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Smart Agriculture Using Voice Controlled Robot

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ABSTRACT

In traditional agriculture, seed sowing and related tasks require significant labour, time, and energy. Tractor-based methods often expose operators to harmful noise and vibration. The integration of robotics in agriculture offers a transformative solution by automating repetitive tasks, improving efficiency, and enhancing crop productivity. This paper introduces an autonomous smart agriculture robot designed for seed sowing, leveraging and watering technologies such as Bluetooth, Arduino microcontroller, and sensors to perform precise farming operations. The robot's functionality includes soil moisture sensing, automated seed placement at optimal depths and intervals, and subsequent watering. Its navigation is guided by user input via a smartphone-enabled Bluetooth interface, ensuring cost-effectiveness compared to a GPS-based system. The robot's modular architecture also supports additional capabilities such as ploughing, levelling, and pesticide spraying. With potential future extensions for automated disease detection and adaptive water management, this system exemplifies the role of precision robotics in advancing sustainable and efficient agricultural practices.

Keywords:- Voice control, Bluetooth, Microcontroller, Sensor, Robotics

1. INTRODUCTION

Agriculture forms the backbone of India's economy, with nearly 54% of the working population directly involved in this sector. Despite this massive workforce, agriculture contributes only 11% to 14% of the national GDP. This stark contrast highlights inefficiencies in traditional farming practices, such as over-reliance on manual labour, time-consuming processes, and limited access to technological tools. To address these challenges, there is a growing need for innovative solutions that modernize agricultural practices, enhance productivity, and ease the burden on farmers. In response to these issues, our project introduces a Voice-Controlled Robot, a technological innovation designed to transform the way agricultural tasks are performed. This robot operates using a Bluetooth controller and integrates seamlessly with an existing Android application [5.1], offering a user-friendly interface that responds to simple voice commands.

Farmers can easily control the robot for a wide range of tasks, such as sowing seeds, watering crops, monitoring soil conditions, or even spraying pesticides. By automating these repetitive and labour-intensive activities, the robot aims to reduce the physical effort required, allowing farmers to focus on decision-making and planning. The project prioritizes accessibility and affordability, ensuring that even small-scale farmers in rural areas can benefit from this technology.

The use of a Bluetooth controller [5.2] minimizes dependency on costly hardware while maintaining reliable functionality. Meanwhile, the Android app provides an intuitive platform that simplifies robot operations, making it accessible to users with minimal technical expertise. Voice commands further eliminate language barriers, enabling farmers to operate the system in their native tongue. This project aligns with the broader vision of smart farming, which integrates automation and digital technologies into agriculture. By enhancing efficiency and reducing the reliance on human labour, it addresses some of the most pressing issues faced by the agricultural community. Moreover, this voice-controlled robot [5.2] represents a step toward sustainable farming practices by optimizing resource usage and minimizing wastage. Through this initiative, we aim to contribute to India's agricultural transformation, empowering farmers with tools that increase productivity, improve work efficiency, and bridge the gap between traditional and modern farming methods. By integrating technology into agriculture, this project has the potential to uplift the sector, improve rural livelihoods, and significantly impact the country's economic growth.

2. MATERIALS AND METHOD

The main components utilized in this project include an Arduino Uno microcontroller, HC-05 Bluetooth module, L293D motor driver [5.2], wires, battery, ultrasonic sensor, and an Android IDE application.

2.1. Arduino Components/Pins Used in the Project

The Arduino Uno is directly connected to the motor shield, and the following pins and components are used:

a) **Motor power supply terminal**: This terminal is used to connect the battery, which powers the motors of the robotic vehicle.

b) **Power supply selection jumper**: This jumper ensures proper connection between the Arduino Uno and the motor driver shield for effective power distribution.

c) **DC motor connector pins**: These pins allow connection of the four motors to the Arduino board.

d) **USB connector**: This USB port is used to connect the Arduino board to a computer. It facilitates loading programs via the Arduino Integrated Development Environment (IDE) and can also be used to supply power to the board.

e) **Analog input pins**: These pins receive sensor data and other analog input signals. They connect the ultrasonic sensor and Bluetooth module to the Arduino board.

2.2. Pins of the Bluetooth Module (HC-05)

The following pins on the HC-05 Bluetooth module are used:

a) **TXD pin**: This pin transmits serial data wirelessly from the module.

b) **RXD pin**: This pin receives serial data and transmits it wirelessly.

c) **GND pin**: This pin connects to the ground, ensuring proper electrical grounding.

d) **VCC pin**: This pin supplies power to the module, which can be either 5V or 3.3V, based on its specifications.

2.3. Pairing the Smartphone with the HC-05 Module

a) Ensure the Bluetooth module is powered on.

b) Search for available Bluetooth devices using your smartphone. The HC-05 module should appear in the list of devices.

c) Select the HC-05 device, click to connect, and pair it by entering the provided password.

2.4. Pins Used in the HC-SR04 Ultrasonic Sensor

The HC-SR04 ultrasonic sensor includes the following pins:

a) **VCC pin**: Supplies the required 5V power from the Arduino.

b) **Trig (Trigger) pin**: Emits ultrasonic pulses when a HIGH signal is applied for 10 microseconds.

c) **Echo pin**: This pin stays HIGH while the ultrasonic signal is in transit and reverts to LOW once an echo is detected.

d) **GND (Ground) pin**: Establishes a connection to the Arduino's ground to complete the sensor circuit.

2.5. Battery and Battery Holder

The robot vehicle is powered by 12V batterie connected and secured in a battery holder.

2.6. Block Diagram of the Robot Vehicle

The project includes a block diagram representing the interconnections between the various components of the robot vehicle. [5.1]

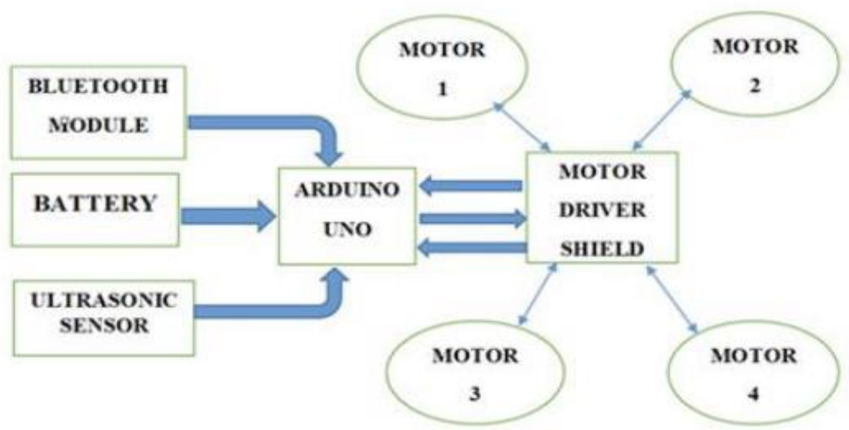

Fig 1: - Block diagram of the robot vehicle

2.7. Android application for the project

We used a pre-existing Android Application "Automation" for controlling the robot, which uses a Google voice-to-text convertor to interpret voice commands given to the robot. GUI (graphical user interface) shown below. Application is user-friendly and easy-to-use

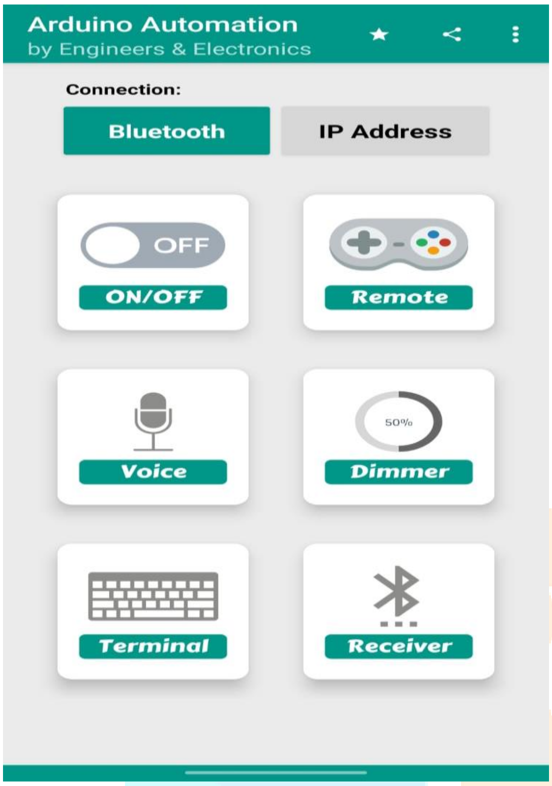

Fig 2: - Home page of Application

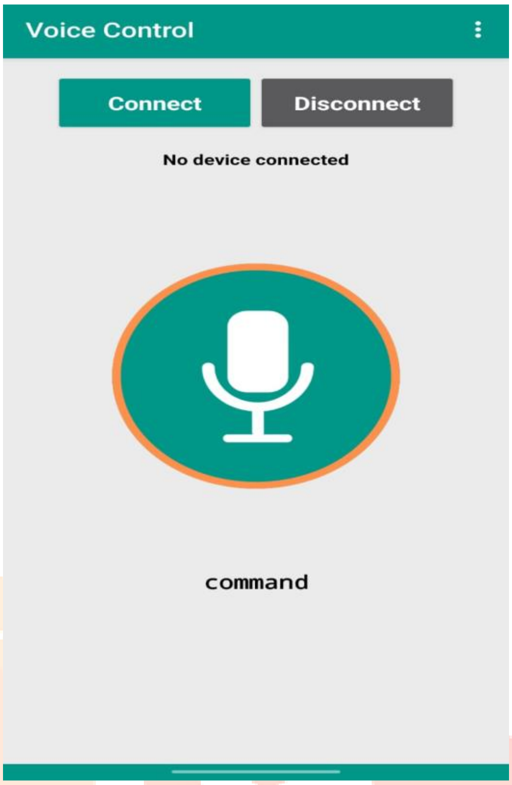

Fig 3: -Voice control of Application

2.8 Hardware and Software Implementation

According Block diagram and requirement we made connection using wire and solder Gun, simulation block diagram is given below which interpret most of our hardware implementation. We used Arduino IDE software to dump the code into microcontroller.

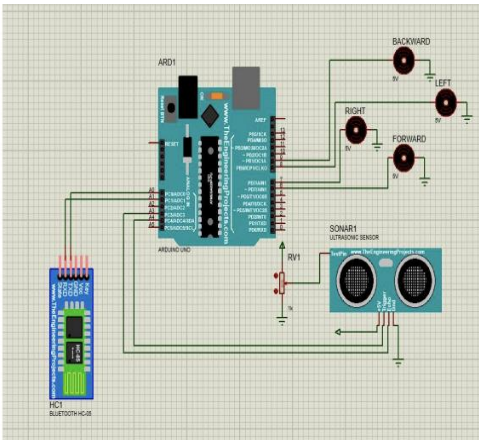

Fig 4: Simulation block diagram

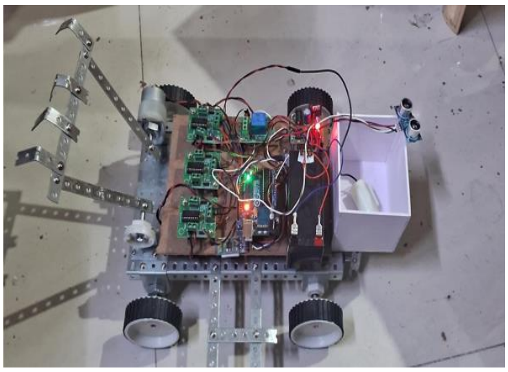

Fig 5: Hardware implementation

We incorporated 12 different voice commands into microcontroller listed in table 1.

Serial no.	Command	Description	Action
1	Manual mode	Switch to Manual mode	Robot will switch into manual mode To perform given commands
2	Forward	Moves Forward	Robot will move forward till next command
3	Back	Moves Backward	Robot will move backward till next command
4	Right	Turns Right	Robot will turn right direction till next command
5	Left	Turn left	Robot will turn left direction till next command
6	Stop	Stops	Robot will enter into stationary state
7	Leveling	It starts leveling	Robot triggers leveling motor to perform leveling task
8	Digging	Starts Digging	Robot triggers digging motor to perf -orm digging task
9	Seeding	Starts Seeding	Robot triggers Seeding motor to perform Seeding task
10	Pump ON	Turn on DC pump	Robot will turn on DC pump for pesticide, water spraying tasks
11	Pump Off	Turn off DC pump	Robot will turn off DC pump
12	Auto mode	Switch to Auto mode	Robot will Switch into Auto mode to perform all tasks one by one

Table 1: Commands and Action performed by Robot

3. RESULTS AND DISCUSSION

We tested project prototype based on Aim of the project; results of the tests listed below.

We tested robot in 2 conditions

a) Ideal condition (low background noise)
b) Noisy condition

Test condition	Error issue	Response time in Second	Attempts	Accuracy in %
Ideal condition	Detection of command	< 1	15	93
Noisy condition	Detection of command	< 1	10	70
	Background Noise	< 1	10	80
	Speech Overlapping	< 1	10	60
	Inconsistent Speech	< 1	10	70

Table 2: Voice command tests result in 2 conditions

Test Based on different commands

Serial no.	Command	Response time	Attempts	Accuracy in %
1	Manual mode	< 1	10	100
2	Forward	< 1	10	100
3	Back	< 1	10	100
4	Right	< 1	10	100
5	Left	< 1	10	100
6	Stop	< 1	10	100
7	Leveling	< 1	10	90
8	Digging	< 1	10	70
9	Seeding	< 1	10	60
10	Pump ON	< 1	10	100
11	Pump Off	< 1	10	100
12	Auto mode	< 1	10	100

Table 3: Accuracy test result for 12 different commands

DISCUSSION

We got most of our result based on aim of our project, we achieved 100% accuracy in 9 commands but in remaining 3 commands such as levelling, Digging and Seeding we achieved 90%, 70% and 60 % of Accuracy respectively, due to error and miss interpretation in google voice to text convertor. We can overcome this by providing commands correctly or by replace the commands in programs, which can easily detect and interpreted into text.

4. CONCLUSION

The voice-controlled robotic vehicle for smart agriculture successfully automates repetitive tasks, improving efficiency and reducing manual labour. Integrating Arduino Uno, HC-05 Bluetooth, and sensors, the system performs operations like levelling, digging, seeding, and watering with precision. The Android app, “Automation”, provides an interface and voice-command functionality, ensuring easy usage by farmers.

This project bridges traditional and modern farming methods, offering an affordable and accessible solution for small-scale farmers. It demonstrates the potential of robotics in promoting sustainable agriculture and addressing inefficiencies. With further refinements, the system can significantly contribute to improving productivity and livelihoods in rural areas. Overall, the project highlights the transformative role of technology in advancing agricultural practices.

5. REFERENCES

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