

Smart Electronic Stick for Visually Impaired

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ABSTRACT: The aim of this paper is to provide a low cost and efficient navigation aid for blind which gives a sense of artificial vision by providing information about the environmental scenario of static and dynamic objects around them. The paper presents a theoretical model and a system concept to provide a smart electronic aid for blind people. The system is intended to provide overall measures – Artificial vision, object detection and emergency messaging facility. The system uses ultrasonic sensors to calculate distance of the obstacles around the blind person to guide the user towards the available path. Output is in the form of beeps which the blind person can hear. GPS and GSM are used to acquire the exact location of the blind person at times of emergency and send the co-ordinates to his relatives or care taker. The hardware consists of Arduino mega board, ultrasonic sensors, infrared sensor, GPS, GSM and two speakers.

I. INTRODUCTION

Vision is the most important part of human physiology as 83% of information human being gets from the environment is via sight. The 2011 statistics by the World Health Organization (WHO) estimates that there are 285 billion people in world with visual impairment, 39 billion of which are blind and 246 with low vision. The traditional and oldest mobility aids for persons with visual impairments are the walking cane (also called white cane or stick) and guide dogs. The most important drawbacks of these aids are necessary skills and training phase, range of motion and very little information conveyed. With the rapid advances of modern technology, both in hardware and software front has brought potential to provide intelligent navigation capabilities. Recently there has been a lot of Electronic Travel Aids (ETA) designed and devised to help the blind navigate independently and safely. Also high-end technological solutions have been introduced recently to help blind persons navigate independently. Many blind guidance systems use ultrasound because of its immunity to the environmental noise. Another reason why ultrasonic is popular is that the technology is relatively inexpensive, and also ultrasound emitters and detectors are small enough to be carried without the need for complex circuit.

II. METHODOLOGY

In the given block diagram, there is an integration of 3 ultrasonic sensors to pins corresponding to digital pins 9- 13 of the arduino mother board. The digital range meaning from 0 to 1023 where 0 means 0 Volts and 5 volts meaning the highest voltage either 5V or 3.3 V. Three ultrasonic sensors are used for the purpose of obstacle detection in the blind stick. Ultrasonic sensors work on the principle of ultrasonics. Ultrasonic is a high frequency acoustic wave. This wave is directed towards a medium. In case of any obstacle or hindrance present in the medium, these waves are reflected back in the form of echoes. These echoes are detected and used for the measurement of distance of the obstacle. The duration the wave takes to get transmitted through a medium, hit an obstacle and return back as echoes are calculated. The duration is then halved to get the distance to the obstacle. In our paper, it is important to know how far the obstacle is and then alarm the blind person to move accordingly so that he doesn't hit himself. The sensor works as both the transmitter and receiver thereby sending the ultrasonic waves and detecting the reflected echoes. It is important that these obstacles are detected and intimated to the user within a certain range. Hence, a threshold value is set, lesser than or equal to this value will set off alarm in the form of beeps. The infrared sensor is used for direction navigation. The infrared sensor has specific values. The blind stick is attached with 2 wheels at the bottom part. One of the wheels has a piece of paper attached to it. Each time the sensor, sensed this piece, it is counted as 1 rotation. Hence the distance between two different points is calculated as the number of rotations needed to reach the point. In other words, the number of times the sensor will sense the piece of obstruction would be equal to the distance needed to be travelled by the stick. The output of this is given in the form of beeps through the speaker. For example, low frequency beeps for left and high frequency beeps for right. These signals help in navigation without the need of a human, thereby making the

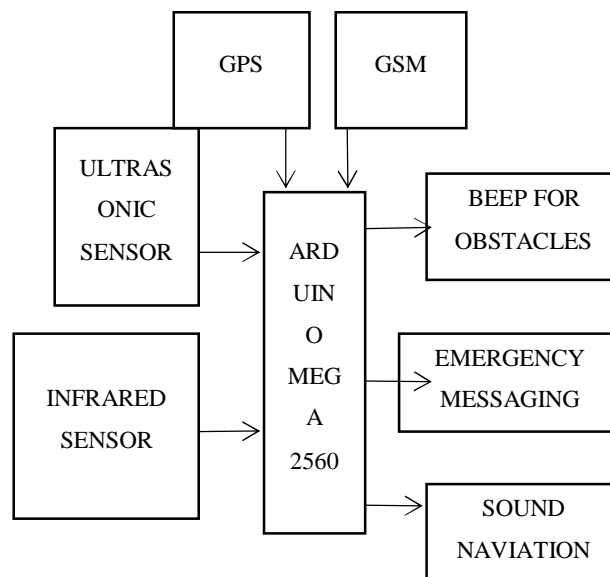
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blind person independent. The GPS module is used to get the latitude and longitude values of the location of the accident. The SKG-13C GPS module internally the GPS module collects information from the satellite and prints it out in the NMEA format comprising of the time details and the latitude details printed and transmitted in a string of characters transmitted at a standard baud rate of 4800. The string of characters is then separated in-terms of the NEMA considerations and sent to the ambulance and the family member. The connections of the GPS module with the Arduino is as in the figure, the tx of the GPS module is connected to the rx or the pin 2 of the Arduino hence initializing the pin 2 to receive the data and the pin 3 to transmit data to the GPS which is not necessary since GPS is a receiving module. The GPS module is continuously receiving data, the choice of when to collect the data and print and essentially the data from the GPS a string of characters has to be decoded and is done only when the sensors exceed a given threshold. The latitude and longitude positions received from the GPS is sent via GSM. The GSM used is a SIM900 Module whose RX is connected to the TX of the Arduino and the TX of the GSM module is connected to the RX of the Arduino the connections once set an AT command is sent which will be dealt in software explanations. The GSM module sends the given data to the specified numbers.

III. IMPLEMENTATION



A. ARDUINO MEGA

The Arduino Mega is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 12 analog inputs, a 16 MHz ceramic resonator, 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.

The specifications of the Arduino MEGA are as follows:

1. Microcontroller- ATmega2560
2. Operating Voltage- 5V
3. Input Voltage (recommended)- 7-12V
4. Input Voltage (limits)- 6-20V
5. Digital I/O Pins- 54 (of which 6 provide PWM output)
6. Analog Input Pins- 12
7. DC Current per I/O Pin- 40 mA
8. DC Current for 3.3V Pin- 50 mA

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9. Flash Memory- 32 KB (ATmega328) of which 0.5 KB used by bootloader
10. SRAM- 2 KB (ATmega328)
11. EEPROM- 1 KB (ATmega328)
12. Clock Speed- 16 MHz

B. ULTRASONIC SENSOR

Ultrasonic sensor is used to trigger the circuit when the distance between the rider and the bike exceeds the preset threshold value. The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats or dolphins do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package. From 2cm to 400 cm or 1" to 13 feet. Its operation is not affected by sunlight or black material like Sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). It comes complete with ultrasonic transmitter and receiver module.

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.

$$\text{Test distance} = (\text{high level time} \times \text{velocity of sound (340M/S)}) / 2$$

The following are its specifications:

- Power Supply :+5V DC
- Quiescent Current :<2mA
- Working Current: 15mA
- Effectual Angle: <15°
- Ranging Distance : 2cm – 400 cm/1" - 13ft
- Resolution : 0.3 cm
- Measuring Angle: 30 degree
- Trigger Input Pulse width: 10Ms
- Dimension: 45mm x 20mm x 15mm

It has 4 pins. These are:

Vcc =+5 V DC

Trig= trigger input of sensor

Echo= echo output of sensor

GND= ground

C. INFRARED SENSOR

An IR sensor is a device which detects IR radiation falling on it. There are numerous types of IR sensors that are built and can be built depending on the application. Proximity sensors (Used in Touch Screen phones and Edge Avoiding Robots), contrast sensors (Used in Line Following Robots) and obstruction counters/sensors (Used for counting goods and in Burglar Alarms) are some examples, which use IR sensors. This is the sensor which when ON will switch ON the whole circuit. If the IR sensor is OFF, then the whole circuit will not work and if it is working it should not give any false reading. Since it is an analog sensor, so fluctuations are very much possible in this case. It should be calibrated accurately. An IR proximity sensor works by applying a voltage to a pair of IR light emitting diodes (LED's) which in turn, emit infrared light. This light propagates through the air and once it hits an object it is reflected back towards the sensor. If the object is close, the reflected light will be stronger than if the object is further away. The sensing unit (for this experiment a Sharp IS471FE will be used), in the form of an integrated circuit (IC), detects the reflected infrared light, and if its intensity is strong enough, the circuit becomes active. When the sensing unit becomes active, it sends a corresponding signal to the output terminal which can then be used to activate any number of devices. For the purpose of this exercise, a small green LED will turn on when the sensor becomes active. It is an analog sensor whose output is distributed in the range of 0-1023 in the Arduino Mega. It penetrates the skin and then reflected back from the skin.

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Some of the IR is absorbed in the body which is different for different parts of the body. There is need to calibrate the sensor accordingly.

FEATURES

- Up to 2 m for proximity sensing
- Photo detector and preamplifier in one package
- Low supply current
- Shielding against EMI
- Visible light is suppressed by IR filter
- Insensitive to supply voltage ripple and noise

D. GPS MODULE

The Skylab SKG13C is a complete GPS module that features super sensitivity, ultra low power and small form factor. The GPS signal is applied to the antenna input of module, and a complete serial data message with position, velocity and time information is presented at the serial interface with NMEA protocol or custom protocol. Its -165dBm tracking sensitivity extends positioning coverage into place like urban canyons and dense foliage environment where the GPS was not possible before. The small form factor and low power consumption make the module easy to integrate into portable device like PNDs, mobile phones, cameras and vehicle navigation systems.

FEATURE

1. Ultra high sensitivity
2. Low power consumption: Max 30mA at 3.3V
3. NMEA-0183 compliant protocol or custom protocol
4. Operating voltage: 3.0V to 3.6V
5. Small form factor: 13x15x2.6mm

E. GSM

This is a GSM/GPRS-compatible Quad-band cell phone, which works on a frequency of 850/900/1800/1900MHz and which can be used not only to access the Internet, but also for oral communication (provided that it is connected to a microphone and a small loud speaker) and for SMSs. Externally, it looks like a big package (0.94 inches x 0.94 inches x 0.12 inches) with L-shaped contacts on four sides so that they can be soldered both on the side and at the bottom. Internally, the module is managed by an AMR926EJ-S processor, which controls phone communication, data communication (through an integrated TCP/IP stack), and (through an UART and a TTL serial interface) the communication with the circuit interfaced with the cell phone itself. The processor is also in charge of a SIM card (3 or 1,8 V) which needs to be attached to the outer wall of the module. In addition, the GSM900 device integrates an analog interface, an A/D converter, an RTC, an SPI bus, an I²C, and a PWM module. The radio section is GSM phase 2/2+ compatible and is either class 4 (2 W) at 850/ 900 MHz or class 1 (1 W) at 1800/1900 MHz. The TTL serial interface is in charge not only of communicating all the data relative to the SMS already received and those that come in during TCP/IP sessions in GPRS (the data-rate is determined by GPRS class 10: max. 85,6 kbps), but also of receiving the circuit commands (in our case, coming from the PIC governing the remote control) that can be either AT standard or AT-enhanced SIMCom type. The module is supplied with continuous energy (between 3.4 and 4.5 V) and absorbs a maximum of 0.8 A during transmission.

FEATURES

High Quality Product (Not hobby grade)
Quad Band GSM\GPRS
850/ 900/ 1800/ 1900 MHz
Built in RS232 Level Converter
Configurable baud rate

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External antennae
Built in SIM card holder
Inbuilt Powerful TCP/IP protocol stack for internet data transfer over GPRS.
Built in Network Status LED
Audio interface Connector

F. SPEAKER

Multimedia speakers, are speakers external to a computer, that disable the lower fidelity built-in speaker. They often have a low-power internal amplifier. The standard audio connection is a 3.5 mm (approximately 1/8 inch) stereo phone connector often color-coded lime green (following the PC 99 standard) for computer sound cards. A few use a RCA connector for input. There are also USB speakers which are powered from the 5 volts at 500 milliamps provided by the USB port, allowing about 2.5 watts of output power. Computer speakers were introduced by Altec Lansing in 1990.^[1] Computer speakers range widely in quality and in price. The computer speakers typically packaged with computer systems are small, plastic, and have mediocre sound quality. Some computer speakers have equalization features such as bass and treble controls. The internal amplifiers require an external power source, usually an AC adapter. More sophisticated computer speakers can have a subwoofer unit, to enhance bass output, and these units usually include the power amplifiers both for the bass speaker, and the small satellite speakers.

Some computer displays have rather basic speakers built-in. Laptops come with integrated speakers. Restricted space available in laptops means these speakers usually produce low-quality sound. For some users, a lead connecting computer sound output to an existing stereo system is practical. This normally yields much better results than small low-cost computer speakers. Computer speakers can also serve as an economy amplifier for MP3 player use for those who wish to not use headphones, although some models of computer speakers have headphone jacks of their own.

Product Information:

- Loudspeaker, mini, Mylar Cone
- Transducer Function: Speaker
- Power Rating RMS: 1W
- Impedance: 8ohm
- Resonant Frequency: 350Hz
- Frequency Response Min: 350Hz
- Frequency Response Max: 20000Hz
- External Diameter: 50mm
- External Height: 7.2mm
- External Width: 50mm
- External Depth: 7.2mm
- External Diameter: 50mm
- External Length / Height: 7.2mm
- Material: Nd-Fe-B
- Operating Temperature Max: 40°C
- Operating Temperature Min: -10°C
- Output Power (Pout): 1.5 W
- Power Rating: 1W
- Sound Level Distance: 10cm
- Sound Level SPL: 94dB

G. Keypad

Punch in your secret key into this numeric matrix keypad. This keypad has 12 buttons, arranged in a telephone-line 3x4 grid. It's made of a thin, flexible membrane material with an adhesive backing (just remove the paper) so you can attach it to nearly anything. The keys are connected into a matrix, so you only need 7 microcontroller pins (3-columns and 4-

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rows) to scan through the pad. Check the tutorials tab for links to an Arduino library and example code. We include a 7-pin extra-long header strip so you can plug this into a breadboard with ease.

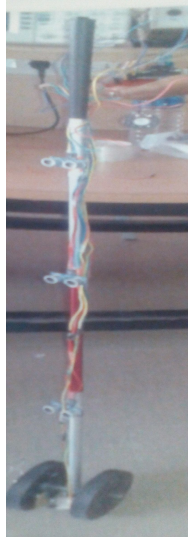


Figure: Final smart cane for viually impaired

TECHNICAL DETAILS

Weight: 7.5 grams

Keypad dimensions: 70mm x 77mm x 1mm (2.75" x 3" x 0.035")

Length of cable + connector: 85mm, 7-pin 0.1" pitch connector

IV. SOFTWARE

The Arduino motherboard have its own software called the Arduino.in. This software has a lot of advantages over the other that are currently available. The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board.

The advantages of this software are:- Easy to code. Flexibility, Adaptable., Wide range of libraries. Wide range of applications. Reduces the space of code

V. CONCLUSION

The electronic guide stick that helps the visually impaired patients to move around freely. They wouldn't need human dependence as this system makes them independent. The sensors use in this paper are highly accurate and sensitive. They provide exact readings of obstacles and distance to be travelled. The GPS and GSM modules used to provide the location of the patient and thus help the patient in time of need by sending an emergency messaging. The speaker helps in human-machine interface by sending the signals to the patient about obstacles and route to be travelled. For simplicity and understanding of the patient is provide two separate speakers. We conclude by saying that this is a step taken to make visually impaired patients to lead an independent life and help them move around freely.

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