International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
April 2018

Navigational Assistive Interface for Visually Challenged People

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Abstract-

This project proposes the implementation of the assistive technology to help the visually challenged/impaired people to navigate on the roads independently, as they need someone to assist them even to walk alone. The information about the existence of obstacles will be given by navigational assistive interfaces which are portable electronic devices. Most of the interfaces that exploit tactile stimulation are destined to the finger tips, palms, and soles of the foot. But the capabilities of tactile foot perception for human navigation is little complex. To overcome this, an audio signal is sent through the earphones to assist the user about the presence of obstacles by using the obstacle detector. A situation like falling down in a particular place, automatically a message is sent to the take carer of the visually impaired person using GSM module. It enhances the independent travel which is useful to reach the destination easier and faster.

Keywords

Assistive technology, tactile, Obstacles, GSM module.

1. Introduction

Every individual in this world needs privacy at least during some situations. For a normal person it is very easy to navigate from one place to other place and can spend their private time alone. But in case of the people who have disabilities in the visual capability, it is difficult to move alone. In these situations they need someone to assist which they don't actually like. To avoid these, assistive devices are used to make their life easy. In the area of mobility assistance for the visually impaired people, many methods have been implemented. So far, all the devices for assisting the blind people to navigate in indoor and outdoor environments integrates with the innovative technologies. The devices for outdoor navigation are cost effective, complex and sometimes become inefficient during the real time implementation which may risks the lives of the users.

Assistive technology which is also referred as adaptive technology is used to increase the capabilities of individuals with disabilities. These technologies specifically refers to electronic and information technology. People with disabilities like visual impairments, hearing impairments, mobility impairments have difficulties to carry out their daily activities which include eating, bathing, toileting, mobility. Assistive technology amends the difficulties in doing the daily activities and provides independence in performing the tasks that they couldn't accomplish. Because of these assistive devices, people with disabilities have more scope to lead an easygoing lifestyle. There are many assistive devices for the blind people like brainport, eSight, tactile foot stimulation and some with reasonable drawbacks [1]. Designing the navigational assistive interface actually involves two challenges. One is, information must be in simple and fast to understand manner and other is the interface should not be cumbersome. Current devices use vibrating buttons or motors on the plantar surface of the foot to warn the upcoming obstacles that are present in their path. The major disadvantage of touch stimulation is that the information displayed could be complex and slow to understand. Some advanced interfaces use acoustic signals to provide the information to the user which is very simple to understand. An additional system called as Personal Emergency Response System (PERS) is used to aware the takecarer of the blind person and to ensure the secured journey of the blind person.

2. Literature review

Decades ago, dogs are the one which are helpful to guide the visually aided people in outdoor environments. Though it is helpful, it requires the dogs to get trained which are only useful about 5 years [2]. Moreover if the person is old, it is difficult to look over another living being. Due to the advancements in the technology many electronic equipments are now available to assist the blind persons usually known as Electronic Travel Aids (ETA) which requires hard training [3]. Further development of the technology, robotics became promising substitute to guide dogs which provides guidance to blind people to navigate from one place to another place. Even though the robotic technology enhances the reliability but it is cost effective. Several institutions throughout the world are performing research work on the devices to assist the blind people.

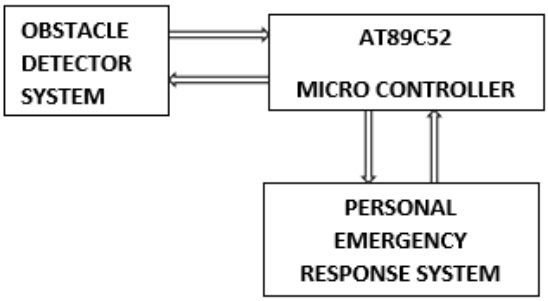
Basically, there are four categories of navigational systems i.e. systems based on sensors, systems based on Global Positioning system (GSM), systems based on camera, systems based on Radio Frequency Identification (RFID) [4]. Earlier in 1960, sensor based systems uses a sweep FM ultrasonic sensors to help the visually disabled persons [5]. Mostly these systems uses ultrasonic sensor, infrared sensor or a combination of both sensors to detect the obstacles.

3. Methodology

The main motive to develop this navigation system is to orient blind people in several indoor and outdoor environments. The prototype of the proposed system consists of two subsystems i.e. Obstacle detector module to detect the obstacles and the Personal Emergency Response System (PERS) to aware the take carer of the blind person and to ensure the users security.

3. 1 Obstacle detector module:

The blocks that come under this system are IR sensor, voice module (aPR33A3), AT895C2 microcontroller, MAX232C, earphones. As shown in the fig, IR sensor is used to detect the objects that the user encounters. The IR transmitter continuously transmits the infrared light. If any obstacle is in front of the user, the transmitted IR rays gets reflected back by to the IR receiver indicating the presence of an object. Whenever the existence of an object or obstacle is sensed by the IR sensor then a voice is prompted through earphones worn by the user and this voice



message can be recorded as our wish and can be played by a voice module called aPR33A3.

Figure 1. Main block of proposed system

3.2 Personal Emergency Response System (PERS):

It is a system which promotes the broadcast of messages to the programmed phone numbers alerting them to an emergency. The blocks that come under this system are mercury switch, AT895C2 microcontroller, MAX232C, GSM module. Whenever the user falls somewhere, at that time the electrodes of the mercury switch gets shorted by the mercury liquid indicating the microcontroller to invoke the GSM nodule to send a text message and a voice call to the care taker of the blind person in order to avoid the risks. Therefore adding fall detection feature to the system allows automatically to call for help, at the moment it detects the user's fall.

4. Hardware Implementation

The following are the components in the proposed system:

1. AT 89C52 Micro controller
2. IR sensor to detect the presence of the obstacles
3. Mercury switch
4. GSM module to send the message and voice call
5. MAX 232C acting as interface between micro controller and GSM module
6. aPR33A3 acting as interface between micro controller and earphones

From the block diagram of the proposed system, AT89C52 micro controller belonging to Atmel's 8051 family is the core part in which the code is dumped. AT89C52 micro controller is a low power 8-bit micro controller with 8K bytes reprogrammable flash memory. An external crystal oscillator of 11.0592 MHZ clock frequency is given to the controller. It facilitates high flexibility and cost effective for embedded applications. It is operated in low voltage programming mode as it is more convenient to program the micro controller of the system. It has four ports each having 8 pins i.e. 32 programmable I/O pins are available to interface many hardware input and output blocks. Its operating voltage is 12V which is supplied by a battery. If the firmware gets stuck, a reset circuit of period 82 milliseconds is provided for the implemented system in order to function normally.

Whenever an obstacle is detected by the IR sensor then it triggers the microcontroller as per the instructions that are dumped in the controller, it sends a voice message to the user through the earphones alerting him/her to stop or to change the direction in order to avoid the obstacles. The voice message which is recorded and played back through a device known as voice processor aPR33A3 which is interfaced with the controller and earphones. The voice processor used in this implementation contains 8 switches. The total recording time is 11.333 minutes (680 seconds) and each switch can record up to 85 seconds.

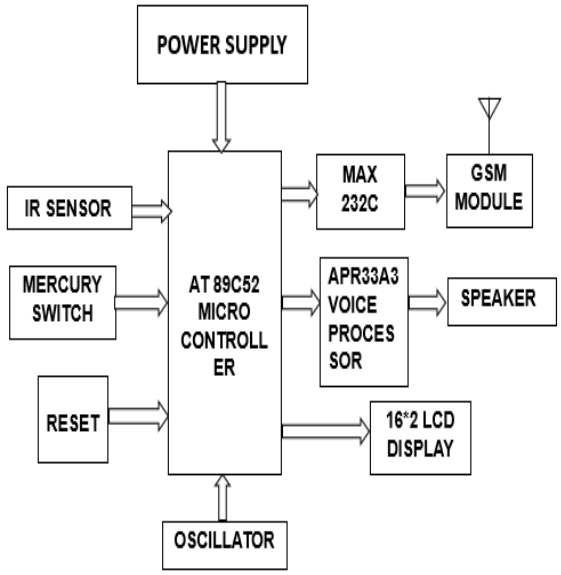


Figure 2. Block diagram

To ensure the safety of the user, PERS system is interfaced to the existing system. To detect the user's fall, mercury switch is used. It is an electrical switch which opens when the mercury liquid is in the other side of the electrodes and closes when the mercury liquid shorts the electrodes. Whenever the user falls somewhere for any reason, then the position of the mercury switch turns from open to close which invokes the microcontroller to execute the AT commands. AT stands for ATtention commands used to control a modem. Every command line starts with the 'at' or 'AT' which just indicates that it is the start of command line to the modem. Some of the AT commands used in this system are +CMGS, +CMSS, +CMGR etc. According to the commands, GSM module which set ups the communication between the proposed system and the care takers mobile through a network sends a text message to alert the care taker of the blind person. If at all if he/ she overlooks the text message, a voice call is made in order to ensure the safety of the blind person (user).

Different devices have different operating voltages as per the specifications of the devices. In this hardware set up, Microcontroller and GSM modem requires 12V which can be directly supplied by the battery of power supply. But the requirement of the 5V supply to the voice processor (aPR33A3) makes the prototype to have a component named MAX 232C which converts one level of voltage to other level. Here the LCD display is used to monitor the current action performed by the system.

5. Results

The proposed prototype gets activated with the power supply. Continuous emission of IR radiations detect the obstacles in the path. Fall detection gets activated when the mercury switch closes. Then the GSM module waits for the network to set up as shown in the fig 3.

Figure 3. Waiting for the sensor signal

Once the network is set up, it gets updated in the LCD display as shown in the fig 4.

Figure 4. Sensor network is activated

After setting up the network, SMS is sent to the care takers mobile which can be seen in the fig 5.

Figure 5. SMS alert

Further to alert the care taker of the blind person, a voice call is made which is indicated in the fig 6.

Figure 6. Call alert

6. Conclusion

Thus the system used to help the visually impaired people is designed which is less complex, more accurate and also ensuring the safety of the user while doing his/her daily activities. Any system to meet the user's need, some essential features should be satisfied such as real time or not, can be used in day time or night time, coverage, range, object type. Those features are considered while designing any system to provide services to blind people. Having all the fundamental features makes the system performance efficient. Features like object type (static or dynamic) and range limits the evaluated system. Ultimately the performance of the devices should meet the ideal device performance i.e. user should able to sense the surrounding environment at all times and everywhere. By adding a new feature like GPS system to the proposed prototype improves performance of the system which provides the appropriate directions to reach the destination easier and fast.

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