A Unique Smart Eye Glass for Visually Impaired People

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***Abstract*—In this paper, we present a unique smart glass for visually impaired people to overcome the traveling difficulties. It can detect the obstacle and measure the distance perfectly using the ultrasonic sensor and a microcontroller. After receiving information from the environment, it passes to the blind person through a headphone. The GSM/GPRS SIM900A module is used to collect the information from the internet. A switch is connected to the system which is used for an emergency task like sending SMS, including time, temperature and location to the subject's guardian when visually impaired people fall into any danger. By using the smart glass visually impaired people can walk in an indoor and outdoor environment.**

Keywords— smart glass; ultrasonic sensors; GSM; microcontroller; visual impairment;

I. Introduction

The number of visually impaired people is growing over the last few years. According to the report of the world health organization (WHO), about 253 million people live with vision impairment. Among them, 36 million people are blind and 217 million have moderate to severe vision impairment. The major portion of visually impaired people is aged 50 or older and live in the developing countries [1-2]. Everyday these visually impaired people face problems in understanding and interacting with the surroundings, particularly those which are unfamiliar. It is really hard for a blind person to go out alone and there are not so many available products that can assist them. However, Researches have been going on for decades for developing an effective device for visually impaired people. Some devices, such as Lightweight Smart Glass System with Audio Aid [3], NavBelt [4], Guidecane [5],VA-PAMAID [6], Electronic Travel Aid [7], and etc. have been made.

In this paper, we present a new and unique design for the smart glasses that can aid in multiple tasks while maintaining at a very low building cost. The device can easily guide the visually impaired people and able to give proper direction.

II. The Proposed Model

The block diagram of our proposed model is shown in Fig.1. The system has three ultrasonic sensors, SD card module, headphone, LED indicator, switch and GPRS SIM900A module with an atmega328p microcontroller. Three ultrasonic sensors are placed left side, front side and right side of the wearable device for perfect detection. In this way, an obstacle can be detected from three sides [8]. When an obstacle comes near to the blind within the range of 5 meters, the sensors measure the obstacle distance and send the value to the microcontroller. The Atmega328p microcontroller is an 8-bit programmable integrated circuit and which has 16 MHz clock frequency. Here the data from ultrasonic sensors are processed by Atmega328p microcontroller. The SD card module has the ability to communicate with Atmega328p microcontroller. The voices are recorded in the SD card module to instruct the visually impaired users, which is played through a headphone according to the ultrasonic data. A switch is connected to the system which is used for an emergency task like sending SMS to the subject's guardian when the blind person falls in danger. GPRS SIM900A module collects such data like location, temperature and time from the internet. All the data from the GPRS SIM900A module are processed by the microcontroller. An SMS including time, temperature and location can be sent to the subject's guardian when the switch is pressed. The LED indicator is used for day or night indication for blind's safety. It is controlled by acquiring the time from the internet with the help of the GPRS module. During the night the LED turn ON automatically so that others can understand the presence of blind when there is no light in the street. Although the device makes the blind to understand about the obstacle, the LED also helps others to understand about the blind person. As a result, the visually impaired person can visit any place without having any difficulties such collide to others.

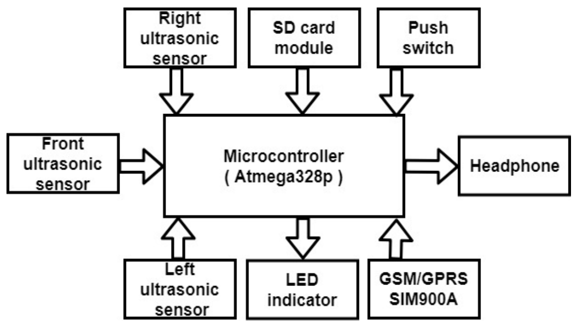

Fig. 1. Block diagram of the proposed model

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A. Power Supply

The power is provided as the requirement of the circuit. The GPRS module requires +12V source, whilst other components demand only +5V. Therefore, we used a +12V lithium polymer battery and regulated the source according to the demand of our system.

B. Ultrasonic Interfacing

The three ultrasonic sensors are connected to the Atmega328P microcontroller shown in the Fig. 2. The front sensor's trig pin is connected to the 7-number pin for sound wave triggering and the echo pin is connected to the 4-number pin for receiving the reflection of the wave. Similarly, right and left sensor's trigger pins are connected to the 28-number pin, 14-number pin and echo pins are connected to 27-number pin, 13-number pin. A 16 MHz crystal is used for generating clock frequency. It is connected to the 9-number pin and 10-number pin. All the sensor's VCC are connected to the source (+5V) and ground is connected the negative terminal of the source. As a result, three ultrasonic sensors can understand obstacle and send the values to the microcontroller [9].

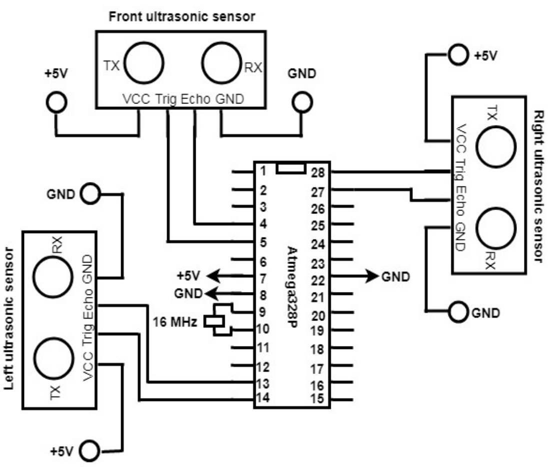

Fig.2. Ultrasonic sensor and signal processing segment

C. SD Card Interfacing

An SD card is connected to the Atmega328P microcontroller for storing the recorded files shown in Fig. 3. The module has six pins CS, SCK, MOSI, MISO VCC and GND. The CS pin is connected to the 16-number pin of the microcontroller. Similarly, SCK, MOSI, MISO pins are connected to the pin of 17, 18 and 19 respectively. The SD card module's VCC is connected to the source (+5V) and ground pin is connected to the negative terminal of the source. Here, SD card communicates with microcontroller using serial peripheral interface (SPI). Voices are stored in the SD card as required to inform the subject. When the sensor finds an obstacle, then audio play through headphone.

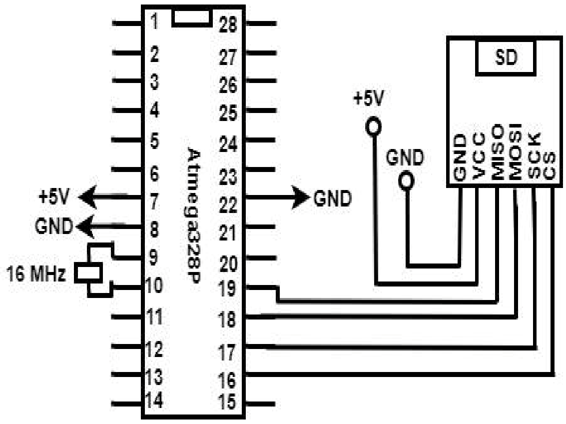

Fig.3. SD card interfacing segment

D. SIM900A GSM/GPRS Module Interfacing

A GSM/GPRS SIM900A module is connected to the Atmega328P microcontroller to collect the information from the internet that is shown in Fig. 4. The TX pin of the module is connected to the 2-number pin and the RX pin is connected to the 3-number pin of the atmega32P microcontroller. In this configuration the microcontroller can able to communicate with the module. Here the module's VCC is connected to the main source (+12V) and the ground is connected to the negative terminal of the main source.

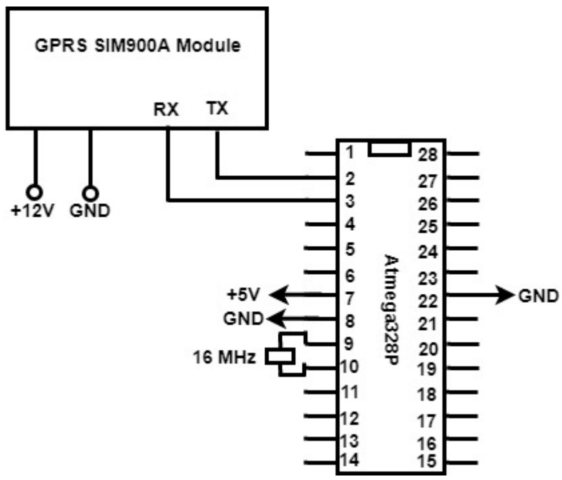

Fig.4. SIM900A GSM/GPRS module interfacing

E. Switch, Indicator and Headphone Interfacing

The Fig.5 shows that a switch is connected as an input to the Atmega328P microcontroller with a pin 11 through 1K and 10k resistors. An LED is connected to the pin of 6 as output for day night indication. The headphone is connected to the pin of 15-number pin of the microcontroller shown in Fig.6. The 25-number pin is a PWM (Pulse width modulation) pin which is able to operate the headphone.

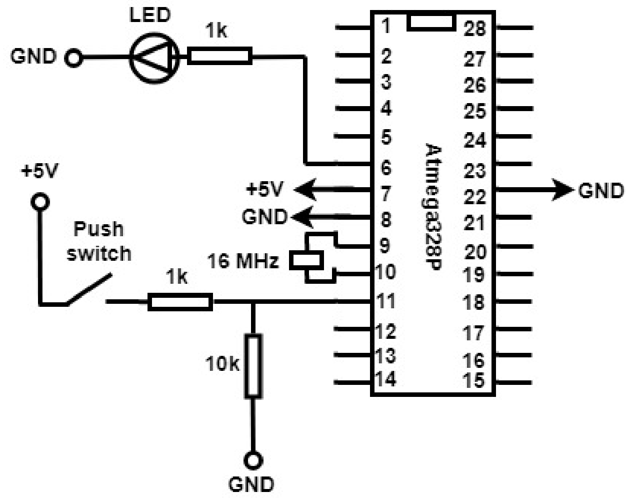

Fig.5. Switch and indicator interfacing segment

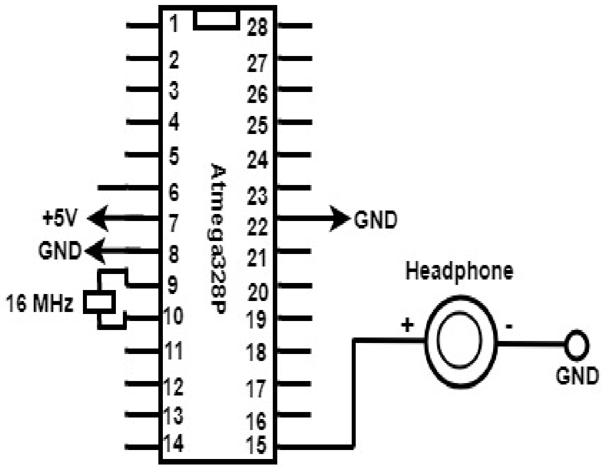

Fig. 6. Headphone interfacing segment

F. Actual Image of Proposed Model

Actual photographs of the proposed model shown in Fig.7 where three ultrasonic sensors are covered with white rubber sheet. The processing unit is covered with a black box and a white headphone is shown that is used for voice command.

Fig.7. Switch and indicator interfacing segment

III. Result and Discussion

We have tested the three ultrasonic sensors at a time by keeping the sensors in left, right and front position. The sensors measure an obstacle distance by transmitting a sound wave and receiving the reflection of the wave. For the reason, we have observed the sensors activity on different surfaces. In table –I sound reflected data are recorded. For the glass surface obstacle, we have tested three times per ultrasonic sensor. Each time we have got different data for the left, front, and right ultrasonic sensors. Similarly, different data are recorded for human body and metal as an obstacle surface. We have found that metal surface reflects more sound wave than glass and the human body surface.

TABLE I. Range of sensing obstacle distance based on different surfaces

Surface of an obstacle	**Test**	**Left Sensor**	**Front Sensor**	**Right Sensor**
		Range in cm	**Range in cm**	**Range in cm**
Glass	1	450	448	452
	2	455	452	440
	3	445	449	447
Human body	1	435	433	430
	2	444	442	440
	3	438	439	448
Metal	1	465	468	470
	2	470	468	467
	3	478	475	485

Although the sensor can measure obstacle within the range of 500 cm, a primitive value is required for perfect guiding to the visually impaired people. The one-third of the average reflection value is used as a primitive value.
Let, left sensor = LS, front sensor = FS, right sensor = RS

Sensor's reflection value on the glass surface is given by,
LS average value = (450+455+445)/3 = 450 cm
FS average value = (448+452+449)/3 = 449.6 cm
RS average value = (452+440+447)/3 = 446.3 cm

Thus, average reflection value of glass surface = (450 + 449.6 + 446.3)/3 = 448.6 cm. Similarly, the average reflection value of the human body and the metal surface are 438.8 cm and 471.8 cm respectively

The total average reflection value of three surfaces,
= (448.6 + 438.8 + 471.8) /3
= 453 cm
So, the total average reflection value is 453 cm from the three surfaces and primitive value is 151 cm. As a result, all three obstacle surfaces can be detected within the range of 453 cm. The primitive value is significant for proper guidance to the visually impaired people. By selecting the primitive value blind individually can able to aware about an obstacle at a distance 151 cm. If we keep 453 cm as the primitive value, then the problem arises in making the final decision while walking on narrow roads and narrow place. For removing the problem we have divided the total average value by three so that blind can able to walk on the narrow path.

The decisions based on ultrasonic sensors tabulated in Table II. To get the final decision efficiently, we fixed the distance 151 cm as a primitive value for the sensor. When the left and right sensor finds any obstacle within 151 cm, at the same time front sensor finds nothing then the device allows going straight. Similarly, if the front and right sensor have an obstacle within a range of 151 cm and the left sensor finds nothing then it makes the decision to go to left. Thus, the all final movement depends on left, front and right ultrasonic sensing values.

TABLE II. Decisions Based on Ultrasonic Sensors

Left sensor	Front sensor	Right sensor	Decision
Range<151 cm	Range>151 cm	Range<151 cm	Go straight
Range>151 cm	Range<151 cm	Range<151 cm	Go left
Range<151 cm	Range<151 cm	Range>151 cm	Go right
Range<151 cm	Range<151 cm	Range<151 cm	Go backward
Range>151 cm	Range>151 cm	Range>151 cm	Go straight

The proposed model is tested in three different places and data tabulated in table III. When visually impaired people pressed the push button in any situation, an SMS is sent with time, temperature and location of the subject to the guardian.

TABLE III. Decisions Based on Emergency push button

Test	Time	Temp. (Celsius)	Location
1	10.15AM	26	Zindabazar,Sylhet
2	12.30 PM	30	Ambarkhana,Sylhet
3	3.05 PM	28	Baluchor,Sylhet

IV. CONCLUSION

This paper presents a unique smart device for visually impaired users, which can help them to travel anytime avoiding any kinds of obstacle indoor and outdoor environment. Our proposed device is more comfortable and less expensive. The ultrasonic sensors are used in this device which is small, light in weight, and consume less power thus users friendly. Although our proposed model response quickly, but it cannot detect the ground level object. Future research work will include (I) making the system wireless and (II) implementing image recognition to get the information of obstacle.

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