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Robotic assistance for the visually impaired and elderly people

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ABSTRACT

This paper presents a smart multipurpose human assistance robot that guides the visually impaired and elderly people to some predefined destination, avoiding obstacles and traffic. The robot can recognize the words spoken by the user command them or take an action according to user command. Voice commands given through an android Smartphone are transferred to the main MCU of the robot using a Bluetooth serial port that runs Bluetooth SPP protocol stack. Touch sensitive skin fitted to the robot senses human finger touch and helps answering requests such as time, date and weather conditions such as light and temperature. The same can be done using voice also. During the day time it can charge itself by moving around within a given region in order to find the maximum sun light thereby freeing the user completely from maintenance issues such as battery charging. Unlike the other guidance systems, the user need not carry this in hand. The robot can also detect the distance between the user and itself and move accordingly offering an efficient human assistance.

***KEYWORDS*:** Ultrasonic sensors, MEMS compass, Android application, Bluetooth serial port

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I. INTRODUCTION

A literature research on the visually impaired system that currently works across the globe use GPS or satellite to locate the position of the user and their destination place. Sometimes unexpected obstacles may not be correctly located by the GPS system. Therefore a system that co-ordinates the work of the present system along with an effective way to avoid unexpected obstacles need to be developed along with the consideration for cost-effectiveness. Guide dogs use the method of way finding to find any remote location [4][5].The key priority of the prototype is to create a low- cost and portable navigation system that utilizes the recent developments in the voice recognition. Presently laser-cane or Nav-belt informs the users about the barriers. But these systems tend to be expensive and they all require Braille interface[7]. A web-based navigation system is widely available now to provide effective guidelines. But they require the area where the user is present to be equipped with the access to a high-speed internet and access to goggle maps. A common man is far out of reach to all these sophistications.

This paper proposes a guide dog based robotic system that makes use of the inexpensive ultrasonic sensor to detect the obstacles and provides direction guidance to the user by means of voice. The request to the robotic system from the user can be made via the Smartphone using the android App developed. The requisition is transferred via the Bluetooth stack since the distance between the robot and the user is not so far. When this distance increases the robot automatically stops and waits for the user to come within its range. Some of the necessity like temperature or day and night are provided to the user upon request. In order to ensure that the system is accessible to a greater proportion of people, the device is made more portable and cost effective.

II. EXISTING SYSTEM

Most of the visually impaired people can walk independently when their walking area is well known to them. Within an unknown area, they require guide dogs or the help of any other person for walking. In India most of the roads are unruly therefore a system that was developed using a map may not suite correctly sometimes. For many visually impaired people, a cane or a stick is a close friend helping them to detect and avoid obstacles in the walking paths. During walking with the cane, they sense and guess directions and locations by hearing sounds surrounding, sniffing smells in the air, feeling touches on skin, counting footsteps they walk, and memorizing events in time and spaces. However, it is difficult for them to do this all the time when surrounding environment could suddenly change, or when they get lost memory of locations.

Special kind of walkers and other guidance systems are used in current technology. There are many deficiencies in the present walker systems. First, many walkers are designed for the indoor environment. Second, most of them are big in size and/or heavy in weight. An indoor robot is often restricted within limited places. Big size makes it impossible to be used in narrow space and heavy weight restricts the maneuverability. The recognition of user's walking intention plays an important role in the study of the walker-type rehabilitation robots [6]. From the viewpoint of the control system of robot, the walking intention provides a real-time reference trajectory for the robot motion controller. Therefore, the more accurately the walking intention is inferred, the more satisfactory the control performance of the robot may be obtained. A new omnidirectional-type cane robot was developed for the elderly and handicapped. The effectiveness of this system was confirmed through experiments. It should be pointed out that the interface between the human and the robot is the multi-axis force sensor, which is expensive and fragile. To lower the cost and improve the system reliability, a low-cost sensing system comprising cheaper force sensors (e.g., force sensing resistors) and range finding sensors for the cane robot has to be utilized. By utilizing some sensor fusion approaches, the state of user can then be reliably recognized and provided to the motion controller.

Most of the sophisticated systems require GPS for tracking the person. One such system is the ARGUS project that focuses onto the development of a service platform and a satellite based navigation terminal for people with impaired visually capabilities, to guide them along a predefined track, using acoustic and audio-haptic signals... ARGUS project primarily retrieves benefits from satellite navigation services and technologies to increase the level of positioning accuracy and reliability as well as the level of service availability. This kind of GPS and satellite navigation adds a huge amount of cost to the system.

III. COMPONENTS OF THE PROPOSED SYSTEM

(i) ULTRASONIC SENSOR HC-SR04:

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:

(1) Using IO trigger for at least 10us high level signal,
(2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.
(3) IF the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning.

Test distance = (high level time×velocity of sound)/ 2

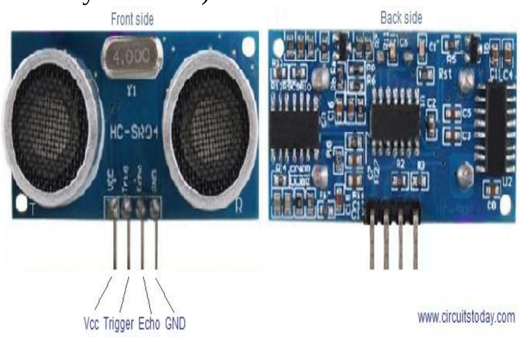

Fig.2 Ultrasonic sensors

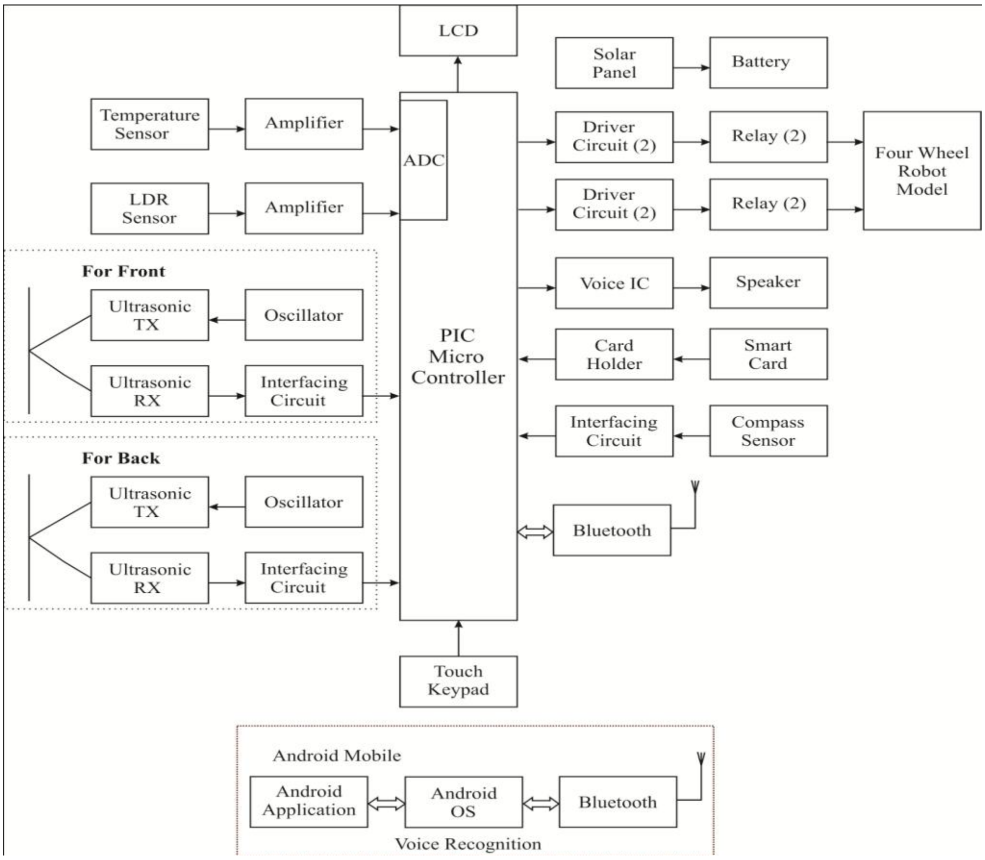

Fig.1 System implementation

(ii)TEMPERATURE SENSOR (THERMISTER):

Thermistors are generally made from ceramic materials such as oxides of nickel, manganese or cobalt coated in glass which makes them easily damaged. Their main advantage over snap-action types is their speed of response to any changes in temperature, accuracy and repeatability. Thermistors are constructed from a ceramic type semiconductor material using metal oxide technology such as manganese, cobalt and nickel, etc.

(iii)SOLAR PANEL:

A solar panel turns the suns light into electricity. We see electricity at work every day. For instance, when you turn on a lamp, electrons move through the cord and light up the bulb. That flow of electrons is called electricity. A solar panel is made up of o many small solar cells. Each of it uses light to make electrons move. The cell is made up of two different layers that are connected together. The first layer is loaded with electrons, so they are ready to jump from this layer to the second layer. The second layer has some electrons take away, so it is ready to take in more electrons. When the light falls on the electron in the first layer, the electron jumps to the second layer. That electron makes another electron move, which makes another electron move, and so on. It was the sunlight that started the flow of electrons, or electricity.

Fig.3 Solar panel

(iv)LDR (Light Dependent Resistor):

The light dependent resistor is a component that uses a photconductor between two contacts. When this is exposed to light a change in resistance is noted. Photoconductivity - the mechanism behind the photoresistor - results from the generation of mobile carriers when photons are absorbed by the semiconductor material used for the photoconductor.

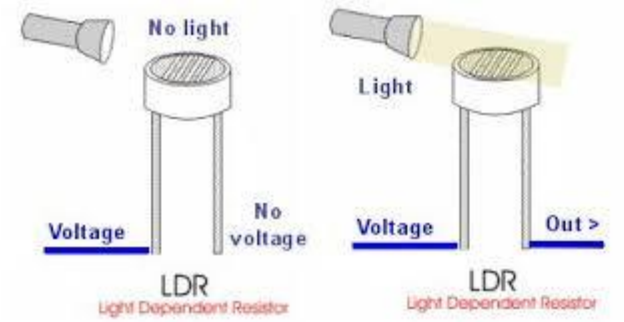

Fig.4 Light Dependent Resistor

(v)MEMS SENSOR:

Micro-Electro-Mechanical Systems, or MEMS, is a technology that in its most general form can be defined as miniaturized mechanical and electro-mechanical elements (i.e., devices and structures) that are made using the techniques of micro fabrication. With the recent introduction of 30 different gyroscopes delivering high performances with reduced current consumption and compact packages, STMicroelectronics is continuing its rapid growth in the MEMS market. The heart of ST's gyroscopes is represented by a micro-machined, mechanical element designed to operate according to a tuning fork scheme, exploiting the Coriolis effect to transform an angular rate into a displacement of a specific sensing structure. STMicroelectronics offers a wide selection of gyroscopes covering from one to three axes of sensitivity and full-scale ranges from 30 dps up to 6,000 dps. This gives system designers the possibility of addressing different applications ranging from image stabilization to gaming, pointing devices and robotics control.

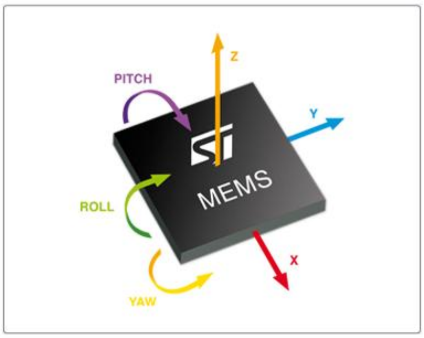

Fig.5 MEMS sensor

(vi)BLUETOOTH:

Bluetooth is an open wireless technology standard for exchanging data over short distancesfrom fixed and mobile devices, creating personal area networks (PANs) with high levels of security. Bluetooth uses a radio technology called frequency-hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands (1 MHz each) in the range 2402-2480 MHz. Bluetooth is a standard communications protocol primarily designed for low power consumption, with a short range (power-class-dependent: 100 m, 10 m and 1 m, but ranges vary in practice; see table below) based on low-cost transceiver microchips in each device.

(vii) ANDROID APPLICATION:

As Android continues to grow beyond smartphones, it will become the brains behind invisible, ubiquitous cloud-connected computing. These days the demand of smart phone is being increased and we have different types of client e.g. Touch Phone, tables, Note etc. The demands of the applications for these smart clients are constantly increasing and we have several operating systems for these smart clients e.g. Android, IOS and Windows etc.

IV. SYSTEM IMPLEMENTATION

The system implementation is done by using PIC16F877A. This microcontroller has an inbuilt ADC function in it that can be used to directly use to convert the temperature and daylight values.

The robotic system walks in front of the person and the ultrasonic sensors are fitted at the front and back of the robot. The distance between the robot and the user is continually monitored by the signals from the ultrasonic sensor when this distance exceeds a threshold, meaning that is the user is unable to receive/send signal, the robot stops until distance is close enough again to move forward.

Table.1Robot direction

Distance (M)	**Pin value**	**Movement**
>40	R2, R4=0,R1,R3=0	Stop
<40	R2,R4=1,R1,R3=0	Forward

The ultrasonic sensors mounted on the front of the robot detects any kind of obstacles present in front of it and instructs the user to move correspondingly to right or left or to stop. The voice signal instructions are stored on the voice IC.The direction of robots is sensed using the MEMS compass. The MEMS compass value is sensed by the processer. Depending upon the value the direction of the robot is predicted as given in the table.2

The signals are sent and received through the Bluetooth protocol stack. The system is designed to measure the value of temperature, day, time through the sensor upon the request by the user. When the recorded temperature is greater than 40 it is regarded as high. If the value of the LDR sensor is greater than 50 it is regarded as night. Communication by the user is done through an android application that is developed for this purpose. Commands are issued either as voice or by touch. They are recognized by application and the signal is sent to the robot system

Table.2 MEMS compass direction

Compass value (in degree)	**Direction**
0 to 40	East
70 to 100	South
100 to 150	North
160 to 200	West

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The robot can be locked for authority using the touch panel. Touch panel is integrated to enable not only visually impaired people and also the other elderly people to use it. The user can send the request also through the touch panel. To get the required power for the system to function solar panel is incorporated on it .The system searches itself for maximum sunlight when it is not in use and charges by itself thereby saving the battery requirement for the system.

V. RESULTS AND DISCUSSION

Experimental results for the proposed system are summarized below. The temperature sensor shows no abnormalities when the value after the conversion to ADC is below 40. Hence in the fig.7 the result is displayed to have no abnormalities which are also sent through the voice output. When the LDR value is sensed above 50 the daylight value is said to be night.

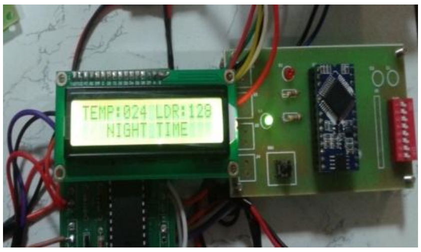

Fig.7 Temperature and light sensing

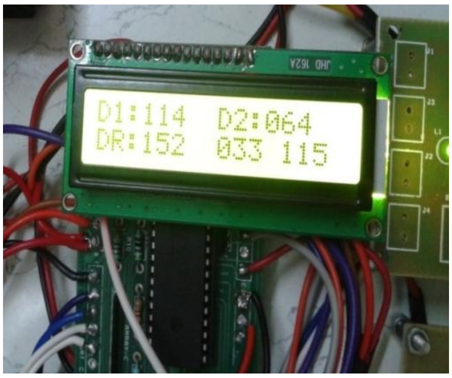

Fig.8 Distance of the obstacle and direction of MEMS compass

The values for the direction and distance are displayed in the LCD as shown in the fig.8. D1 is the distance between the obstacle and the robot. D2 is the distance between the robot and the user. DR is the direction the of the MEMS compass orientation in the corresponding directions.

VI. CONCLUSION

Information is provided in natural MP3 quality voice interface via an external speaker. Capacitive Touch eliminates finger pain while using older Braille keys and allows blind people to enter notes and control device operation easily. Sun finding based intelligent charging with GPS less path following based on compass and distance sensor makes it cost effective. To ensure that a navigation system will be accessible to the greatest proportion of vision impaired people, usability is a key focus of the project, and speech recognition technology was identified as a priority feature of the system. It is also designed to act as an advanced multipurpose human assistance and service robot that is able recognize the words spoken by the user, talk to them and take action according to the spoken voice command.

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