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Implementation of Smart Stick for Obstacle Detection and Navigation

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ABSTRACT: A smart stick has been built for the visually impaired people that help to detect obstacles with the use of infrared, ultrasonic and water sensors. Obstacles within the distance of about 3m can be detected with the help of these sensors. Also, we make use of GPS module to give positioning and navigation to the stick. Using GPS module assists the blind person to reach his destination. While the blind person navigate, the GPS receiver gets the location of the person updated and the co-ordinates of that location can be used to keep track of the blind person for safety concerns. The blind person can also send emergency message or make an emergency call at times of risk, to his guardian, using GSM module. In this way, the GSM module will be used to give notifications when the blind person has threats.

KEYWORDS - GPS module, GSM module, Sensors, Smart stick.

I. Introduction

An individual shall be considered to be blind for purposes of this title if he has central visual acuity of 20/200 or less in the better eye with the use of a correcting lens. An eye which is accompanied by a limitation in the fields of vision such that the widest diameter of the visual field subtends an angle no greater than 20 degrees shall be considered for purposes of the first sentence of this subsection as having a central visual acuity of 20/200 or less.

Many people with serious visual impairments can travel independently, using a wide range of tools and techniques. Orientation and mobility specialists are professionals who are specifically trained to teach people with visual impairments how to travel safely, confidently, and independently in the home and the community. These professionals can also help blind people to practice travelling on specific routes which they may use often, such as the route from one's house to a convenience store. Becoming familiar with an environment or route can make it much easier for a blind person to navigate successfully.

Tools such as the white cane with a red tip may also be used to improve mobility. A long cane is used to extend the user's range of touch sensation. It is usually swung in a low sweeping motion, across the intended path of travel, to detect obstacles. However, techniques for cane travel can vary depending on the user and/or the situation. Some visually impaired persons do not carry these kinds of canes, opting instead for the shorter, lighter identification (ID) cane. Still others require a support cane. The choice depends on the individual's vision, motivation, and other factors.

II. Existing System

Existing systems which provides guidance to blind like Guide Cane, Smart vision use ultrasonic sensors or laser sensors to detect obstacles in front of the blind by transmitting the wave and reception of reflected waves. It produces either an audio or vibration in response to detected obstacles to warn blind.

Systems like Sound View use single camera or stereo video cameras mounted on a wearable device to capture images. These captured images are resized, processed further and converted to speech, audio, musical sounds or vibrations. In such systems, the frequency of warning sound signal is correlated with the orientation of pixels. Some systems like UltraCane help blind people by collecting information through sensors and then transmitting recommendations through vibration or sound message to the user.

The above solutions have disadvantages for instance, they can't detect obstructions that are hidden but very dangerous for the blind such as downward stairs, holes etc.

III. Proposed System

The smart stick, as shown in Fig. 1, is basically an embedded system integrating the following: pair of ultrasonic sensor to detect obstacles in front of the blind from ground level height to head level height of the stick in the range of 400 cm ahead, infrared sensor to detect upward and downward stairs, water sensor for detecting puddles. The sensors collect the real-time data and send it to the microcontroller for processing. After processing, the

microcontroller invokes the right speech warning message through a Bluetooth earphone. The system is powered by a rechargeable battery.

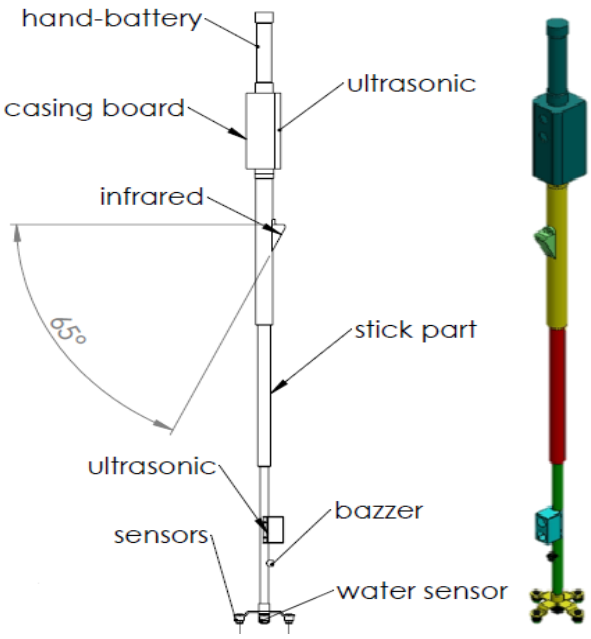

Fig. 1. Design of Smart Stick

The GPS based blind device with user input interfacing get alert the blind person when he reaches his destination by voice. This consists of microcontroller module, GPS Unit and a voice module to generate voice output. It stores the data of the current location which it receives from the GPS system, so that it can make use of the data stored to compare with the destination location of the user. By this it can trace out the distance from destination and produce an alarm to alert the user in advance.

IV. Implementation

The proposed system provides improvements to the existing system design. It tries to make the existing system more efficient, convenient and user- friendly.

The implementation of the proposed design of the stick requires following hardware components:

1. Ultrasonic sensors
2. Infrared sensor
3. Water sensor
4. GPS module
5. GSM module
6. Arduino Uno Microcontroller Board

4.1 Ultrasonic sensor:

In the proposed system we use a pair of ultrasonic sensor. An upper one at a height of about 90 cm to detect upper obstacles and another sensor at a height of about 30 cm to detect obstacles below knee level.

Each ultrasonic sensor detects the obstacles in a range of about 200 - 400 cm. The distance of the obstacle is determined based on the delay between the emission of sound and the arrival of an echo. The distance of the obstacle can be measured as,

: *Distance = (time*speed of sound in air)/2 (1)*

Where, *time* is the time duration for which the ultrasonic waves have travelled and *Speed of sound* in air is 340m/s.

We divide the product of time and speed by 2 because the time is the total time it took to reach the obstacle and return.

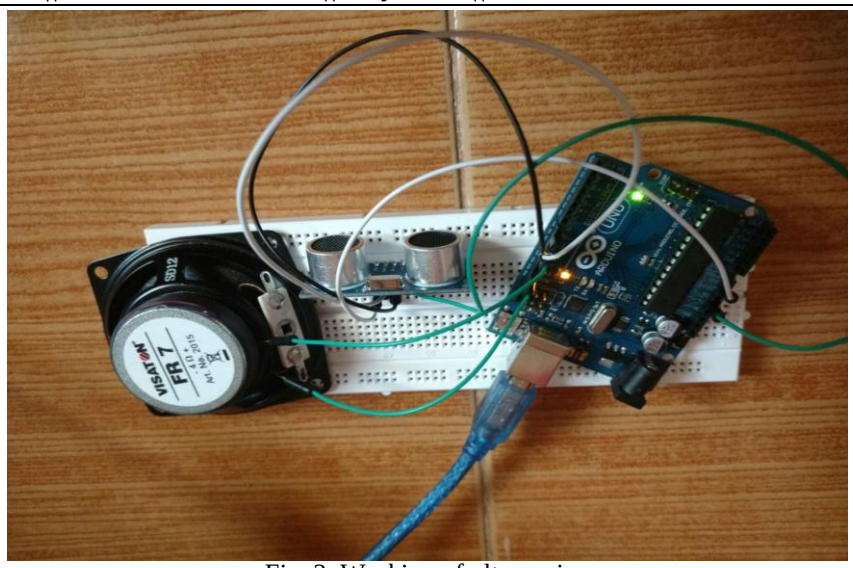

Fig. 2. Working of ultrasonic sensor

4.2 Infrared Sensor:

Infrared sensor recognize small obstacle but with less accuracy than laser sensors. However using laser sensor is costly which contradicts to our aim in obtaining affordable aiding devices. Infrared sensor includes a transmitter and a receiver.

The IR transmitter is an IR LED (Light Emitting Diode) and the receiver is an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, its resistance and correspondingly its output voltage change in proportion to the magnitude of the IR light received. This is the principle of working of Infrared sensors. It can detect obstacles in a range within 50 cm at an angle of +/- 45 degrees accurately.

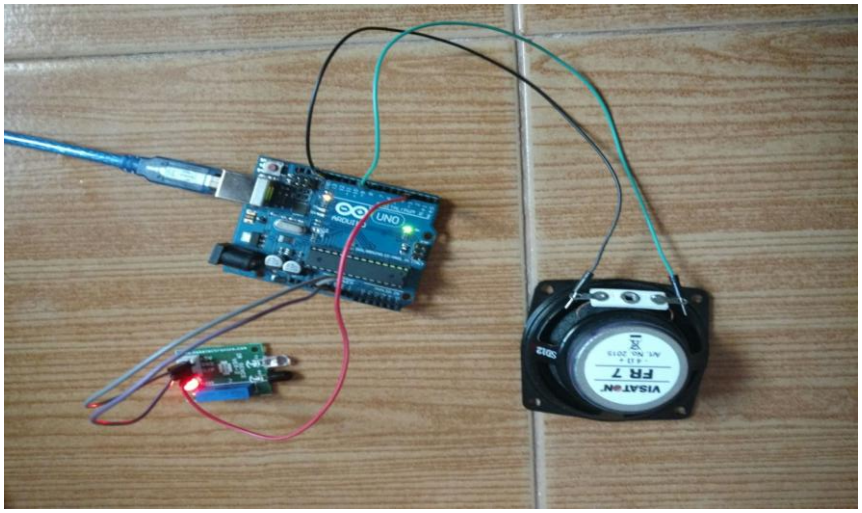

Fig. 3. Working of Infrared sensor

4.3 Water Sensor:

Water sensors available are used to detect water levels inside tanks and very expensive. Our objective is to detect water existence regardless its level. So we used a costless alternative. Three wire probes fit at the bottom of the stick to sense obstacle like water pits, puddles and water spread. Two wires are used to complete the circuit and another one wire is used to short circuit. Once wires touch water, the circuit is shorted, this interrupts the microcontroller, and beep sound is produced by the speaker to warn the blind person about the puddle.

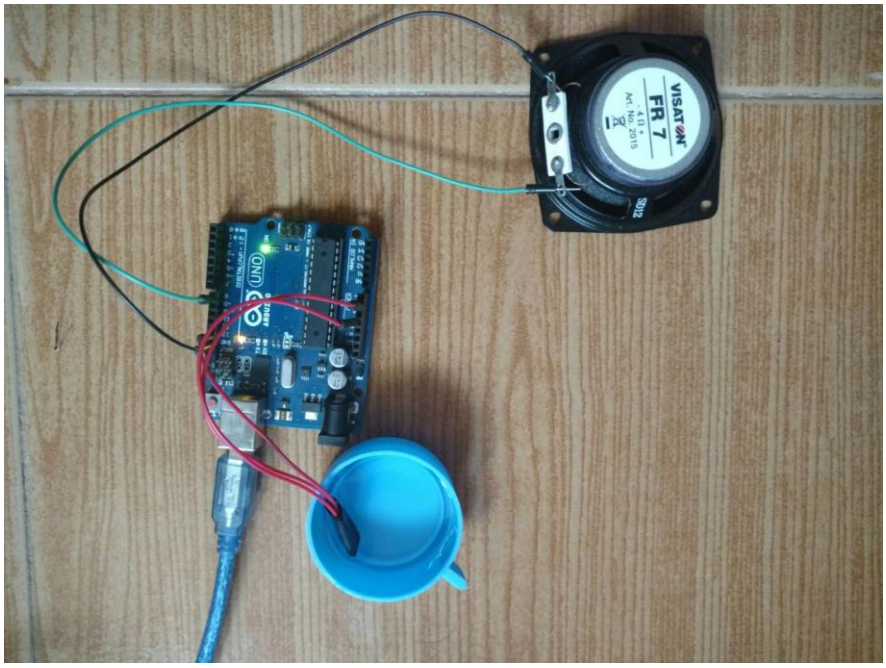

Fig. 4. Working of Water sensor

4.4 GPS module:

The GPS based device proposed, with user input interfacing get alert the blind person when he reaches the destination by voice. A GPS module consists of GPS receiver and an antenna. GPS antenna is a device that helps to boost the reception signal to a GPS unit. GPS (Global Positioning System is a satellite system originally developed by the United States Department of Defense. It utilizes more than two dozen satellites orbiting the Earth to allow receivers to tell exactly where they are. Using this location, devices can detect not just latitude and longitude, but also altitude and even speed. A GPS unit is used in the smart stick to obtain the latitude and longitude of the location of the blind person. The data obtained are used to find the address of the blind person's location. While the person navigates with the stick, the latitude and longitude data are updated. Thus, these data are helpful to keep track of the blind person.

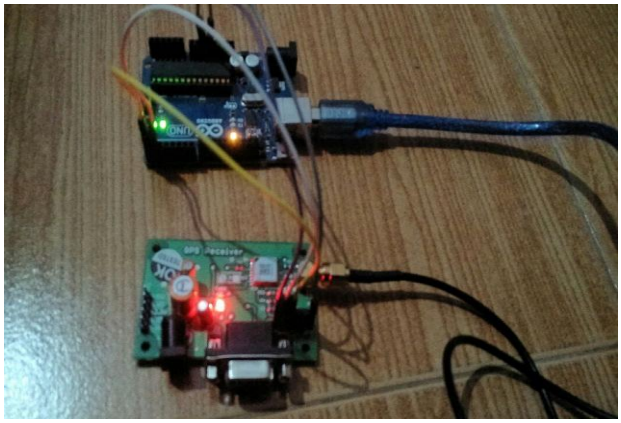

Fig. 5. Working of GPS module

4.5 GSM/GPRS module:

GSM (Global System for Mobile communications)/ GPRS (General Packet Radio Service) module is an embedded piece of hardware which can be integrated with an equipment to make use of the module's functionalities. GSM module requires a registered SIM card to be inserted into it in order operate. It facilitates making and receiving voice calls, sending SMS messages wirelessly.

GPRS is an extension to GSM data transmission capabilities. GPRS enables data transmission with higher speed than GSM. It provides inter-networking facility through internet.

These features of GSM/GPRS module can be made use of in the smart stick which imparts great advantage for the blind person in emergency situations. A visually impaired person during urgent or risky situations may use a switch on the stick that allows the GSM module to send an emergency message (which also specifies his location) to the concerned person, whose number has been saved already, requesting help. The blind person can also make an emergency call or receive any calls to his number.

The GSM module's extended technology GPRS provides a service which connects to the internet. The GPS module can use GPRS for connecting to internet, to gather the data regarding the current location of the person using the smart stick. The blind person can be tracked using the location data provided by the GPS module. The GSM/GPRS module uses AT commands to perform operations. Every command line starts with "AT" which informs the module about the start of a command line.

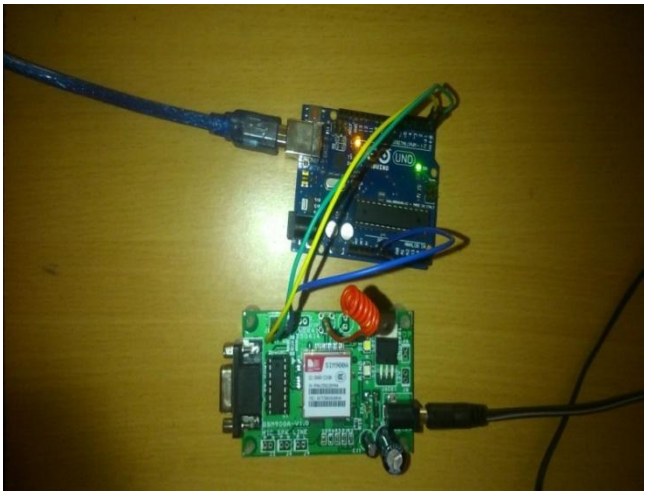

Fig 6. Working of GSM/GPRS Module

4.5 Arduino Uno:

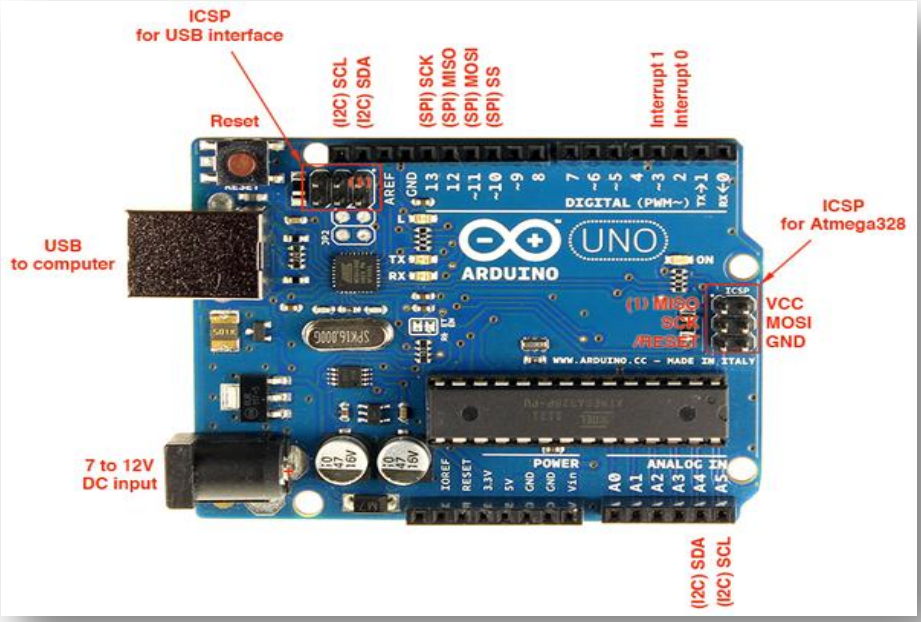

Fig 7.Arduino Uno Board

The Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it

to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

V. Future scope

The future scope of the existing smart stick, guides the visually impaired person in his navigation independently in an efficient manner ensuring the person's safety.

a. The Braille input device gives the blind person an uncomplicated method to provide the destination address for navigation.
b. The programmable wheels would steer the stick away from the obstacles and also leading the blind person towards the destination.
c. Internet of Things is a trending concept which can increase the benefits of the smart stick by allowing one stick to communicate with another smart stick (or mobile , PCs) nearby to utilize the functionality of the other stick when one stick's functionality breaks down.
d. In order to run this integrated set of hardware we can use solar panels as an alternative to the battery. The use of solar panel occurs to be more advantageous as it uses sunlight, the easily available renewable resource of energy, to get recharged.

VI. Conclusion

This paper presents the implementation of a smart stick that assists a visually impaired person to his destination safe and secure. We make use of various sensors to detect the obstacles ahead and warn the blind person about the obstacle through beep sound. The intensity of the beep sound increases as the person nears the obstacle which aid him to move aside of the obstacle. We take the benefits of GPS module and GSM/GPRS module, where GPS module helps to trace the blind person using the data collected by it. In case of dangerous circumstances the person whose phone number has been saved is notified that the blind person is at risk, along with the current location of the blind person. The smart stick also facilitates the blind person to make calls at times of emergency. All these features are beneficial in lending a hand to make the visually impaired people become self-reliant while navigating.

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