Design and Implementation of an Intelligent Voice Controlled Mobile Robot

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Abstract—
Robots are now playing a key role both within and outside of the industry. The use of robotics in commercial and residential applications has become quite important for executing difficult tasks in a more conveniently simple manner.Speech is the most important form of interpersonal communication. The main goal of this project is for the robot to monitor ambient temperature and relative humidity. Voice recognition's goal the robot's job is to listen and respond to commands. This gas sensor method was applied to a robot that locates a gas source.The Raspberry Pi 3 Model-B is linked to an Ultrasonic Distance Sensor in the proposed system. The Android App is used to communicate with the Robot.If an obstacle is detected, the robot stops and emits a beep sound through the buzzer. The robot moves in accordance with the commands given by the user.The camera serves as the robot's eye, or Robo vision, and aids in monitoring. The proposed system also includes the creation of a live video streaming robot that can be controlled via an Android app.

Index Terms—Raspberry Pi Model B, Android Application, Robotics, Obstacle, Buzzer, Camera.

I. Introduction

A robot is a package of systems that includes Mechanical, electrical, IT, automation of the technology that can be used for various executions task. And with the increase in development in this area robots can now be controlled by more direct humans Interventions to achieve more natural interactions machine. One way to do this is robot by voice command. Process audio the command is a simple and efficient way to use smartphone. Smartphones are powerful devices can perform many functions similar to computer. Proprietary independent operating system and they are increasing internet connection used in many applications. One of the main features use mobile hotspots. This allows the phone to communicate with the robot.

Internet connection exchanges data short distance but very capable communication between two devices such as: Microprocessors and smartphones. That is robots that take orders without delay, like us use mobile hotspot as the main communication method. Such robots can be used in everyday life specific navigation and control guidance position. Using four basic commands a robot that moves forward, moves to the right and left, and stops to guide you robot. Ultrasound is used to detect and avoid obstacles the module is implemented and programmed to stop the robot when there is an obstacle on the way. Ultrasonic sensor pick up sound waves using sound wave transmitters and receivers get the echo time and use it to calculate the distance. Voice Robo application is used for Android development application. With robot obstacles are measured and displayed on Android application (Voice Robo). A DTH11 (Temperature and Humidity) sensor is used to record and display the temperature on android application. The gas sensor also used for gas detection and display on the android application.

II. Related Work

Many projects and systems for developing a critical area and home security system have been proposed. They have established a system using various Processors and features with a common Motto.The authors discuss "a system developed for remote house surveillance using a raspberry pi 3" in [1]. It is monitored throughout the system. The introduced concept avoids an obstacle and measures the distance from the obstacle to the robot. And the images will be captured by a webcam connected to the RPI 3 robot. The robot has also been successfully controlled from a remote location using Putty software.The authors of [2] describe a system called a "Object Tracking algorithm" and how to evolve a set of voice commands for moving the robot's wheels. Voice commands are handled and transmitted to a cloud server in real time by the Android OS-based platform's input side. The voice commands are converted to text and sent to the robot's onboard Bluetooth module via the smartphone's Bluetooth module. The robot's Bluetooth module receives commands in the form of text and sends them to the controller for future operation. The software-controlled speed control mechanism ensures that the robot is stopped before a pre-set differential delay-time.According to [3,] the "robotic arm can be controlled using Raspberry pi, Android application, and WIFI." The Raspberry Pi is used to control the entire system. The system receives input from a smart phone running an Android application. Using this application, the user can provide input to the system via commands. Raspberry Pi controls the robotic arm in response to input from a smart phone. For remote control, an Android application and WIFI are used.The author states in [4] that for a robot to understand voice commands, the robot must have speech recognition capability. This section provides a brief overview of speech recognition methods and available speech recognition software. Furthermore, aspects of voice recognition related to natural language interfaces for robot control are investigated. A real movable robot system is used as an example. In this system, voice communication is accomplished using a computer, with a mobile phone connected via modem and sound cards. Because the process of voice recognition is dependent on the quality of the received sound, a comparison of voice commands transmitted via different mobile phones was carried out.

In [5]. The author describes a "robot assistant that will assist those in need in hospitals, care facilities, and homes." The main goal is to create a voice-controlled machine to help people who are disabled or immobile. HuBot is a wireless robot that assists patients by

carrying out tasks using the user's voice as input. HuBot is a wireless voice-controlled robot that employs an RF module. HuBot is designed and developed with the goal of assisting and supporting people and can be used effectively with voice commands.

III. System Overview

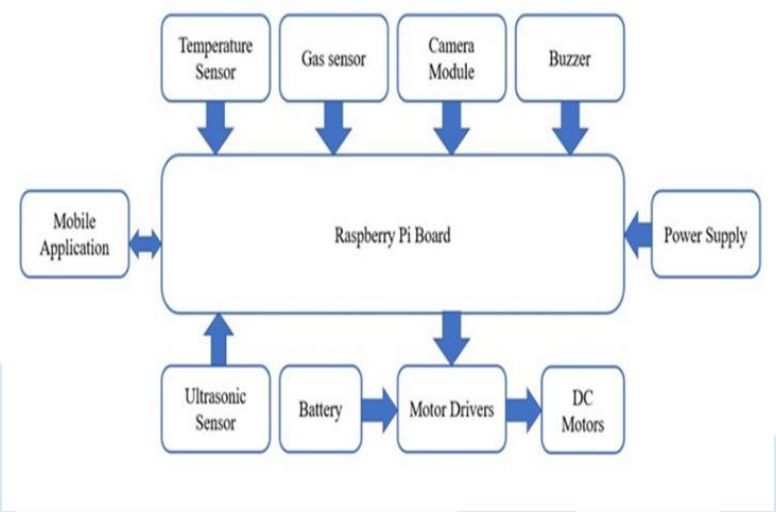


Fig 1. Block Diagram for Proposed System

Figure 1 depicts a block diagram of the proposed system. The Raspberry Pi 3 Model-B serves as the system's brain. It is linked to an Ultrasonic Distance Sensor. The Android mobile APP is placed at the input for giving commands to the remote working robot. The Raspberry Pi 3 Model-B receives commands from the Android application. RPI 3 commands the robot to perform the required operation. An Ultrasonic sensor detects the presence of the object. The ultrasonic sensor aids in determining the distance between the object and the robot. The Raspberry Pi-3 Model B receives sensor signal access. DC motor that aids in the movement of the robot in a specific direction. The user can view the robot from a remote location and send commands using the Android application. If the robot detects an obstacle in its path, it will come to a complete stop in the same location. Also, the Alert sound (beep sound) is sent to the user. The power supply is the RPI system's input. The DHT11 sensor is used to display the temperature and humidity of the surroundings, and if there is any gas leakage, we can see it in the voice robo app, and a camera is attached for live streaming.

IV. Hardware Requirement

A. Raspberry Pi 3 Model-B

The Raspberry Pi 3 controller is the most popular and up to date. The RPI's maximum size is a credit card. Providing a slower computing and processing speed. It only makes use of the Python programming language. The BCM2837 controller is found on the Raspberry Pi 3 board. The Broadcom chip used in the Raspberry Pi 3 is this one. The only significant difference is that the ARMv7 quad core cluster has been replaced with a quad-core ARM Cortex A53 (ARMv8) cluster. The ARM cores run at 1.2GHz, making the device roughly half as fast as the Raspberry Pi 2.

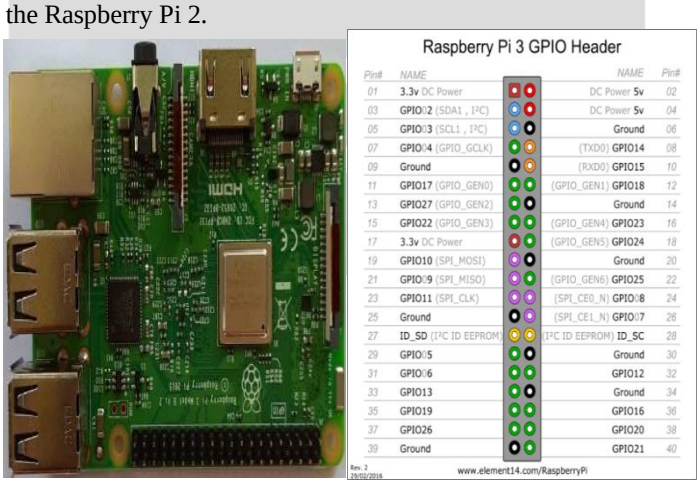


Fig 2. Raspberry Pi 3 Model – B with Pin Configuration

Features:

- Broadcom BCM2837 64-bit ARM Cortex-A53

Quad Core Processor SoC running @ 1.2GHz
- 1 GB RAM
- 4 x USB2.0 Ports with up to 1.2A output
- Expanded 40-pin GPIO Header
- Video/Audio Out via 4-pole 3.5mm connector,

HDMI, CSI camera, or Raw LCD (DSI)
- Storage: microSD
- 10/100 Ethernet (RJ45)
- 27 x GPIO
- UART
- I2C bus
- SPI bus with two chip selects
- +3.3V
- +5V
- Ground

Power Requirements: 5V@2.4 A via micro-USB power source
Supports Raspbian, Windows 10 IoT Core, Arch Linux, RISC OS and more.

B. Android Mobile

Android is an open source and Linux-based mobile operating system for smartphones and tablet computers. The Open Handset Alliance, led by Google, and other companies created Android. Android provides a unified approach to mobile application development, which means that developers only need to develop for Android, and their applications should be able to run on various Android-powered devices. Android applications are typically written in Java and developed with the Android Software Development Tool. Once developed, Android applications can be easily packaged and sold via a store like Google Play, Slide ME, Opera Mobile Store, Mobango, F-droid, or the Amazon Appstore.

Fig 3. Mobile

C. Ultrasonic Sensor

At regular time intervals, ultrasonic sensors emit short, high-frequency sound pulses. It travels through the air at the speed of sound. If they collide with an object, they are echoed back to the sensor, which calculates the distance to the target based on the time between emitting the signal and receiving the echo.

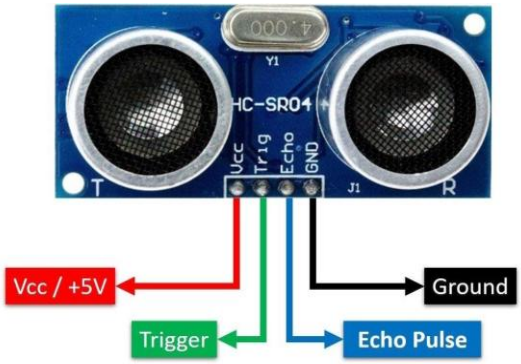


Fig 4. Ultrasonic Sensor

Because ultrasonic sensors are excellent at suppressing background interference because the distance to an object is determined by measuring the time of flight rather than the intensity of the sound.

D. Motor Driver IC

Motors are required to drive the robot, and motor driver ICs are required to drive the motors. Because the current delivered by the microcontroller is insufficient to drive the motors, motor driver ICs are used. They act as current amplifiers, taking in low current input and producing high current output, which is sufficient to drive the motors. The L293D, a dual H-bridge motor driver IC, was used in this project as the motor driver IC. Also available is Automatic Thermal Shutdown.

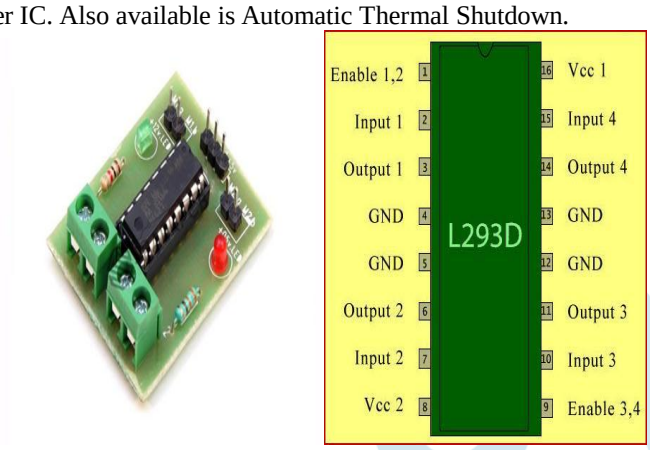


Fig 5. L2393D Motor Driver

E. DC MOTORS

Any of a class of rotary electrical machines that convert direct current electrical power into mechanical power is referred to as a DC motor. The most common types are based on magnetic field forces. Almost all types of DC motors have an internal mechanism, either electromechanical or electronic, that changes the direction of current flow in a portion of the motor on a regular basis.

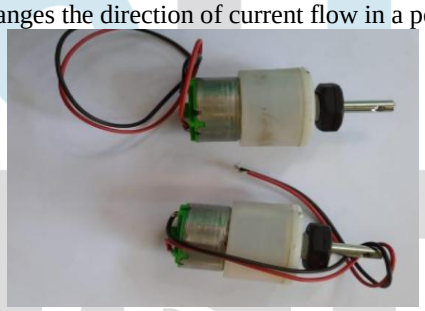


Fig 6.Dc Motors

F. Battery

A rechargeable battery, storage battery, secondary cell, or accumulator is a type of electrical battery that can be charged, discharged into a load, and recharged numerous times, as opposed to a non-rechargeable or primary battery, which is supplied fully charged and discarded once discharged. It's made up of one or more electrochemical cells.

Fig 7. Power bank

G. DTH 11 Sensor

The DHT11 is a simple and inexpensive digital temperature and humidity sensor. It measures the surrounding air with a capacitive humidity sensor and a thermistor and outputs a digital signal on the data pin (no analogue input pins needed). It is simple to use, but data collection requires precise timing. We can get new data from it once every 2 seconds, so sensor readings can be up to 2 seconds old when using the Adafruit library.

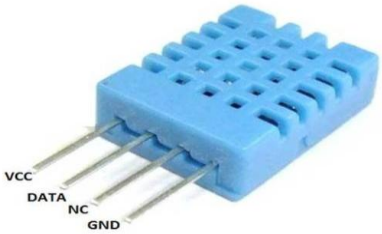


Fig 8. DHT11 Sensor

Specifications:

- 3 to 5V power and I/O.
- Good for 20-80% humidity readings with 5% accuracy.
- Good for 0-50°C temperature readings ±2°C accuracy.
- Body size 15.5mm x 12mm x 5.5mm.

H. MQ-6 Gas Sensor

A gas sensor detects the presence or concentration of gases in the atmosphere. The sensor generates a corresponding potential difference based on the concentration of the gas by changing the resistance of the material inside the sensor, which can be measured as output voltage. The type and concentration of the gas can be estimated using this voltage value.

Features:

- Operating Voltage is +5V
- Can be used to Measure or detect LPG, Alcohol, Propane, Hydrogen, CO and even methane.
- Analog output voltage: 0V to 5V
- Digital Output Voltage: 0V or 5V (TTL Logic)
- Preheat duration 20 seconds

Fig 9.MQ-6 Gas Sensor

I. Buzzer

A beeper or buzzer is an electromechanical, piezoelectric, or mechanical type of audio signaling device. The primary function of this is to convert the audio signal to sound. In general, it is powered by DC voltage and is used in timers, alarm devices, printers, alarms, computers, and so on. According to the it comes in a variety of designs and can produce a variety of sounds such as alarm, music, bell, and siren.

Fig 10. Buzzer

Specifications:

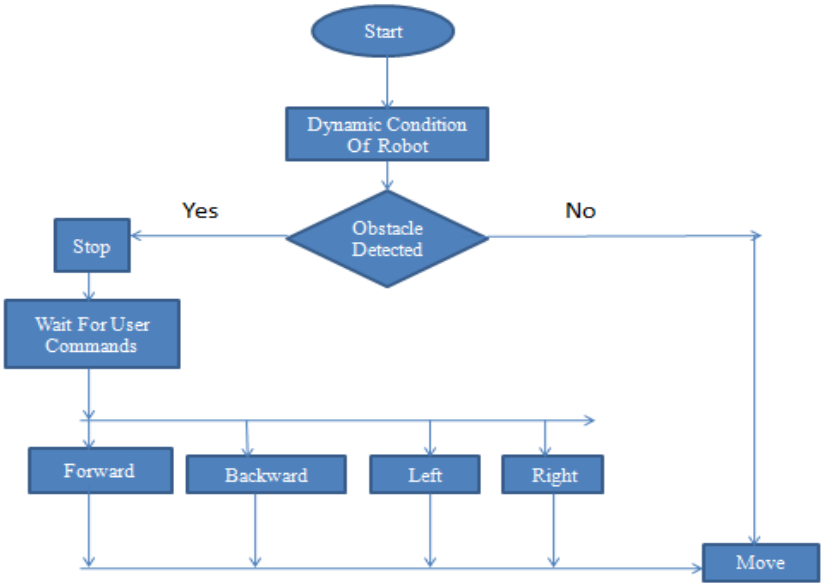
- The frequency range is 3,300Hz
- Operating Temperature ranges from – 20° C to +60°C
- Operating voltage ranges from 3V to 24V DC
- The sound pressure level is 85dBA or 10cm
- The supply current is below 15mA

J. Camera

The camera serves as the robot's eye, or robo vision, and aids in monitoring. In our project, a camera is used to live stream the robot so that it can see its surroundings as it moves. The Zeb-Crystal Pro is a USB-powered web camera with a 3P lens that captures clear video. It has a built-in microphone, night vision, and a clip-on design for easy mounting.

Fig 11. Camera

V. Flow Chart



VI. Implementation and Result

The prototype is made up of a voltage regulator circuitry, an L293D motor driver, and a Raspberry Pi. The mobile application will be used to provide real-time voice.

Step 1: Build the Robotic unit, we can use DC Motor based simple robot. To control your motors, we need L293D IC. Here we used L293D ICs for controlling two motors.

Step 2: Connection of power Supply. Here we used 9v rechargeable battery for driving the motors. But asper specifications Pi will work on 5V, so we use IC 7805 for this, and an external portable battery bank can be used directly. We connect battery terminals directly to motor driver IC.

Step 3: Now design the control page that provides a way to control our robot this page is designed with PHP and write the controlling of the robot code based on the L293D IC logic used.

Step 4: Setting up the raspberry pi and installation of operating system from raspberrypi.org. Here we used Raspbian OS.

Step 5: Install the required packages in the pi using suitable commands.

Step 6: Connect a Wi-Fi dongle to connect raspberry Pi with Wi-Fi router. After connecting Wi-Fi dongle to PI, open WiConfig application this application is pre-installed in Raspbian OS & connect your PI with your Wi-Fi router. When it relates to Wi-Fi router.

Step 7: Setting up the Temperature Sensor- DHT 11, Gas Sensor – MQ – 2 Gas Module and connecting to the Raspberry Pi.

Step 8: Do all the required connections between Raspberry Pi, L293D IC, and Ultrasonic Sensor.

Step 9: Connect the camera to see the live streaming of robot.

Step 10: Pi gets turn on as soon as you connect 5V supply: you can see green LED blinking while startup process.

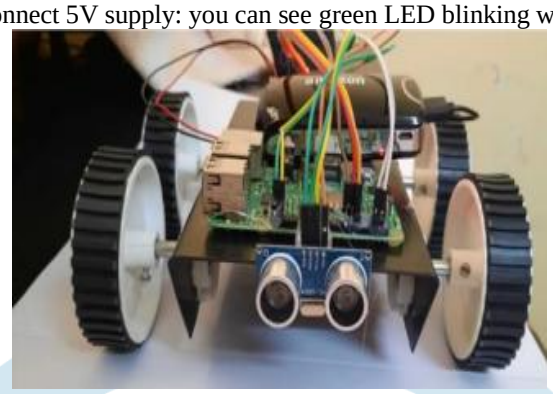


Fig .7. Experimental setup

Figure (7) depicts the proposed system's experimental setup. Figure (7) depicts the connection of DC motors, stepper motors, and an ultrasonic sensor to a Raspberry Pi 3. The L293D driver is used to connect the Raspberry Pi to DC motors. The robot has two motors that require one motor driver IC to control. Two motors can run independently at different speeds using L293D. The robot can move forward, reverse, and turn left or right using these two motors. The input pins of the H-bridge circuit are connected to the RPI GPIO pins, and the output of the H-bridge is connected to the motors. The Python program for motors can be run in RPI via Terminal. The ultrasonic sensor has four pins that are connected to the RPI via the GPIO pins. Similarly, stepper motors are connected via RPI GPIO pins. The robot can move forward, backward, left, or right, depending on the distance sensed by the ultrasonic sensor, according to the Python program.

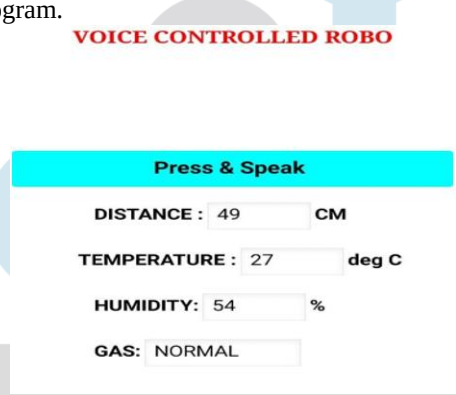


Fig 4.2: Voice robo app

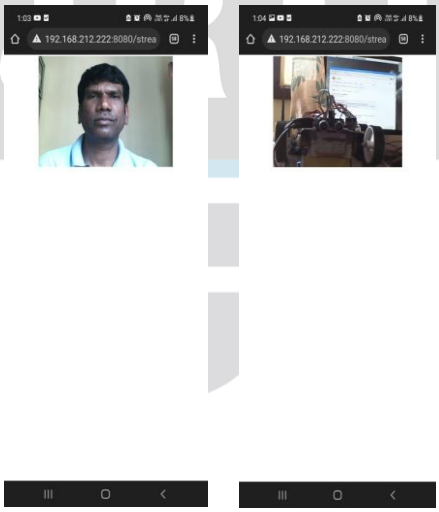


Fig 9. Images from Camera

Figure (8) depicts the mobile screen for controlling the robot via voice command using the button command android app. The images captured by the camera are then shown in fig (9).

VII. Conclusion

Robotics is becoming more reliable, with many new methods and developments being implemented. Our project's proposed framework demonstrates how a robot can be controlled. The Raspberry Pi 3 model-B has been successfully used to control a robot.

The developed robot can move in any direction based on a voice command received from the user via an Android phone. The results show that the robot can successfully detect and avoid obstacles by measuring their distance from the obstacle. When the robot is 50cm or less away from the obstacle, it stops moving and emits a beep sound. Voice commands allowed the robot to move forward, backward, left, and right. The voice command "Stop" can be used at any time to stop the robot from performing any type of movement. The App displays distance, temperature, and humidity readings.

VIII. FUTURE SCOPE

We can use this system for military purposes by installing appropriate sensors. Detecting and disposing of bombs to save as many human lives as possible. By adding the robotic unit with a camera that will show live streaming for its dynamic path, we can watch the robot's surroundings and monitor it using an Android application. We will be able to assign IP addresses to this system in the future. If more than one device (IoT) is connected to this IP address, we will be able to see live streaming of multiple robots. For surveillance, we can also equip the robot with voice recognition.

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