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Design and Implementation of a Voice Controlled Robot with Human Interaction Ability

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***Abstract*—The purpose of robotics in commercial & residential intention has come to be quite essential for executing challenging work into more conveniently simple way. There are a lot of researches working on to enhance the connection between humans and robot. The paper presents the research of the designing & development of a voice controlled talking robot using mobile phone based on Arduino Uno microcontroller. The control system of the robot movement will be employed by the voice and the robot will response the commanding persons by generating sounds of human voice with each verbal instruction. The proposed system will be designed based on microcontroller which is connected to smart android phone through Bluetooth module for receiving voice command. The voice command is converted to text by an app of the android phone and sends necessary data to the microcontroller for controlling robot movement. After receiving the data the robot responses according to the command by performing proper movement to the proper direction according to the voice command. A SD card module along with a SD card which will consist some pre-recorded human voice as audio file will be used by the robot for the development of the robot's talking system. After getting each command the robot will act according to the instruction and will be able to speak different sentences.**

Keywords— Voice command, Robot , Arduino

I. INTRODUCTION

The surprising raise in the utilizing of robots and automation offers various advantages as well as it has drawn the attention of both academic investigation and commercial programs [1]. The analysis on numerous technique of controlling robot has accomplished quite a few success by introducing a number of innovative & unique methods of robot movement control. Verbal interaction intended for robot controlling is actually sort of an innovative process among many methods which are introduced regarding robotics control [1].Previous works on voice controlled robots [1]-[3] shows that the design of those robot were complicated and none of them were able to interact with users. Robots are anticipated to socialize along with its user however it has not yet arrived at this kind of level [2], [3]. There are numbers of techniques to control robot using voice identification yet it is reasonably limited [1].

The development of a voice controlled robot is demonstrated in this paper which has the ability to follow voice command from user and does communicate with user by using pre-recorded human voice sound. Previously developed robot used ZigBee [10] which is a costly device. Another Voice Controlled Robotic Vehicle utilized computer with a sound card and a microphone which was not user friendly [11]. A technique to give voice command using android based smart phone using Bluetooth is presented to construct the robot based on microcontroller. The robot can accept instructions from users verbally and interact with user by speaking various sentences which will make it user friendly.

II. OVERVIEW OF PROPOSED SYSTEM

The robot will be based on microcontroller Arduino Uno because of its versatile features along with numerous advantages which is based on Atmega328P and an open source platform with the benefit of physical computing [4]. The system will utilize Bluetooth technology and Standard communication interface known as SPI interface. Bluetooth uses radio waves with safe, less power consuming device to connect and exchange data between devices without using of any kind of physical contact like wires and cable [6]. SPI interface is a synchronous serial information process utilized by microcontrollers for interacting along with one or more peripheral devices swiftly through limited ranges [8]. There are two main applications that robot will be able to perform which are discussed below.

A. Movement control of the robot using voice command

The movement of the proposed robot will be controlled by the voice command of the user. The user will use an android operated smart phone to give voice command. The command can be fetched using an app which will convert the voice command into text. The phone will be connected to the microcontroller using a Bluetooth module. After conversation of the voice command into text the app will send necessary data to the microcontroller using Bluetooth of the phone and microcontroller will receive the data using Bluetooth module. According to the command, the robot will move forward, backward, left, right or fully autonomous. For driving the robot there will be two geared DC motors with gripped tyre which will be operated by the help of DC motor driver. An ultrasonic sensor will be employed for obstacle detection during autonomous mode. Arduino Uno will send signals according to reading of the ultrasonic sensor to provide data about any obstacle in front of the robot within a specific range. There will be a command for stopping the robot at instant.

B. *Communicate with the user by talking while performing each command*

To communicate with the user, the robot will be able to talk while executing a specific command. After power up the robot, it will greet the user and ask for command for performing its action. When user will command for any specific direction, the robot will be saying by generating voice record that the robot is moving for that direction and ask for next command. Until the robot will receive the next direction, it will continue to follow the previous command. Each command robot will receive, it will generate sound of every sentences defined for its each actions. As example, for backward command, the robot will say "The robot is moving backward". Similarly, robot will speak with every instruction the user will give. The sound will be pre-recorded human voices and stored to a micro SD card connected to the microcontroller unit using a SD card module.

III. PROPOSED ROBOT MODEL

A. *Functional diagram*

The functional diagram of the proposed robot is shown in figure 1. The central processing unit will be a microcontroller connected with an android operated smart phone via a Bluetooth module. It will be used to give voice command using an app and will convert the voice command into text as well as send the data to the microcontroller using Bluetooth.

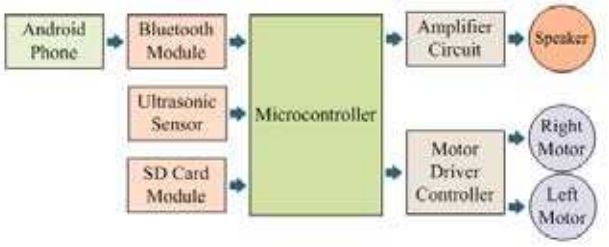


Fig. 1: Functional block diagram of the proposed robot model.

Motor driver will be required for controlling the movement of the robot and it will be operated by the microcontroller to control two different motor of left and right by controlling the direction of rotation of motors. An ultrasonic sensor will be interfaced to detect obstacle and help robot to operate full automatically. A SD card module will be connected to the microcontroller for storing the pre-recorded human voices. An amplifier with a speaker will be connected for generating the received sound of recording from micro SD card through microcontroller.

B. *Circuit Diagram*

Circuit diagram of the proposed robot is shown in figure 2. The main central processing will be an Arduino Uno consisting of 14 digital and 6 analog pins. The development of the power supply will be implemented using lM7805 & LE33 which has three terminals of input, ground and output and able to provide fixed voltage with accuracy to maintain the voltage regulation [5]. Capacitors of different values will be used to construct circuit for filtering and bypass purposes. Bluetooth module will be interfaced with microcontroller using two data pins known as RX and TX. Echo and trig pins of ultrasonic sensor will be connected to the digital pin of 7 and 8 of microcontroller. SD card Module will be attached with the Arduino Uno utilizing SPI communications.

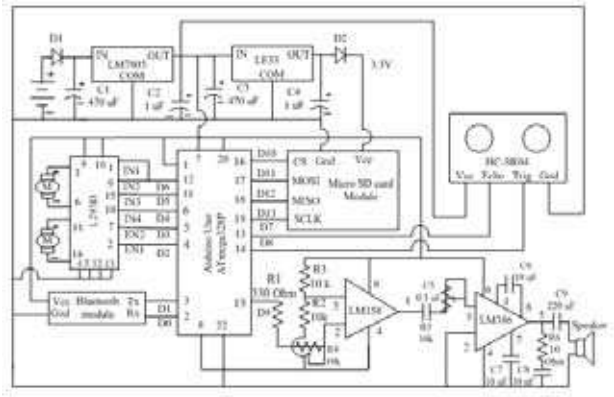


Fig .2: Circuit diagram of the the proposed robot model.

Motor driver L293D has 16 pins where 4 pins are used to connect two DC motors and another 4 input pins are connected to the microcontroller for controlling the motors. Operational amplifier LM 358 and power amplifier LM 386 will be used to construct amplifier circuit.

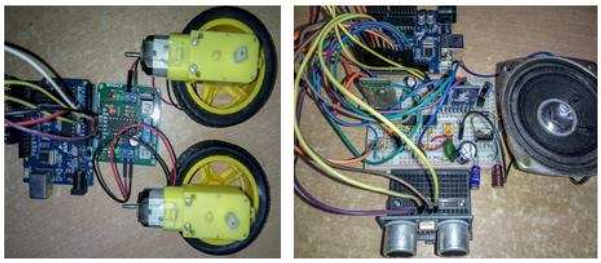
IV. DESIGN AND IMPLMENTATION

During the implementation of the proposed robot, power supply unit is first developed using 7805 to convert 9 volt into 5 volt and LE 33 to convert 5 volt into 3.3 volt. Electrolytic polarized capacitor as well as the bypass capacitors has employed for steady the slow changes and bypass very small period spikes and extremely tiny duration spikes to the ground with no distress the other components. Diodes D1 and D2 are used to prevent back current.

The motor driver controller is based on L293D which is a quad, high current, half bridge driver that is created to provide bidirectional drive currents of up to 600mA at voltages range from 4.5 V to 36V [9]. Input 1 and Input 2 are connected to the digital pin of 2 and 3 for left motor and input 3 and input 4 are connected to the digital pin of 4 and 5 for right motor according to the figure 2. Enable pin of l293D is connected to the digital pin number 6 of Arduino Uno for speed control.

RX of the Bluetooth module is connected to TX of Arduino Uno which is digital pin 1 and TX of Bluetooth module is connected to Rx of Arduino Uno which is digital pin 0.Ultrasonic sensor HC-SR04 is used for obstacle detection and avoidance by measuring distance in range of 2cm-400cm with accuracy of 3mm.The ultrasonic sensor consists of ultrasonic transmitter, receiver and the control circuit [7] and has worked by sending pulse and check echo to determine the distance of the obstacle. Emitter and detector of Ultrasonic sensor are able to produce 40 kHz sound wave and detect same frequency as well as sends electrical signal back to the microcontroller [7].

Interfacing SD card Module with Microcontroller has implemented by interconnecting of Arduino Uno and SD Card module's mutual pins known as MISO, MOSI & SCLK which are defined pins for SPI communication. The chip Select pin of SD Card module is connected with the digital 10 pin of Arduino Uno.3.3 volt is required which is supplied by LE33. Along with an SPI connection there is usually one particular master unit that manages the peripheral systems. MISO (Master in Slave Out) is the Slave line used for delivering data to the master, MOSI (Master out Slave In) is the master line for the purpose of delivering data to the peripherals, SCK (Serial Clock) is the clock pulses [8].



(i) (ii)

Fig. 3: Implemented model view of proposed robot
(i) Motor driver circuit, (ii) Amplifier, Bluetooth and sonar sensor circuit

A preamplifier is designed utilizing LM358 op-amp that is attached in a negative feedback manner along with an adjustable resistor R4 attached in the feedback route for minor fragile signals which are need to be increased through utilizing pre amplifier that can be effective to boost the actual transmission along with substantial large gain however is actually not capable in order to generate the actual output for absence of proper current gain. A power amplifier is employed using LM386 that is capable to supply output power of 2.5W along with internal fixed 34dB gain in order to retrieve the actual enhanced transmission through preamplifier to boost the current where the non-inverting port is provided with the output of the preamplifier via variable resistor of 10k although the inverting port is grounded. The filtered output is obtained from pin 5 of LM 386 and is supplied to an 8 ohm speaker. Figure 3 is showing the implementation of the circuit.

V. Software Development

The microcontroller is programmed using Arduino IDE which is the official software based on C programming supplied from vendor and is used to program Arduino Uno.

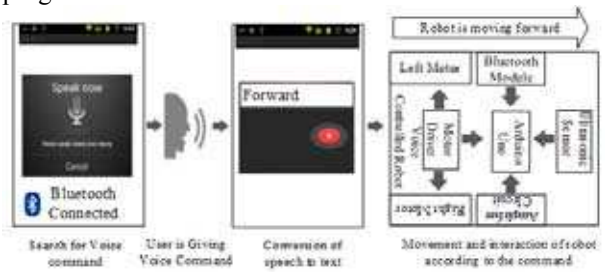


Fig. 4: Descriptive diagram of model software
(i) Speech recognition, (ii) movement and (iii) communication with user.

An android software is created that gets voice command information and transform into textual content utilizing google speech recognition technology. Figure 4 shows the process for Speech recognition, movement and communication with user. The android software is using google speech to text technology to convert voice command into to text and then the text is sent to the Arduino Uno. Arduino Uno is programmed to receive a textual command via Bluetooth and according to the command it is programmed to move forward, left, right, backward and stop. A programming for autonomous is also developed which is able to make the robot to operate fully autonomously by employing ultrasonic sensor to detect obstacle and avoid collision.

VI. Result Analysis of Developed Robot

A. *Speech Recognization Process & Movement of the Robot according to the Voice Command*

By using the android app the textual content was transmitted to the Arduino using Bluetooth through mobile phone handsets which had built-in microphones to process the signal and the robot made movement according to voice command [2]. Table 1 shows the instructions utilized for the movement of the robot. The robot was able to move forward, backward, left and right according to the input given to L293D from Arduino Uno which gave input according to the command received from user. If user gave the voice command "autonomous" the robot started moving autonomously without hitting any obstacle. The avoidance of the obstacle was guided by the ultrasonic sensor which was able to senses the obstacle. Then it gave command to microcontroller to move in such a way so that the robot did not face any obstacle on its way.

B. *Interaction with User by genrating human voice recording*

Speaking ability of the robot was developed using several prerecorded sound of human voice for different interactions and stored in SD card as wav file which were played through the amplifier circuit when any specific voice command was given.

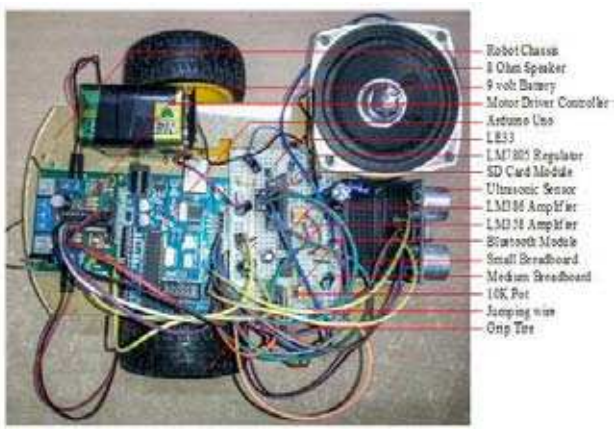


Fig. 5: Illustrative overview of the implemented proposed robot.

The Arduino Uno was programmed to response by playing the wav files through speaker if any voice command was received. The wav files from the SD memory card were selected by chip select pin of SD card module and given as input to the inverting terminal of the amplifier of LM358 whenever a constant supply from voltage diver is given to non-inverting terminal. The input audio signal was amplified according to the gain set by the POT. But due to less current the pre amplified signal was given to the non-inverting port of the amplifier circuit of LM386 which amplifies the current of the signal and sound can be heard in an 8Ω speaker. Figure 5 shows the overall view of the robot. TABLE II is showing different recorded sounds of voice recording of the robot for different voice command.

TABLE I
Input For Different Logic

Voice Command	Input 1	Input 2	Input 3	Input 4	Direction
Stop	0	0	0	0	Stop
Forward	1	0	1	0	Forward
Backward	0	1	0	1	Backward
Left	0	1	0	0	Left
Right	0	0	0	1	Right
Autonomous					Autonomous

TABLE II
Different Sounds of Voice Recording According to different Command

Voice Command	Robot Interaction
Stop	The robot has stopped moving.
Forward	The Robot is moving forward.
Backward	The Robot is moving backward.
Left	The Robot is moving left.
Right	The Robot is moving right.
Autonomous	The robot is now moving as autonomous.

VII. Discussion and Conclusion

The robotics is becoming more reliable and adopting many new methods as well as development. In this paper development of a prototype is presented although a lot more further future developments and researches are needed to make the developed robot into a complete product for consumers. Commercial production of this robot can be possible of following future researches and updates can be done for more improvement of the robot.

The developed robot are able to move in any direction according to the voice command received from the user by android phone and bluetooth .Voice commands has able to control the robot to move forward,backward, left and right. There is a voice command “Autonomous” which can instantly makes the robot to move fully automatically without hitting any obstacle using ultrasonic sensor. Instant stopping of the robot from any kind of movement can be done by the voice command “Stop” at any time. The devloped robot has ability to interact with its user using the prerecorded human voice file. For each command, different individual response’s audio files are recorded and stored as wav files on SD card. When user will command any instruction the robot will generate the related human voice as response on amplifier from micro SD card.

Further future development can be conducted by developing a system which will be able to receive voice command through direct voice recongnization hardware to recognize the voice command and no android app will be needed for controlling the robot.The developed device used prerecorded human voice sound to communicate with user but artificial inteligence can be implemented for interection purpose so that the robot will be able to interact more appropriately by analyzing the testing enviroment and user’s behaviours.

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