NAVIGATING LIFE: THE DEVELOPMENT OF A BLIND ASSISTANT ROBOT

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Blindness is a major problem among the disabilities of Human. It is difficult to lead a normal life for blind person..So, most of the blind person require travel aids to move freely in unknown environment. To gain free movement, a device with more features is required. For this issue,we introduce our product "The Blind Assistant Robot" . This device avoid the requirement of human assistance for blind . It has reliable parts and has a comparatively low cost to industrial bots. Every parts of the device is simulated ,sampled and tested. The device can run by any operator and requires low power and it is highly efficient. Arduino Mega (ATMega2560) used as the processor, ultrasonic sensors used to detect any obstacles in front of the bot, IR sensors provided here to sense line. For navigation here use Two dc motors are connected followed by a full bridge motor driver (L98) module. A buzzer and a vibration motor and a feedback used to give notification to the user. The device will follow a predefined line and will follow the instructions , will detect obstacle, crater,fire and stairs and gives beep sound to the user. The device will act as an assistance of the blind peoples and make a friendly environment to the challenged people.

KEYWORDS: Ultrasonic sensors, voice notification system, IR sensors, Arduino Mega.

1. INTRODUCTION

In the current world, a huge number of peoples around the world are physically disabled. Among them majority number of peoples are visually impaired or completely blind. It is difficult to lead a normal life for them. Because lack of sight is a great problem for them to navigate independently. Visually impaired peoples dependent on the help of sighted person to find their way or need an accompanying person to follow. Most of the blind peoples can not find their way autonomously to an unknown area. Technologies became hope for them to navigate freely. Blind Stick[1,2], Tactile Display[3] , Book reader etc. But the technologies are either insufficient or not cost friendly. However, in this project report, a device is proposed to help blind to navigate freely or independently; without help of other human. The proposed device will fulfill the demand of other human for assistance. The device will act as an intelligent robotic friend of blind.

2. LITERATURE REVIEW

2.2.1. The Guide Cane – A Computerized Travel Aid by Johann Borenstein

The Guide Cane is one of the first assistive technology introduced for blinds; a novel device designed to help blind or visually impaired peoples to navigate safely and relatively quickly among obstacles and other hazards faced by a blind pedestrian[4] .a long handle and a sensor head attached at the end of the handle. The sensor head is mounted on a steerable 2 free wheeled axle. Ultrasonic sensors are mounted on the sensor head to detect obstacles ahead of it. The device steers when it found any obstacle and user feels the steering command through the handle. But the major drawback of the device is; it can only detect obstacle in front of it and the device is dependent on user. The device is easy to operate and can carry easily. Figure 2.1 shows a blind user walking with the Guide Cane. White cane like which is used widely, the user holds the Guide Cane in front of him/herself while walking. The Guide Cane is heavier than the white cane, but it rolls on wheels that support the Guide Cane's weight during regular operation. At the lag end of the Guide Cane is a pair of guide wheels. A steering servo motor, operating under the control of the Guide Cane's built-in computer, can steer the guide wheels left and right, relative to the cane. On the guide wheels , array of ultrasonic sensors is mounted in a semi-circular fashion for the detection. But the limitation of the device is, it can only detect obstacle ahead of it.

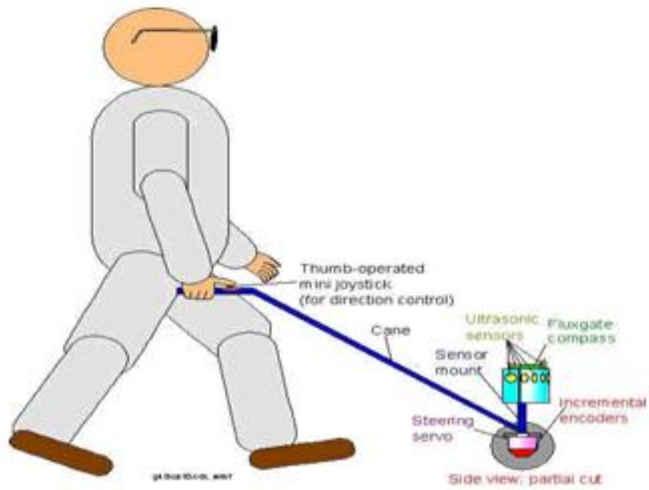

Figure2.1: The Guide Cane – A Travel aid for blind .

2.2.2 Smart Walking Stick by Mohammad Hazzaz Mahmud

Mohammad Hazzaz Mahmud, RanaSaha and Sayemul Islam designed a prototype[5] of a smartest contest of SMART WALKING STICK for blind people which rendered a fresh dimension of useful assistance and gives a bit of artificial vision with occlusion avoiding capability. This low power, light weight and cost effective device is designed to take pattern of portable devices. The main purpose of this paper is based on conquering the challenges of blindness by constructing a microcontroller based automated hardware that can stabilize a blind to detect obstacles in front of him/her instantly. The hardware consists of a microcontroller accompanied with ping sonar sensor, proximity sensor, wet detector, a micro pager motor .

The implanted smart walking stick scheme based of several subsystems. These subsystems fundamentally sensor based. The integral system is designed with a circuitry fundamental on a PIC microcontroller (PIC16F90). This microcontroller operates the whole scheme by functioning and linking the subsystems in good order.

Figure2. 3 shows Physical Structure of Smart stick The sensor based circuitry consisting of sensors Ping Sonar Sensor is used to detect ranges from obstacles, GH311 Ultrasonic Obstacle Sensor is applied to notice what's at the bottom of the stick, a pair of electrodes are used to observe wetness at its underneath. A PIC16F690 microcontroller reads these sensors and drives a buzzer, a LED and a motor with PWM. Vibratory module included with a Micro Pager Motor which outputs is fixed by PWM to obtain different vibratory pattern. An audio output is designated by a buzzer alarm. The output signals are operated by PWM to hold distinct sound form as well as it indicates the scheme's status.

Figure 2.2: Smart walking stick.

2.2.3. Wearable Obstacle Avoidance Electronic Travel Aids by DimitriosDakopoulos

There are 3 main categories of these systems: Electronic travel aids[2] , electronic orientation aids , and position locator devices. This paper presents a broad survey among portable/wearable obstacle detection/avoidance systems (a subcategory of ETAs) in an effort to inform the research community and users about the capabilities of these systems and about the advance in assistive technology for visually challenged people. The survey is based on various characters and performance parameters of the systems that classify them in categories, giving qualitative–quantitative measures. Finally, it offers a ranking, which will serve only as a reference point and not as a critique on these systems .Electronic travel aids (ETAs): devices that transform information about the environment that would normally be relayed through vision into a form that can be prescribed through another sensory modality. Electronic orientation aids (EOAs) devices that provide orientation superior to, or during the travel. They can be external to the user and/or can be carried by the user (e.g., infrared light transmitters and handheld receivers). Position locator devices (PLDs): which include technologies like GPS, European Geostationary Navigation Overlay Service (EGNOS) etc.

3. METHODOLOGY

3.1 Introduction

The motive of the project is to help blind peoples to navigate without help of others. Ultrasonic Sensors are used to detect front obstacles, to detect wall on both sides, to detect stair or slope, to detect holes on front side. IR sensor is used to detect path. The robot will follow walls and path and also gives notification via buzzer and vibration to its user for every operation. Arduino IDE (V1.6.3) used as the programming software in this project. Developed algorithm is implemented by this software. Circuit diagram is drawn in Proteus 7.7, simulation software developed by Labcenter Electronics.

3.2 Block Diagram of the project

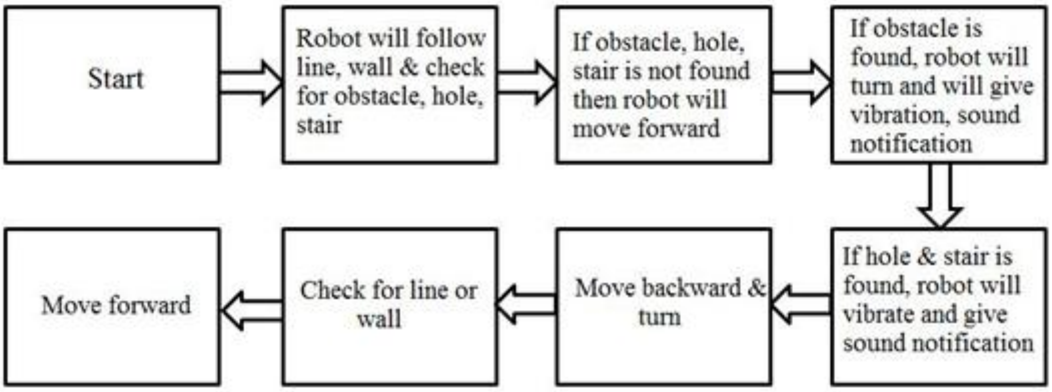

Figure 3.1: Functional Block Diagram of Proposed System

Figure 3.1 shows the complete block diagram of the project. Robot will start when it gets power and will move forward following wall and line. Then it will check for obstacles as well as hole and stair. If any obstacle, hole or stair is not found, robot will move forward. If it detects obstacles, then robot will turn and at a time will give vibration and beep once. If robot will found hole or stair then it will stop instantly and vibrate as well as beep twice. Then it will move backward and turn left or right. If the robot turn right then it will beep for three times and if turn left, it will beep for four times. Again the robot will search for line or wall and move forward.

3.3 Hardware Development

Major Components needed for this project are:

- Arduino Mega (ATmega2560)
- Line Tracking IR Sensor Array
- Full Bridge DC motor Driver: L298
- Ultrasonic Sensors
- Buzzer
- DC Motors
- Vibration Motor

3.3.1ARDUINO Mega (ATmega2560)

Arduino Mega (ATmega2560) [5]is the most advanced microcontroller board of Arduino based on the ATmega2560 processor . Figure 3.2 shows an Arduino Mega (ATMega2560). it has 54 digital IO/OP pins and 16 analog inputs. 14 out of 54 digital input/output pins can be used as PWM (Pulse Width Modulation) output. It has also 4 UARTs (hardware serial port, a 16 MHz Crystal Oscillator and a USB connector, a power jack, an ICSP header, and a reset button, simply connecting it to a computer with with a AC to DC adapter or battery to get started. The Arduino Mega is compatible with most of the shields designed for the ArduinoDuemilanove or Diecimila. Table 3.1 shows the features of the Arduino Mega (ATmeg2560).

Table 3.1: Features of Arduino Mega (ATmega2560).

Parameter	**Characteristics**
Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (Recommended)	7-12V
Input Voltage (Limits)	6-20V
Digital Input/Output Pins	54 (of which 14 used as PWM output)
Analog Input Pins	16
DC Current per Input/Output Pins	40mA

DC Current for 3.3V Pin	50mA
Flash Memory	256 KB of which 8 KB used by boot loader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz

Line Tracking IR Sensor Array
Line Tracking Sensor Array consists of 4 pair of IR Transmitter-Receiver shown in Figure 3.1. A POT is used to control intensity of the infrared wave for every pair. IR Sensors work by using a specific light sensor to detect light wavelength in the Infra-Red (IR) spectrum. By using a LED which produces light at the same wavelength as what the sensor is looking for, can be looked at the intensity of the received light.

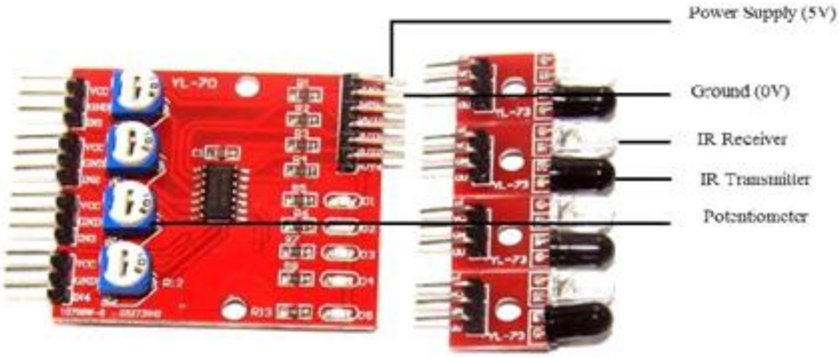

Figure 3.1: Line Tracker IR Array Module .

3.3.2 Full Bridge DC Motor Controller: L298D
The motor driver module is based on L298 dual dc motor driver IC. It can control a maximum of 2 DC motors at a time in desired direction. To use this module, simply connect the two leads of the motor to the blue terminal block connector and give proper signal to the all enable and input pins.The module has on board voltage regulator for supplying 5V to L298 IC. There is also three separate power rails for Input voltage, Ground and 5V supply so the module can be used as a small power distribution board. The enable switch performs the activation and deactivation of the L298 IC. It has 15 pins where four input, four output, two enable, one Vcc, one Vs, one ground and two current sensing pin.

3.3.3 Ultrasonic Sensor: HC –SR04
An Ultrasonic sensor is a device that can measure distance or detect obstacles ahead of it by using sound waves. It measures distance by sending out a ultrasonic sound wave at a specific frequency and listening for that sound to bounce back. An Ultrasonic Sensor. The module is consists of a transmitter, a receiver and a control circuit including a crystal oscillator. The four pins of the ultrasonic sensors are supply pin,,trigger pin,echo pin,ground.The working principle of the device is similar to the radar and sonar system. Active ultrasonic sensor generate high frequency sound waves and evaluate the echo which is received back by the sensor. By measuring the time interval between sending and receiving the echo, the distance between the sensor to the object can be measured. Ultrasonic ranging module: HC-SR04 is used in this project. The range of the sensor is 2cm to 400cm and the ranging accuracy can reach to 3mm.

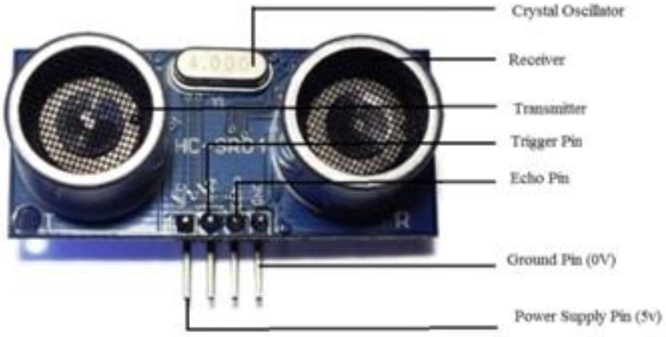

Figure 3.2: Basic working principle of the Ultrasonic Sensor

3.3.4 Buzzer

Buzzer is a sound generating device. 5v continuous tone buzzer used in this project .It is magnetic type transducer. Sound pressure level is 82dB and frequency is 203KHz. It can generate continuous beep tone. Operating voltage of this is 5VDC and rated voltage is 3VDC.

3.3.5 DC Motors

DC gear motor [4]is used for the purpose of navigation of robot. Two DC motor is used in this project. Wheel can be mounted in either side of the motor. The motor operates from 3 to 6 volt DC where at 5 volt, it rotates smoothly. Maximum torque of the motor is 800g.cm. speed without load 90 rpm (app.). no load current is 190mA and operates upto 250mA. Stall current rating is 1A .It is very efficient and high speed so it is user friendly.

3.3.6 Vibration Motor

Coin type vibration motor is used in this project. The physical shape of Coin type vibration motor. This small device is consists of rotor, stator, armature, windings, brushes etc. need of smaller and thinner designs led to the adaptation of brush motor technology into the coin-type vibration motor. Figure 3.11(b) is an internal construction diagram of the brush coin-type motor. As same as to the bar-type vibration motor, coin-type vibration motor is comprised of a weight, a ring magnet, rotor with commutation points attached in the front and coils as filled on the back, and power supplied brushes attached to the ring magnet. The commutation points are in contact which are the yellow part on the bottom pic, with the end of the brushes. It will stimulate the electrical coils in the rotor. Stimulating the coils produce a magnetic field and it is strong enough to interact with the ring magnet integrated into the stator, causing rotation. A force is generated due to the magnetic field. This force causes the weight to displace. The repeated variations of the weight produces a varying force which is felt as vibration. The attaching points are used in changing the polarity pairs, so that as the rotator moves, the coils are constantly reversing the polarity.

3.4 Circuit Development

Circuit development is divided into two parts:
Circuit Diagram
Operating Principle

3.4.1 Circuit Diagram

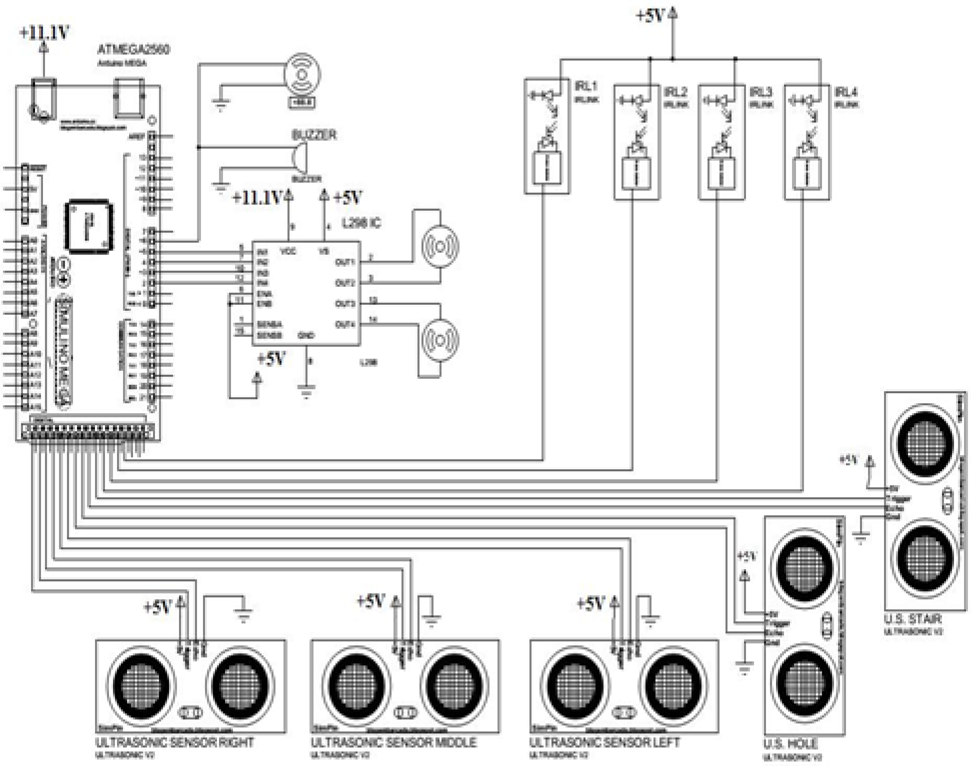

Figure 3.3: Circuit Diagram of the proposed Blind Assistive Robot.

Figure 3.3 shows the circuit diagram of Blind Assistive Robot which is consists of a Arduino Mega (ATMega2560), five Ultrasonic sensors, four on board line tracking IR pair, two DC motor, a buzzer and a Vibration motor. Ultrasonic sensors are used for: left obstacle or wall detection, front obstacle detection, right obstacle or wall detection, hole detection and stair detection. Trigger Pin and Echo pin of Left ultrasonic sensor is connected to 52 and 53 no. pin of Arduino Mega respectively. Similarly, Middle ultrasonic sensor is connected to 50 and 51 no. pin, Right ultrasonic sensor is connected to 58 and 49 no. pin, hole detecting ultrasonic sensor is connected to 42 and 43 no. pin, stair detecting ultrasonic sensor is connected to 40 and 41 no. pin of Arduino Mega.Line Tracking IR sensors pin are connected to 46,47,45,44 no. pin of Arduino Mega. Vibration Motor is connected to 6 no. pin and Buzzer is connected in parallel with Vibration motor. Left motor is connected to 2 and 3 no. pin of Arduino Mega. Positive lead is connected to pin 2 and Negative lead is connected to pin 3. Right Motor is connected to 4 and 5 no. pin of Arduino Mega. Positive lead is connected to pin 4 and Negative lead is connected to pin 5.

3.4.2. Operating Principle

If IR2 and IR3 sensor output pin gets high, IR1 and IR4 sensor output pin is low than both motor will rotate forward. If IR1 output is high than right motor will rotate forward. And for IR4=1, left motor will rotate forward. If any obstacles detected on middle ultrasonic sensor, right motor will rotate forward (4 no. pin = 1, 5 no. pin =0) and left motor will remain stop. It will also give beep continuously. Left and right ultrasonic sensor follows wall. If left and right ultrasonic sensors reading are more than 30 cm, both motor will rotate forward (2 no. & 4 no. pin = 1, 3 no. pin & 5 no. pin =0) so robot will move forward. If left ultrasonic sensor reading is less than 30cm and right ultrasonic sensor reading is more than 30cm, left motor will rotate forward and right motor will stop, so robot will turn right and beep twice. If left ultrasonic sensor reading is more than 30 and right ultrasonic sensor reading is less than 30cm, right motor will rotate forward so robot will turn left and beep once. If both left and right ultrasonic sensor reading is less than 30cm, both motor will rotate reverse. if downward facing ultrasonic sensor reading is more than 20cm, then both motor will stop because it indicates hole or downward stair. Upward stair detected if top ultrasonic sensor reading is greater than middle ultrasonic sensor.

4. CONCLUSION AND FUTURE SCOPE

The project: "Design and Implementation of a Blind Assistant Robot" is completed after researching a lof previous work related to this project. Major goal of the project was to mitigate difficulties of blind people while navigating or travelling. The device promises relatively smoother navigation both indoor and outdoor for blind. In this project, limitation comes out such as availability of components, complex algorithm, getting proper data from sensors etc. algorithm developed after several experiment to avoid complexity around the walkway of blind person.

5. FUTURE SCOPE

This project covers a lot of sectors of blind assistive technology. But still there are a lot of scope to contribute. There are some limitation in this work which could make this project more reliable. However, the scope available in this project are:

- Using Solar panel with rechargeable batteries the anxiety about charging could be removed.
- Voice notification and navigation feature can be added later.
- The device can be attached with wheelchair with autonomous navigation for crippled blind person.

6. ACKNOWLEDGEMENT

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