a blanking interval is required between signal transmission and reception to eliminate false echoes (i.e., a transmitted signal being detected as its own echo).

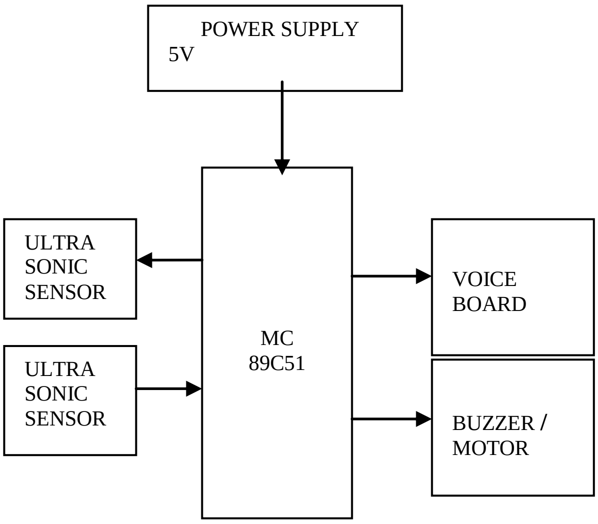

Fig.4 ultrasonic sensor with microcontroller

Ultrasonic sensor is interfaced with the microcontroller. Whenever it detects any object nearer to the blind user, the motor interfaced with the microcontroller will run thereby producing vibration in the body of blind user. It gives the haptic sense to the user. So if we implement a device with this ultrasonic sensor and stepper motor (produce vibration), it can also be useful for deaf.

C. Navigation system incorporating both ultrasonic and zigbee technology

The system used by the blind user is in the following form:

BLIND PEOPLE SECTION:

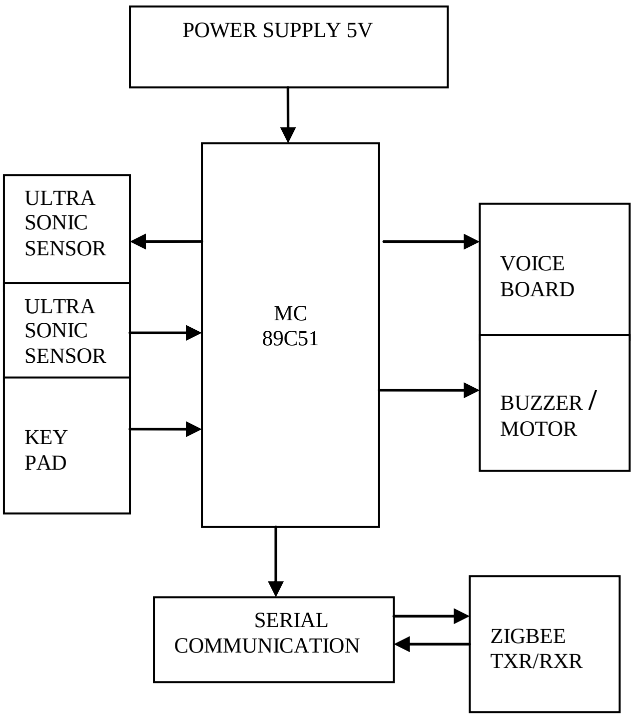

Fig.5 blind user system

This is the system which is used by the blind people. Here in this transmitting section we are using Ultrasonic ping sensor wherein we have both transmitter and the receiver at the same position. And we will be having a transmitting Zigbee node(always transmits and receives signals), a MAX-232 chip, Voice board circuit for relaying information to the user, a microcontroller at the heart of the circuit, a power supply to drive it, a buzzer/ motor circuit to intimate about the obstacles present and finally an alphanumeric keypad to enquire about the destination. The user can enter their queries by pressing keys in the alphanumeric keypad.

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The system in other areas consists of Zigbee nodes only and is shown in *fig*

BUILDING AREAS SECTION:

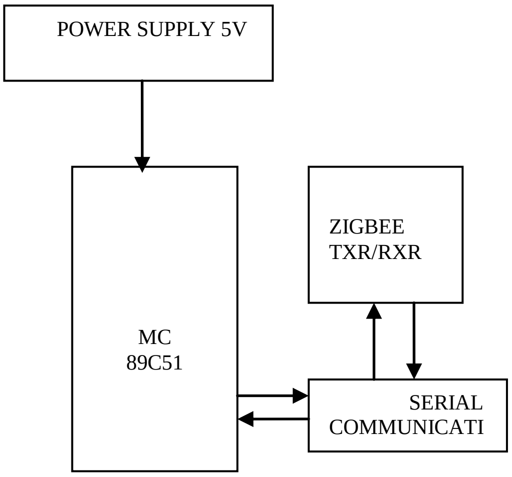

Fig.6 system in various areas of building

The Reference nodes can be coded with their coordinates with respect to a pre-defined coordinate system through the use of microcontroller. The transmission and reception of signals between the Zigbee nodes in user system and various areas of building helps in identifying the position of user and guides the user through the voice board (speaker system) to reach the correct destination

This system is useful for the visually challenged in two ways. To reach the correct destination without the help of others and to navigate safely without stumbling on the obstacles

IV. Conclusions

In our work, we proposed a system with to two technologies namely ultrasonic and Zigbee. Ultrasonic technology supports the blind people to navigate safely without stumbling on movable and non-movable objects. Zigbee technology supports the blind people by guiding them to reach their desired destination without the help of others.

Hence the visually challenged people will navigate safely in familiar as well as unfamiliar environments without the guidance of others. If all the places have such type of construction in future that is, fixing of Zigbee nodes in future, then the blind people as well as stranger never face any navigating problems. By implementing this successfully and by using this portable system by the blind, we can easily avoid the inequality problem between the normal and the handicapped.

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