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Voice Controlled Robotic Arm Using ESP32 And Smartphone

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ABSTRACT
This project presents the design and implementation of a voice-controlled robotic arm using an ESP32 microcontroller and a smartphone application. The system allows users to control the movement of a robotic arm through voice commands, enhancing accessibility and ease of operation in various applications. The ESP32 microcontroller serves as the central processing unit, receiving voice commands from the smartphone application via Bluetooth communication. The pick and place robot (robotic arm) designed with microcontroller unit, functions according to the command signals generated and transmitted from the android device. Based on this information the robot will be moved in all directions. This robot is equipped with a gripper mechanism at its front side for picking the object and after holding the object it will be lifted up to a certain height and then can be carried to the required place.
KEYWORDS-Robotic arm,ESP32 Module, Bluetooth, DC Motors, Jumper Wires, Android application.

I.Introduction:

In today's world, technology has advanced to a point where we can interact with machines using natural language commands and control them remotely using smartphones. One such exciting application is the development of a voice-controlled robotic arm using ESP32 and a smartphone. The combination of ESP32, a powerful microcontroller with built-in Wi-Fi and Bluetooth capabilities, along with the versatility of smartphones, offers a robust platform for creating innovative projects like a voice-controlled robotic arm.

This project aims to demonstrate the integration of voice recognition technology with robotics to create a user-friendly interface for controlling a robotic arm wirelessly. By leveraging the ESP32's processing power and connectivity options, along with the smartphone's voice recognition capabilities, users can intuitively command the robotic arm using simple voice command. The voice-controlled robotic arm, sophisticated fusion of mechanical engineering, electronics, and artificial intelligence, exemplifies cutting-edge capabilities of modern technology in facilitating human-machine interaction. The pick and place robot is a microcontroller based mechatronic system that detects the object, picks that object from source location and places at desired location.

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II. Block diagram:

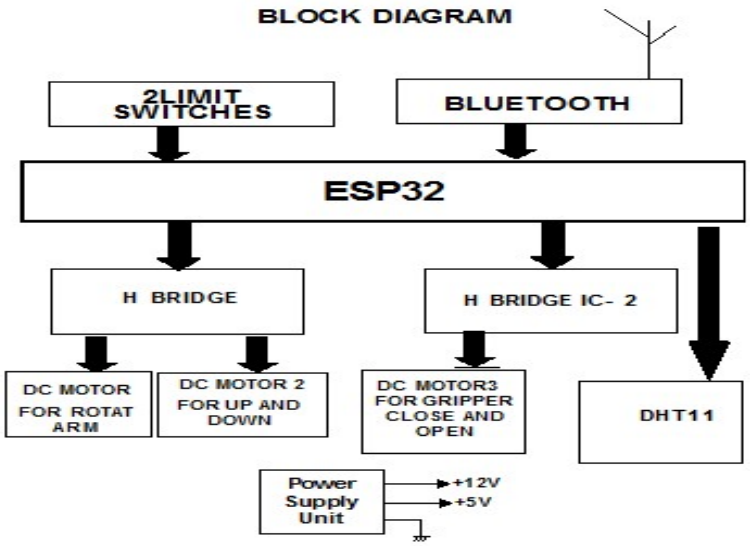

Fig: Block diagram of the project

The smartphone serves as the user interface, allowing the user to send voice commands to control the robotic arm. The smartphone communicates wirelessly with the ESP32 microcontroller, typically using Bluetooth or Wi-Fi connectivity.

The converted text commands are transmitted from the smartphone to the ESP32 microcontroller via Bluetooth or Wi-Fi communication protocols. The ESP32 is equipped with the necessary hardware and software to establish and manage this wireless communication link.

The ESP32 acts as the brain of the robotic arm system. Upon receiving the text commands from the smartphone, it processes the commands and determines the corresponding actions to be performed by the robotic arm.

The robotic arm consists of multiple joints and actuators controlled by individual motors. The motor drivers adjust the rotation and position of these motors based on the commands received from the ESP32, allowing the robotic arm to move and perform specific tasks as instructed by the user's voice commands. The entire system is powered by a suitable power supply, providing the necessary voltage and current levels to operate the ESP32, motor drivers, and robotic arm components effectively.

III.Hardware Description:

A.Robotic Arm:

A robotic arm is a mechanical device that mimics the function of a human arm, typically consisting of a series of joints and segments controlled by motors or actuators. They are designed to perform precise and repetitive tasks with accuracy and efficiency, often operated remotely or programmed to execute specific movements autonomously. Robotic arms can have different configurations and capabilities depending on the intended use, ranging from simple pick-and-place operations to complex manoeuvres requiring advanced sensors and algorithms for navigation and manipulation.

B.DC Motors:

DC motors are widely used, inexpensive, small and poweful for their size. They are most easy to control. One DC motor requires only two singals for its operation. They are non-polarized, means you can reverse the voltage without any damage to motor. DC motors have +ve and –ve leads. Connecting them to a DC voltage source moves motor in one direction (clockwise) and by reversing the polarity, the DC motor will move in opposite direction (counter clockwise). The maximum speed of DC motor is specified in rpm (rotation per minute). It has two rpms: no load and loaded. The rpm is reduces when moving a load or decreases when load increases.

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C.Bluetooth Module:

A Bluetooth module is usually a hardware component that provides a wireless product to work with the computer; or in some cases, the Bluetooth may be an accessory or peripheral, or a wireless headphone or other product (such as cell phones can use.). This wireless technology is especially useful in short rage wireless communication, where there exists hardly any infrastructure. Operating over unlicensed, universally available frequency of 2.4 GHz, it can link digital devices within a range of 10 m (approximately).

D.L293D Motor Driver:

The L293D motor driver is available for providing User with ease and user-friendly interfacing for embedded application. L293D motor driver is mounted on a good quality, single sided non-PTH PCB. The pins of L293D motor driver IC are connected to connectors for easy access to the driver IC's pin functions. The L293D is a Dual Full Bridge driver that can drive up to 1Amp per bridge with supply voltage up to 24V. It can drive two DC motors, relays, solenoids, etc. The device is TTL compatible. Two H bridges of L293D can be connected in parallel to increase its current capacity.

E.ESP32 Module:

The ESP32 is a powerful microcontroller with built-in Wi-Fi and Bluetooth capabilities, making it ideal for IoT projects. It acts as the brain of the robotic arm, receiving commands from the smartphone via Wi-Fi or Bluetooth. It controls the movement of the robotic arm's motors or servos based on the received commands. The smartphone serves as the interface for voice commands. The converted text commands are then sent to the ESP32 module over Wi-Fi or Bluetooth.

F.Jumper Wires:

Jumper wires are used to create electrical connections between different components in a circuit. In the context of a voice-controlled robotic arm using an ESP32 and smartphone, jumper wires would be used to connect various sensors, motors, and other electronic components to the ESP32 microcontroller. These wires allow signals to flow between the different parts of the circuit, enabling the robotic arm to receive commands from the smartphone via the ESP32 and execute actions based on those commands.

G.Power Supply:

To generate required power source to drive the vehicle 12V, 2.5 AH, rechargeable, lead acid heavy duty battery is used. Here we require two different DC levels of +5V & +12V, the battery as it is delivering 12V is used to drive the DC motors & H Bridge, whereas for the remaining electronic circuitry consists of microcontroller & RF receiver requires +5V constant source. To generate a stable supply of +5V, 7805 three terminal voltage regulator chip is used which provides constant supply, though the battery terminal voltage falls down to 8V.

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IV.FLOW CHART:

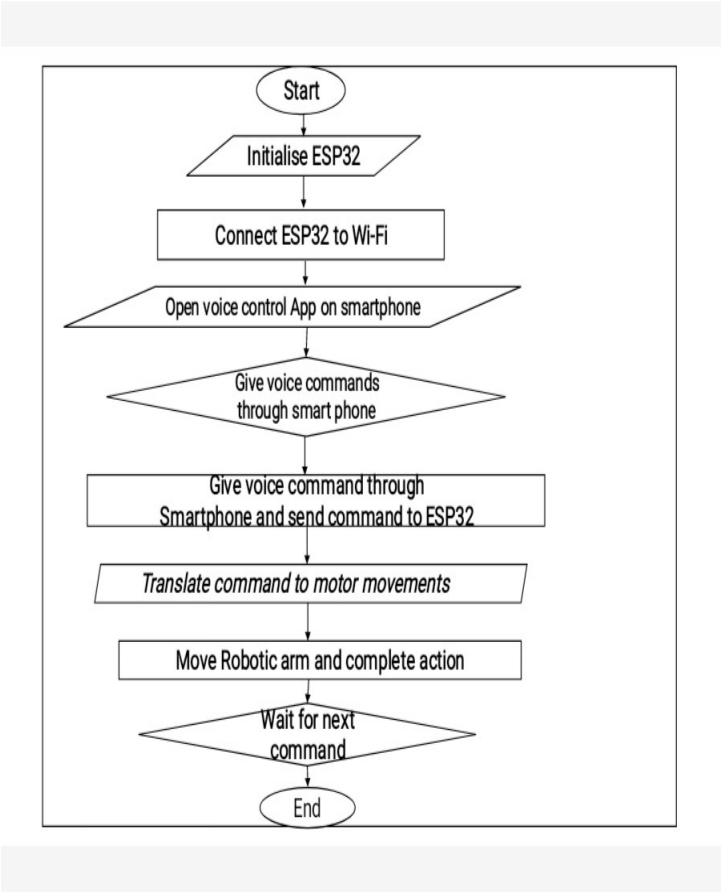

Fig: Flow chart of the project

This flow chart provides a high-level overview of the steps involved in controlling a robotic arm using voice commands via a smartphone and an ESP32 microcontroller. Each step requires careful implementation and testing to ensure seamless operation and reliable performance. The system is powered on, and the initial setup begins. The ESP32 microcontroller is initialized with the necessary libraries and configurations for Wi-Fi, Bluetooth, and GPIO pins for the robotic arm control. ESP32 attempts to connect to a predefined Wi-Fi network to enable communication with the smartphone if Wi-Fi is used for communication. If Bluetooth is used, this step is bypassed. The smartphone application starts and initializes the speech recognition module to listen for voice commands.

TABLE1: COMMANDS OF ROBOTIC ARM

Commands	**Movements of Robotic Arm**
Go up(U)	Moves in the upward direction
Go down(D)	Moves in the downward direction
Hold(H)	Holds an object
Release(X)	Releases an object
Clockwise(C)	Moves in the clockwise direction
Anti Clockwise(A)	Moves in the anticlockwise direction

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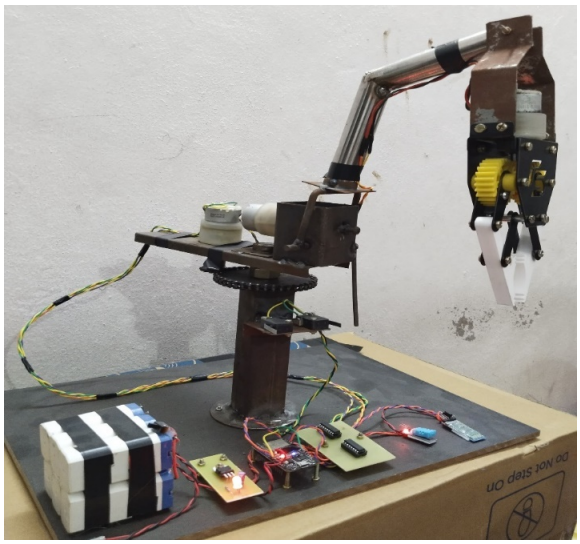
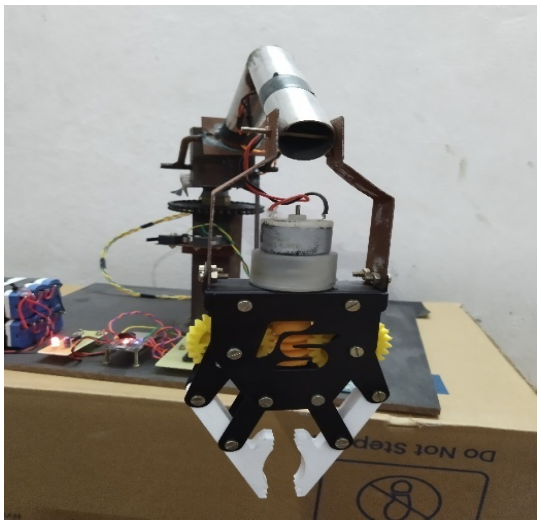
V.RESULTS AND DISCUSSIONS:



(Fig: DOWN)



(Fig: UP)

(Fig: HOLD)

(Fig: RELEASE)

The above figures depicts us about the commands given to a robotic arm using voice control in the Android application. The commands involved are up, down, hold, release, clockwise and anticlockwise.

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Fig: Bluetooth App

VI.CONCLUSION:

The development of a voice-controlled robotic arm utilizing ESP32 and smartphone integration has been a significant technological advancement, offering a glimpse into the future of human-machine interaction. Through this project, we successfully demonstrated the feasibility of controlling a robotic arm through voice commands, enhancing its usability and accessibility in various real-world scenarios. One of the primary achievements of this project is the seamless integration of ESP32 microcontroller and smartphone, providing a user-friendly interface for commanding the robotic arm remotely. By leveraging the power of voice recognition technology, we have enabled intuitive control, making it accessible to users with diverse abilities

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