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# Design and Implementation of a Voice Controlled Multifaceted Robot

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***Abstract*: In the modern world, the Robots play a vital role in replacing manual works especially in assisting handicapped people. In the traditional method the Robots were considered to perform solitary task assigned to it. The proposed work is designed to operate in multifaceted modes, such as RF Transmitter-Receiver mode (remote mode), Hand Gesture mode, Voice Controller mode, Line Follower mode, medicine dispensing mode using a microcontroller Arduino Mega2560 board. In addition to this, Wireless Camera, APR module, Temperature sensor, Obstacle detection and avoidance features have made this Robot versatile which can be used in various applications.**

***Keywords*: gesture control, medicine dispensing, voice control.**

## 1. Introduction

Innovation and development in technology is to provide comfort and ease to human life. The Robots have the potential to be deployed for disinfection, delivering medications and food, and in which the proposed Robot can assist handicapped people [6]. The proposed work is to solve the issues encountered in assisting handicapped people and senior citizens. This work enables the physically disabled people to return to their normal life, by multifaceted controlling modes, as this Robot can be modeled as wheelchair [7].

By Voice control mode, when the Bluetooth application is turned on and when connected with the current system via Bluetooth, one will operate the Robot by giving Wireless command from the application using the functions already programmed in the app [1].

Gesture recognition technologies are much younger in the world of today. At this time there is much active research in the field and little in the way of publicly available implementations. Several approaches have been developed for sensing gestures and controlling robots. Glove based technique is a well-known means of recognizing hand gestures. It utilizes a sensor attached to a glove that directly measures hand movements [2].

The proposed robot identifies and tracks black line on white surface area [4]. A Line following robot must be able to detect a specified line and maintain track on it and does the assign jobs [8]. The proposed work can be modified quite easily to include a camera well that can stream the videos to the user over Wi-Fi using Wi-Fi module.

## 2. System Design

Methodology gives the systematic, theoretical analysis applied to design the block diagrams as shown in Fig 1 and Fig 2 for the transmission and reception of the signals for the Robot operation. The block diagram shown in Fig 1 is the Gesture control using Arduino Uno microcontroller that cooperates to act as the transmitter for controlling the robot through Gesture controlling mode of operation.

The block diagram of Gesture Control Transmitter consists of microcontroller Arduino Uno board which is interconnected to a RF Transmitter and an Accelerometer with an input Power supply is as shown in Fig. 1. The signals are transmitted with respect to the angle of tilt made by the hand through the transmitter which is then received by the Receiver connected to the Robot and acts accordingly. The block diagram shown in Fig 2 consists of a microcontroller unit Arduino Mega board which is inter-connected to Ultrasonic Sensor 1, Ultrasonic Sensor 2, IR sensor 1, IR sensor 2, four-channel switch, Temperature sensor, LCD, power supply module, Bluetooth module, Esp8266 Module, Motor driver 1, Motor driver 2, Motor driver 3, RF Receiver, Fingerprint scanner and Speaker which is connected to aPR33A3 Voice Recorder.

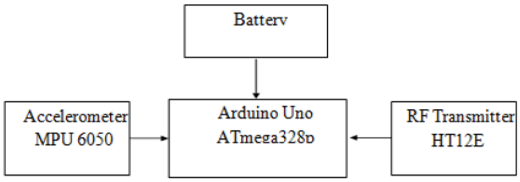


Fig. 1. Block diagram of gesture control using Arduino Uno as a transmitter

The input to the microcontroller unit is given by the 12V Power Supply and the expected output from the block diagram is as follows:

- Instructions are given to the motors through Bluetooth app of Android Smart phones by the user.

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- Voice control mode can be achieved through Bluetooth module which is connected to Arduino Mega Board through which Robot movements in four directions: Forward, Backward, Left and Right can be achieved.
- Object detection can be achieved by Ultrasonic sensors.
- Line follower can be accessed by IR sensors'
- Human body temperature can be detected through Temperature sensor.
- The transmitted signals are received through RF module in the Receiver as per the instructions given by the user which tends to drive the wheels through Motor driver 1 and Motor driver 2.
- The stored commands are recorded in the APR Voice Recorder and the feedback is received through the speaker.
- Medicine dispensing application can be achieved by Motor driver 3 accessing fingerprint scanner.

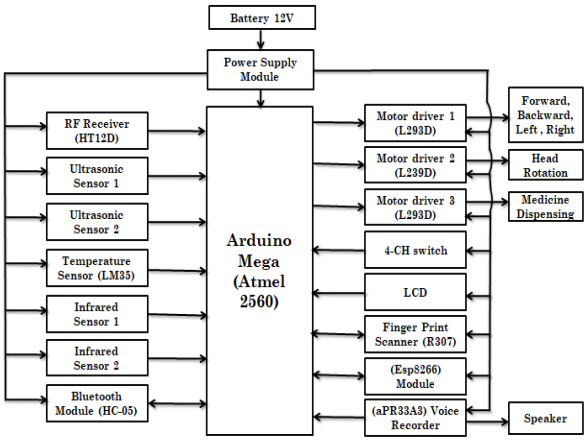


Fig. 2. Block diagram of design and implementation of a voice controlled multifaceted robot as a receiver

## 3. Component Description

### *A. Arduino MEGA*

The microcontroller board Arduino Mega depends on the ATmega2560 microcontroller. It includes digital input/output pins- fifty-four, where sixteen pins are for analog, fourteen are used for PWM outputs hardware serial ports (UARTS), a crystal oscillator- 16 MHz, an ICSP header, a power jack, a USB connection, as well as an RST button.

### *B. Arduino UNO*

A microcontroller Arduino Uno is a small computer which is used to perform a programmed task which is built on a solitary coordinated circuit containing a processor at center, memory chip and programmable info peripherals. The equipment comprises of fourteen digital pins, six analog pins and programmable with Arduino IDE.

### *C. RF Wireless Encoder and Decoder module*

RF Wireless communication board has RF Encoder and Decoder interfacing board with HT12E IC and HT12D and chips. Features: Easy interfacing with the RF module, using the female headers for placing the modules.

### *D. Accelerometer Gyroscope*

The MPU6050 is a sensor based Micro Electro-Mechanical Systems (MEMS) technology, which consists of a three-axis Accelerometer and three-axis Gyroscope inside it. Accelerometer works on the principle of Piezo-Electric Effect. MPU 6050 has six Degrees of Freedom or IMU sensor that is it gives six values as output: three values from accelerometer and three values from gyroscope.

### *E. HC-05 Bluetooth Module*

HC – 05 module is simple to use Bluetooth SPP (Serial Port Protocol) module, designed for clear wireless serial association setup. The Bluetooth Module is utilized in a Master or Slave configuration, creating it a good resolution for wireless communication.

### *F. ESP8266 Wi-Fi Module*

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to the Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

### *G. Fingerprint Scanner*

R307 fingerprint module is a fingerprint sensor with TTL UART interface. The user can store the fingerprint data in the module and can configure it in 1:1 or 1: N mode for identifying the person.

### *H. APR33A3 Voice Recorder Module*

APR33A3 Voice play back provides high quality recording and playback with eleven minutes audio at 8 kHz sampling rate with 16-bit resolution. APR33A3 Voice module is a local module. It is used to play voice files for the robot. This voice module has eight pins and can store eight voice/sounds.

### *I. Ultrasonic Sensor*

The ultrasonic sensor is used to measure the distance using ultrasonic waves. In this model ultrasonic sensor has a single oscillator that emits and receives ultrasonic waves alternatively. The ultrasonic sensor can detect for a range of 10 meters having a total path length of 20 meters that is total length of emitted wave and echo wave.

### *J. IR Sensor*

The IR reflective sensor utilizes a TCRT5000 to detect color and distance. IR sensor is an electronic device that emits the light in order to sense some object of the surroundings. It emits IR and then detects if it receives the echo. This sensor is often used in line following robots, auto data logging on utility meters because this module can sense if a surface is white or black.

### *K. LM35 Temperature Sensor*

LM35 is a temperature measuring device having an analog output voltage proportional to the temperature. It provides output voltage in Centigrade (Celsius). It is a three-terminal

sensor used to measure surrounding temperature ranging from -55 °C to 150 °C. LM35 gives temperature output which is more precise than thermostat output.

## 4. Design and Implementation

In the Traditional method the Robots were considered to perform solitary task assigned to it. The proposed method is designed in such a way that the Robot can operate in multiple modes, as the unique features in isolated Robots are integrated. The dependency on a caretaker for patients can be prevented. The proposed work is designed to operate in multifaceted modes, in which the Gesture Control mode of operation can be achieved from the circuit built as shown in Fig. 3.

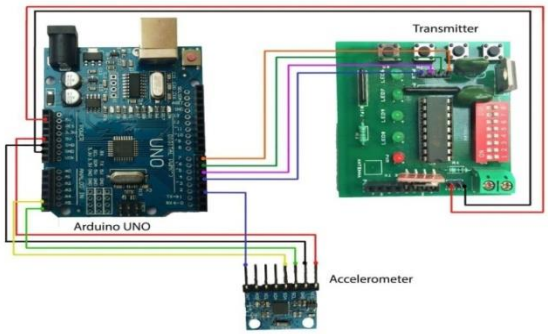


Fig. 3. Circuit diagram of gesture control using Arduino as a transmitter

The proposed work is designed to operate in multifaceted modes, in which the Gesture Control mode of operation can be achieved from the circuit built as shown in Fig. 3.

The circuit diagram shown in Fig. 3 is the Gesture Control using Arduino UNO microcontroller that combines to act as the transmitter for supervising the Robot through Gesture Control mode of operation.

The MPU 6050 communicates with the Arduino through the I2C protocol. The program will be running in the Arduino Board taking advantage of Arduino's Interrupt Pin by connecting to Digital Pin 2 (Interrupt Pin 0) of Arduino UNO to the INT Pin on MPU 6050.

The MPU 6050 is a six DOF (degrees of freedom) or six axis IMU (Inertia Measurement Unit) sensor, which means that it gives six values of output: three values from the accelerometer and three from the gyroscope. An accelerometer works on the principle of piezoelectric effect, the current is produced from the collision on the piezoelectric walls determining the direction of inclination and its magnitude.

The 433MHz Wireless RF Transmitter is interfaced with Arduino UNO by connecting its four digital pins to the four switches on the RF Transmitter board (encoder HT12E) for forward (FWD), reverse (REV), left (LEFT), right (RIGHT) motions. The data is transmitted four times in succession. It consists of different lengths of positive going pulses for '1' and '0'. The frequency of these pulses may lie between 1.5 and 7 KHz.

The circuit diagram shown in Fig. 4 consists of a microcontroller Arduino Mega board where digital pins of Arduino Mega relate to sensors and motor drivers. The 433MHz wireless receiver is connected to the Arduino Mega board which can be controlled in two ways: firstly, through Remote control mode that is through wireless transmitter and secondly through Gesture control mode through the angle of tilt made by the hand. The fingerprint scanner is initialized, enrolled, and evaluated by four-channel switch which is displayed through LCD for Medicine dispensing feature, that shows whether the patient has taken the medicine or not, later, message is received through telegram with the help of Esp8266 Wi-Fi module. HC-05 Bluetooth module is a simple wireless communication device based on the Bluetooth protocol.

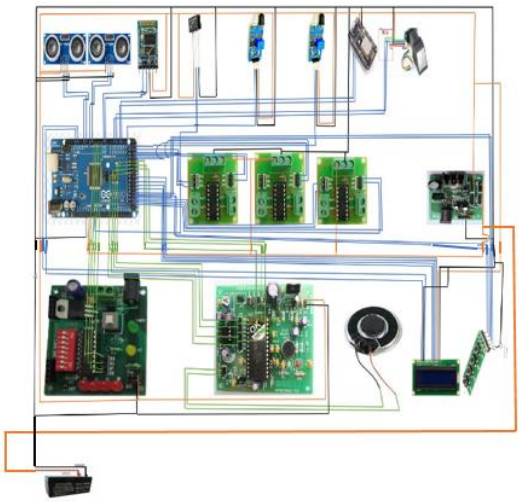

Fig. 4. Circuit diagram of design and implementation of a voice controlled multifaceted robot as a receiver

The Robot performs series operations according to the instructions given through Bluetooth application 'VOICEBOT'. The Bluetooth App receives the voice commands and converts it to text and sends the wireless signal to the Microcontroller Unit (MCU) which is annexed with sensors and modules. The instructions given in the form of voice commands can be listed with the help of connectors as follows:

- Audio
- Voice
- Radio
- Line
- Object
- Temperature
- Medicine/Tablet

The Robot circuit is powered on by giving 12V power supply. When the Bluetooth app is turned on through the mobile application connects with the current system via Bluetooth HC-05. If the connection is secured precisely then the application is ready to connect with Robot or else if the connection is not secured precisely then the application is not ready to connect with Robot as shown in Fig 5. Here, the commands are given through the Bluetooth application called "Voicebot". The commands given to Voicebot are as shown in Table 1.

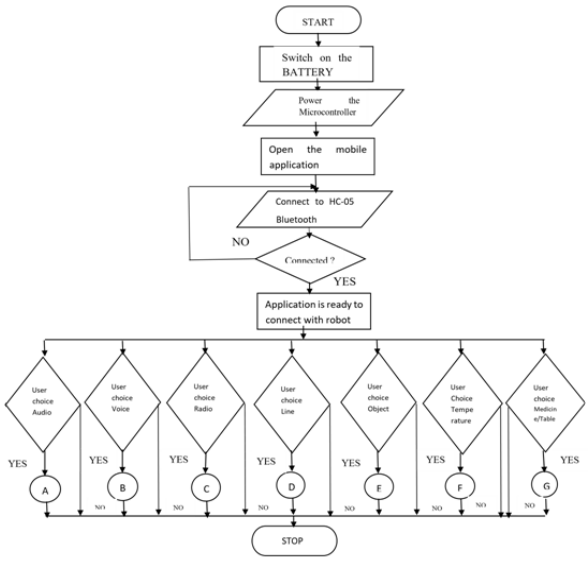


Fig. 5. Voice controlled multifaceted robot flowchart

Table 1
Voice commands given through Bluetooth

| Connector | Commands | Features |
|---|---|---|
| A | Audio | Voice feedback |
| B | Voice | Controlling movements through voice |
| C | Radio | Remote control and gesture control |
| D | Line | Line follower |
| E | Object | Object detection and re-route path |
| F | Temperature | Temperature detection |
| G | Medicine/Tablet | Medicine dispensing |

## 5. Results and Discussions

Fig. 6 represents the experimental setup of Design and Implementation of a voice controlled multifaceted robot with all the sensors and modules interfaced with MCU.

Fig. 7 represents the Bluetooth connection held between HC-05 Bluetooth module in connection with MCU and Voicebot android based application.

The voice commands such as Hi, Name, and Doing fetch the result in terms of voice respectively through the voice feedback module.

The movements of the robot are achieved through motor driver attached with DC Motors.

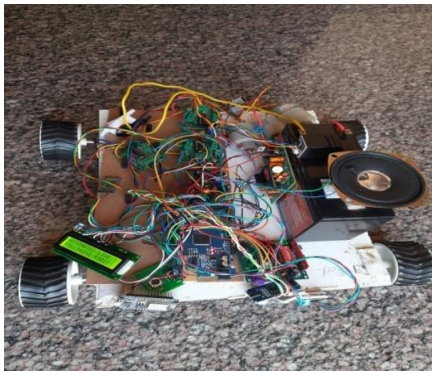

Fig. 6. Experimental Setup with all the sensors and controller interfaced

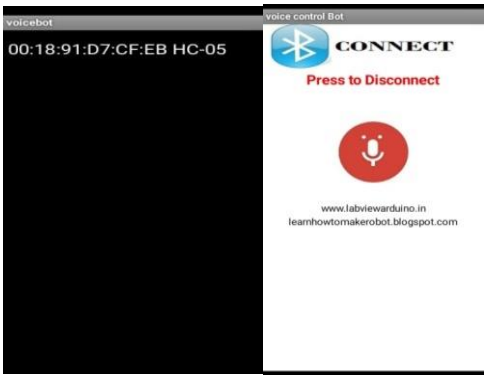


Fig. 7. Procedure for Bluetooth connection to give commands

Results for the command RADIO can be fetched in two ways. Fig. 8 represents the working of the RADIO command in terms of Remote-control mode where the user gives the data through switches.

Table 2
Voice commands with their respective results

| Connector | Command | Feature | Result |
|---|---|---|---|
| A | Hi<br>Name<br>Doing | Voice feedback | Hello<br>RIO<br>Executing commands |
| B | Forward<br>Backward<br>Left<br>Right | Controlling movements through voice | Forward<br>Backward<br>Left<br>Right motions |
| C | Radio | Remote control<br>Gesture control | Forward<br>Backward<br>Left<br>Right<br>Head Rotation |
| D | Line | Line Follower | Line Follower |
| E | Object | Object detection and re-routes path | Object detected at front or<br>Object detected at back<br>And re-routes path |
| F | Temperature | Temperature detection | High temperature or<br>Low temperature |
| G | Medicine/Tablet | Medicine Dispensing | Medicine Dispensing |

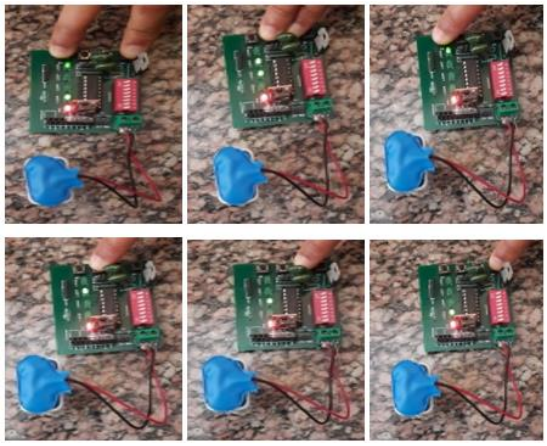

Fig. 8. Controlling robot through remote control (RF transmitter module)

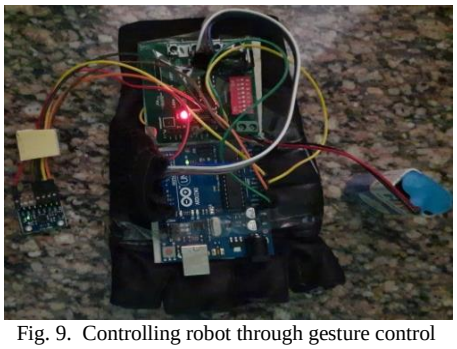

Fig. 9. Controlling robot through gesture control

Fig. 9 represents hand Gesture mode of control where the Robot acts according to the angle of tilt made by the user.

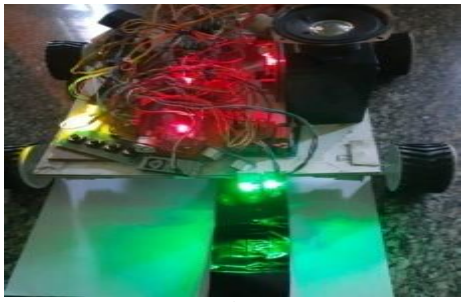

Fig. 10. Line follower mode

Fig. 10 represents that the Robot follows the black line on the white surface area acting as the Line Follower Robot. Whenever any obstacle is detected less than 15cm the Robot re-routes the path towards opposite direction of the obstacle with voice feedback that “Obstacle detected at front” or “Obstacle detected at back” thereby, acts in Obstacle detection and avoidance mode of control.

Temperature detection is achieved through voice feedback after sensing the sensor. Robot detects human temperature as “high temperature” or “low temperature” as per the limits given while coding.

Medicine dispensing feature governs two different medicines dispensed to two different patients or to a single patient or one type of medicine dispensed to two different patients under the command MEDICINE or TABLET that includes the sub-features such as locating the patient residing in the room, identifying the patient through fingerprint authentication as shown in Fig. 11.


Fig. 11. Fingerprint authentication of the patient

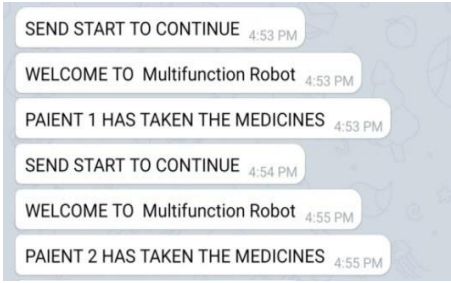


Fig. 12. SMS received by the caretaker through telegram application

The medicines are dispensed soon after the authentication later, notified to the caretaker through the Telegram application as shown in Fig. 12.


Fig. 13. LCD display of medicine/tablet dispensing

Fig. 13 illustrates the indication of the medicine dispensing operation through LCD board.

## 6. Conclusion and Future Scope

The possibility to migrate features from different individual Robots collectively into a sole Robot with multifaceted (to have many different aspects or features), by using a microcontroller reducing the target system is obtained. The Robot is designed and implemented using simple technologies rather than complex ones, to achieve maximum efficiency with reduced cost and area. Thus, the Robot has been designed to work effectively at restaurants, office and hospital environment.

Real time clock with GSM module can be implemented for Medicine dispensing application such that at a particular time coded, the Robot would automatically dispense the medicine without giving voice commands.

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