CHAPTER 1

INTRODUCTION

1.1. Preamble

The title “Multi-tasking robot using microcontroller for agriculture application” describes that in response to the growing need for efficiency and sustainability in agriculture, our project focuses on developing a multitasking agriculture robot. This innovative system aims to automate a range of essential farming tasks, such as ploughing, seeding, and crop monitoring, thereby enhancing productivity and reducing the reliance on manual labour. Leveraging advanced technologies, including microcontrollers, sensors, and artificial intelligence, our robot is designed to operate with high precision and adaptability across various agricultural environments. The project emphasizes the integration of a user-friendly mobile application for remote control and real-time monitoring, providing farmers with greater flexibility and control over their operations. By addressing the challenges of modern farming, such as labour shortages and the need for increased efficiency, this project seeks to contribute to a more sustainable and technologically advanced agricultural future.

1.2. Overview

Agriculture is the main backbone of India. The history of Agriculture in India dates back to Indus Valley Civilization Era and even before that in some parts of Southern India. Today, India ranks second worldwide in farm output. The special vehicles play a major role in various fields such as industrial, medical, military applications etc., The special vehicle field are gradually increasing its productivity in agriculture field. Some of the major problems in the Indian agriculture are rising of input costs, availability of skilled labours, lack of water resources and crop monitoring. To overcome these problems, the automation technologies were used in agriculture. The automation in the agriculture could help farmers to reduce their efforts.

The vehicles are being developed for the processes for ploughing, levelling, water spraying. All of these functions have not yet performed using a single vehicle. In this project the robots are developed to concentrate in an efficient manner and also it is expected to perform the operations autonomously. The implemented idea can perform the functions such as ploughing, seed sowing, mud levelling and water spraying. These functions can be integrated into a single vehicle and then performed.

Agricultural robots are seen as one of the key trends that will deeply influence the agriculture industry in future. The heart of this phenomenon is the need to significantly increase the crop production yields. Agricultural robots automate slow, repetitive, and dull tasks for farmers, allowing them to focus on improving the production yields, while increasing farm efficiency as well as reducing labour requirements and the overall operating costs. Agricultural robots also enable precision agriculture, in which resources are distributed more efficiently, leading to significant savings in resource use and contributing to a lower environmental impact. Robot is designed for agricultural purposes. It is designed to minimize the labour of farmers in addition to increasing the speed and accuracy of the work. It performs the elementary functions involved in farming i.e., harvesting, spraying, seeding and cutting. And they gradually appear advantages in agricultural production to increase productivity, improve application accuracy and enhance handling safety.

1.3. Significance

In the field of agriculture, crop plantation begins with ploughing the land and sowing seeds. The traditional method of manually sowing seeds by hand is a highly inefficient and time-consuming process that requires a lot of human effort and can lead to health issues for the farmers due to excessive bending and ergonomic strain. With the rise of large agriculture fields all over the world, traditional methods of sowing seeds have been unable to meet the increased crop seeding requirements. As such, agriculture machinery designed specifically for crop seeding were introduced. However, spreading seedlings using tractors results in a high wastage of seedlings and an irreversible damage to agriculture fields due to the compaction of soil from the weight of the heavy machinery. Therefore, one area where robots are perfectly suited to be used in the agriculture operations are the crop seeding process.

The concepts of smart farming and precision agriculture are related but do not exactly mean the same. These concepts emerged as a helping tool in bridging the knowledge gap. Both are concerned majorly with improving crop yield. The purpose of this innovative approach is to boost agricultural production and encourage farming. Prediction in smart farming looks at gathering and analysing data about farming factors such as soil parameters, fertilizer required and atmospheric weather essential for crops' optimum performance. With this information, smart farming models are developed to manage and ensure the accurate utilization of the farming resources autonomously Smart farming or precision agriculture are particularly important, especially in developing countries like Nigeria, where Agriculture is mostly practised traditionally.

Traditionally in the sense that is still practised by the mere experience of the elderly people. However, the accurate prediction of these crucial farming factors can best be achieved with the aid of machine learning techniques. In this regard, the authors emphasized that prediction is one of the basic qualities of machine learning in smart farming that is used as a preventive measure. In a related view, the researchers asserted that machine learning is applicable in all fields of human endeavour for automation purposes. In summary, agriculture is a cornerstone of human civilization, essential for sustaining life, supporting economies, and shaping cultures. Its significance extends beyond mere food production, influencing various aspects of life and the planet.

1.4. Relevance

This work aims to develop a low-cost agricultural robot for crop seeding in agriculture fields. The driving force behind this work is to reduce human interference, labour requirements, and the overall operating costs in the field of agriculture. In order to keep the costs to a minimum, the implemented prototype was assembled using simple, cost-effective, and off-the-shelf components. The agricultural robot developed in this research work consists of two parts, namely a mobile base for robot movement and a seeding mechanism attached to the mobile base for crop seeding application. The mobile base has a four-wheel design for ease of movement on uneven terrains. The agricultural robot operates in accordance to the commands of an operator.

As farms grow in size, together with the size of the equipment used on them, there is a need for ways to automate processes, previously performed by the farmer himself, such as controlling the fields for pests. These tasks are perfectly suited for autonomous robots, as they often require numerous repetitions over a long period of time and over a large area. The use of robots is a rather new development as most of the existing solutions for automatic supervision, is designed for standard farm equipment, such as tractors, combines and pesticide sprayers.

1.5. Organization of Report

The mini project report is organized into 5 chapter

Chapter 1 provides a brief introduction of our domain, the significance and relevance of our project. It provides the reader with a comprehensive understanding of the report's context, the issues it addresses, and the goals it aims to achieve.

Chapter 2 provides the literature review of the existing research and scholarly works relevant to the project, providing a foundation for understanding the current state of knowledge in the field. It deals with the existing technologies of the field providing an overview of the domain and research gaps.

Chapter 3 provides the methodology employed in the study, outlining the systematic approach taken to achieve the research objectives.

Chapter 4 provides the findings of the study, detailing the implementation process and analyzing the results obtained.

Chapter 5 provides a comprehensive summary of the study's findings and their implications, concluding the research with a reflection on the outcomes and directions for future work.

CHAPTER 2

LITERATURE SURVEY

2.1. Introduction

When conducting a literature survey for agricultural robots, it is crucial to explore existing research and publications in the field. By examining various studies, articles, and academic papers, one can gain valuable insights into the different types of agricultural robots, their applications, and the advancements in technology within this domain. Understanding the challenges faced by agricultural robots, such as navigation, sensing capabilities, and autonomous operations, is essential for comprehensive research. Analyzing case studies and industry reports can provide a broader perspective on the current state of agricultural robotics and help in identifying future research directions and opportunities for innovation in this field.

2.2. Review on Literature Survey

[1] Agricultural Robot for Automatic Ploughing and Seeding by Amrita Sneha A., Ankita A., and Abirami E (2015). This paper discusses the development and implementation of a robotic system designed to automate the agricultural processes of ploughing and seeding. The primary focus of the research is to address the labor-intensive nature of traditional farming methods, which often require significant human effort and are prone to inefficiencies. The proposed agricultural robot leverages advanced technologies in robotics and automation to enhance productivity and precision in the field. The authors discuss prior work on agricultural robots, noting the advancements and ongoing challenges in developing reliable, cost-effective, and user-friendly systems. They emphasize the potential of their proposed robot to revolutionize farming practices by reducing manual labor, increasing operational efficiency, and enhancing crop yields. The literature review sets the stage for the detailed technical description of their robotic system, including its design, functionality, and experimental results, which demonstrate its effectiveness in automating ploughing and seeding tasks.

[2] Design and Implementation of Seeding Agricultural Robot by P. Usha and Dr. V. Nandagopal (2015). This paper delves into the development of an agricultural robot specifically tailored for the seeding process. This research aims to address the challenges associated with traditional manual seeding methods, which can be time-consuming, labor-intensive, and inconsistent in terms of seed placement and depth. Additionally, the literature review examines existing seeding robots, assessing their performance, reliability, and cost-effectiveness. The authors identify the limitations of these systems, such as high costs, complexity, and limited adaptability to varying field conditions. They highlight the need for more versatile and affordable robotic solutions that can be easily adopted by farmers.

[3] Automated Farming Using Microcontroller and Sensors by Abdullah Tanveer, Abhish Choudhary and Divya Pal (2015). This paper explores the use of microcontrollers and sensor technologies to automate various farming processes. The primary aim of this research is to enhance agricultural productivity and efficiency by leveraging modern technology to reduce human intervention and increase precision in farming activities. Key technologies and methodologies reviewed include different types of sensors (such as soil moisture sensors, temperature sensors, and humidity sensors) and their integration with microcontrollers to create intelligent farming systems. The review highlights how these technologies can monitor environmental conditions in real-time, enabling automated decision-making processes that optimize resource use, improve crop yields, and minimize labor costs.

[4] IOT Based Smart Agriculture by Nikesh Gondchawar, Prof. Dr. R. S. Kawitkar (2016). This paper comprehensive study on the integration of the Internet of Things (IoT) in modern agricultural practices. The research focuses on how IoT technologies can be employed to create smart agriculture systems that enhance productivity, efficiency, and sustainability in farming operations. The review highlights the role of IoT in transforming agriculture by enabling real-time monitoring, data collection, and automated decision-making processes. Key components of IoT systems, such as sensors, actuators, connectivity, and data analytics, are discussed in detail, illustrating their applications in various agricultural tasks.

[5] Digging and Seed Sowing AGRIBOT by Renuka Dhavale, Shweta Kalshetty, Bhushan Patil, Prachi Choudhari, and Ajay Pal Singh (2021). This paper investigates the development of a robotic system designed to automate the processes of digging and seed sowing in agriculture. The primary goal of this research is to create an efficient, reliable, and cost-effective solution that can reduce the labor-intensive nature of traditional farming methods while ensuring precision and consistency in field operations. The authors discuss the integration of various technologies in the development of agricultural robots, such as sensor systems for environmental monitoring, GPS for accurate navigation, and robotic arms for precise digging and seed placement. They emphasize the importance of these technologies in enhancing the efficiency and effectiveness of farming operations, particularly in tasks that require repetitive and precise actions like digging and seed sowing.

2.3. Existing Techniques

- Conventional Farming

Conventional farming involves traditional methods of agriculture that heavily rely on manual labour. This includes processes such as ploughing, where the soil is turned and prepared using hand-held tools or animal-drawn equipment. Sowing involves manually planting seeds either by placing them in rows or broadcasting them across the field. Weeding requires physical removal of unwanted plants that compete with crops for resources. Finally, harvesting is conducted by hand, gathering mature crops for processing. While these methods are deeply rooted in agricultural history and require minimal technological investment, they are often labour-intensive and less efficient compared to modern practices.

- Mechanized Farming

Mechanized farming represents a significant advancement in agriculture through the use of machinery to automate labour-intensive tasks. Tractors serve as the backbone, pulling implements like ploughs, harrows, and seeders across the fields. Ploughs and harrows prepare the soil by breaking it up and levelling the field, making it ready for planting. Seeders and planters precisely sow seeds at optimal depths and spacing, ensuring better germination and crop uniformity. Harvesting machines like combines efficiently separate crops from non-edible parts, significantly reducing the time and labour required for harvesting. This mechanization enhances productivity, reduces labour costs, and increases crop yields.

- Precision Agriculture

Precision agriculture leverages technology to optimize farming practices and improve crop management. Utilizing GPS and GNSS systems, machinery can navigate fields with pinpoint accuracy, ensuring that tasks like planting, fertilizing, and irrigation are carried out precisely where needed. Remote Sensing technologies, including satellite imagery and drones, provide vital data on crop health, soil conditions, and moisture levels.

2.4. Summary

The literature survey on multitasking agriculture robots explores the advancements and challenges in developing autonomous systems capable of performing multiple farming tasks. The survey reviews various robotic platforms and technologies, examines the integration of sensors and artificial intelligence (AI) for precise decision-making and task execution, including soil sensing, crop monitoring, and targeted interventions like seeding and weeding. Additionally, it addresses the technical and economic challenges, including the complexity of developing versatile robots, the high initial investment costs, and the need for robust AI algorithms capable of handling diverse field conditions. The literature points to a growing trend towards sustainable agriculture, where multitasking robots can play a crucial role in optimizing resource use and reducing the environmental footprint of farming operations.

CHAPTER 3

METHODOLOGY

3.1. Introduction

Integrating agricultural robots, into farming practices necessitates a comprehensive approach. Identifying specific agricultural challenges, such as labour shortages, precision farming needs, or environmental concerns, is the foundational step. A thorough economic feasibility analysis, considering factors like purchase price, operational costs, and potential return on investment, is essential to determine the financial viability for farmers. Engaging farmers in the development process, providing comprehensive training, and addressing community concerns fosters trust and acceptance. Developing necessary infrastructure, including reliable internet connectivity, power supply, and repair facilities, supports agrobot operations. Pilot implementation allows for performance evaluation, data collection, and feedback incorporation. Scaling and commercialization involve strategic partnerships, market analysis, and establishing effective sales and distribution channels. A supportive policy and regulatory framework is vital to address safety standards, liability concerns, and encourage adoption. Continuous improvement through data analysis and technological advancements ensures the long-term success of agrobots. Additionally, considering environmental impact, social implications, and ethical concerns is crucial for responsible and sustainable agrobot integration.

3.2. Objectives

- To design and develop a robot capable of performing multiple agricultural tasks, such as ploughing, seeding, and crop monitoring, thereby reducing the need for manual labour.
- To develop a mobile application interface that allows for easy remote control and real-time monitoring of the robot's operations, providing farmers with greater convenience and flexibility.
- To enable the robot to collect valuable agricultural data, such as soil quality and crop health, providing farmers with insights for better decision-making and farm management.

3.3. Block Diagram

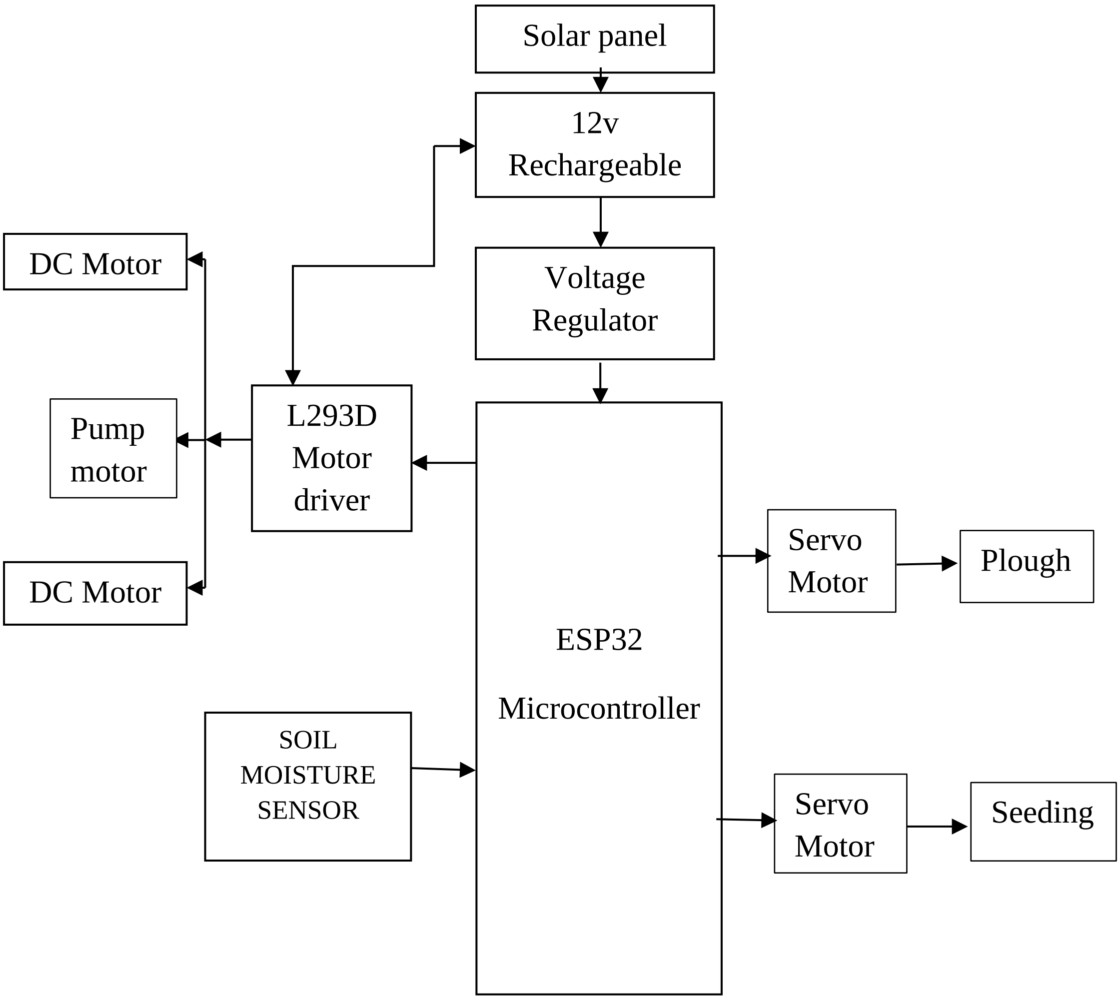

Fig. 3.1: Block Diagram of working model

The robot is controlled using Android App specially designed for this system. It works on Bluetooth protocol. The system is solar powered thereby ensuring conservation of electricity. The block diagram is shown in Fig 3.1

The system is development using ESP32 microcontroller that also has an inbuilt Bluetooth facility. A L293D motor driver is used for driving the two motor of the robot. ASG90 servo motor is connected for the function of seed dispensing. A soil moisture sensor aids in sensing the moisture content of the soil. A mini solar panel is connected to a rechargeable lead acid battery for powering the robot. IC7805 fixed voltage regulator provides 5V DC regulated supply as required by the circuits.

3.4. Hardware Requirements

3.4.1. ESP32 Microcontroller

Fig 3.2: ESP32

The ESP32 microcontroller has Wi-Fi and Bluetooth functionality, Bluetooth Low Energy (BLE) communication, independent timers, analog to digital and digital to analog converters (ADCs and DACs), capacitive touch sensors, and a Hall Effect sensor. The ESP32 microcontroller includes two 240MHz cores, each with a Tensilica Xtensa 32-bit LX6 microprocessor. The ESP32 microcontroller is incorporated in several formats, ranging from a development board to an integrated watch with touchscreen and GPS. The variety of different ESP32 formats illustrates the diversity of projects centered on the ESP32 microcontroller.

The selected formats are the ESP32 DEVKIT DOIT, the TTGO T-Display V1.1, the TTGO LoRa32 V2.1 1.6, the ESP32-CAM, the TTGO T-Watch V2 with GPS, and the M5Stack Core2 module. All formats incorporate the ESP32-D0WDQ6 chip, with either revision 1 (ESP32 DEVKIT DOIT and ESP32-CAM) or revision 3, except the TTGO LoRa32 V2.1 1.6, as the ESP32-PICO-D4 chip replaced the ESP32-D0WDQ6 chip of the TTGO LoRa32 V1.0. The selected range of ESP32 module formats is not exhaustive, but does represent a comprehensive range of modules available with the ESP32 microcontroller.

More recently, new models were added, including the ESP32-C and -S series, which include both single and dual core variations. These two series also rely on a Risc-V CPU model instead of Xtensa. Risc-V is similar to the ARM architecture, which is well supported and well-known, but Risc-V is open source and easy to use.

Table 3.1: Specification of ESP32

Type	ESP32
Processor	Tensilica LX6 Dual-core
Clock frequency	240MHz
SRAM	512kB
Memory	4MB
Wireless Lan	802.11b/g/n
Frequency	2.4GHz
Bluetooth	Classic/ LE
Data Interfaces	UART/ SPI/DAC/ADC
Operating Voltage	3.3V (operable via 5V microUSB)
Operating temperature	-40 C to -125 C
Dimension	48 x 26 x 11.5mm
Weight	10g

3.4.2. DC Motor

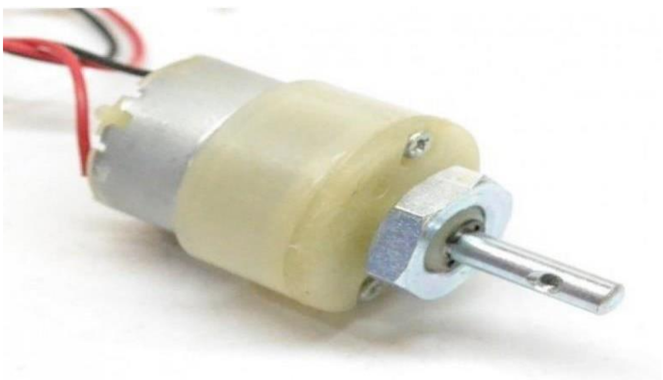

Fig. 3.3: DC Motor

Gear Motor is a commonly used term that designates a hoist that derives its lifting and lowering power from a mechanical setup involving a gear set and pneumatic or electric motor. As the name implies a gear motor or geared motor is a motor having an attached gear assembly.

The gear assembly or gear train enable the gear motor to provide greater torque at a lower RPM than the motor alone would be capable of providing. That is, gear motor refers to a combination of a motor plus a reduction gear train.The gear reduction or gear train reduces the speed of the motor, with a corresponding increase in torque. Gear ratios range from just a few to huge. A minute ratio can be achieved with a single gear pair while a large ratio requires a series of gear reduction steps and thus more gears.

3.4.3. L293D Motor driver module

A motor driver IC is an integrated circuit chip which is usually used to control motors in autonomous robots. Motor driver IC's act as an interface between microprocessors in robots and the motors in the robot. These IC's are designed to control 2 DC motors simultaneously. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor. Motor Driver IC's are primarily used in autonomous robotics only.

The L293D is a 16 pin IC, with eight pins, on each side, dedicated to the controlling of a motor. There are 2 INPUT pins, 2 OUTPUT pins and 1 ENABLE pin for each motor.. It has two voltage pins, one of which is used to draw current for the working of the L293D and the other is used to apply voltage to the motors. The L293D contains dual H-bridge drivers, allowing it to drive two motors simultaneously, with each bridge capable of driving up to 600 mA of current and a peak of 1.2 A. The IC can operate with a supply voltage ranging from 4.5V to 36V, making it versatile for different power requirements.

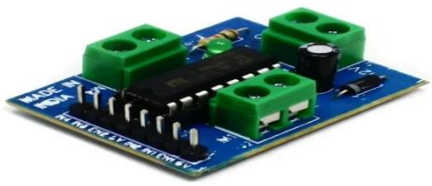

Fig. 3.4: L293D motor driver

3.4.4. Lead-Acid Battery

Fig. 3.5: Lead acid battery

The rechargeable batteries are lead-lead dioxide systems. The diluted sulfuric acid electrolyte is absorbed by separators and plates and thus immobilized. The battery being accidentally overcharged produces hydrogen and oxygen, special one-way valves allow the gases to escape thus avoiding excessive pressure build-up. Otherwise, the battery is completely sealed and is, therefore, maintenance-free, leak proof and usable in any position.

General Features of lead acid battery:

● UL-recognized component.

● Can be mounted in any direction.

● Lead and calcium tin alloy grid is designed using computers for high power density.

● Lead acid battery provides long service duration.

● Maintenance cost is free.

● Low self-discharge.

3.4.5. Soil moisture sensor

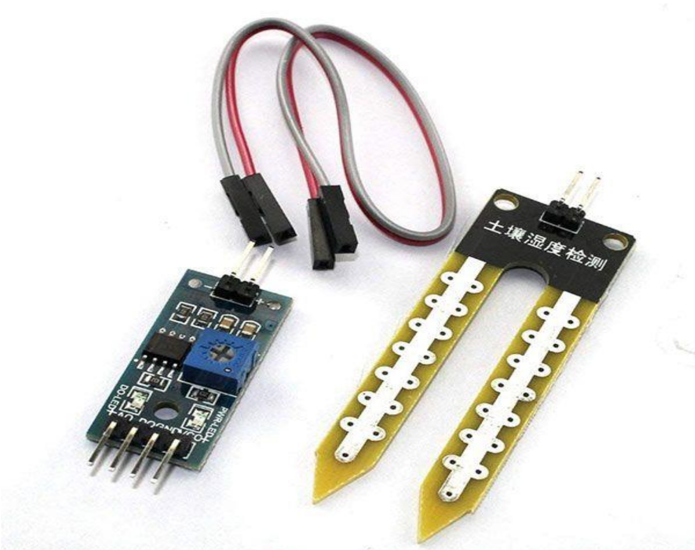

Fig. 3.6: Soil moisture sensor

The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. As the straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content.

The relation among the calculated property as well as moisture of soil should be adjusted & may change based on ecological factors like temperature, type of soil, otherwise electric conductivity. The microwave emission which is reflected can be influenced by the moisture of soil as well as mainly used in agriculture and remote sensing within hydrology.

Soil Moisture Sensor Pin Configuration

- VCC pin is used for power
- A0 pin is an analog output
- D0 pin is a digital output
- GND pin is a Ground

3.4.6. Solar panel

Fig. 3.7: solar panel

The main component of a solar panel is a solar cell, which converts the Sun's energy to usable electrical energy. The most common form of solar panels involves crystalline silicon-type solar cells. These solar cells are formed using layers of elemental silicon and elements such as phosphorus and boron. The elements added to the silicon layers form an n-type layer, which has an excess of electrons, and a p-type layer, which has a deficit of electrons. These two layers form a p-n junction.

When light falls on a solar cell, electrons are excited from a lower-energy ground state, in which they are bound to specific atoms in the solid, to a higher excited state, in which they can move through the solid. In the absence of the junction-forming layers, these free electrons are in random motion, and so there can be no oriented direct current. The addition of junction-forming layers, however, induces a built-in electric field that produces the photovoltaic effect. In effect, the electric field gives a collective motion to the electrons that flow past the electrical contact layers into an external circuit where they can do useful work.

3.4.7. Servo Motors

Fig. 3.8: SG90 Servo Motor

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a servo mechanism. A servo motor usually comes with a gear arrangement that allows us to get a very high torque servo motor in small and lightweight packages. Due to these features, they are being used in many applications like toy car, RC helicopters and planes, Robotics, etc.

3.4.8. Mini Water Pump

A mini water pump is a compact, portable device designed for moving water in small-scale applications. These pumps come in various types, including submersible, centrifugal, and diaphragm pumps, each employing different mechanisms for water movement. They are typically powered by electricity, batteries, or solar energy, offering versatility in different settings. Made from durable materials like plastic or stainless steel, mini water pumps are commonly used in aquariums, fountains, small-scale irrigation, and cooling systems. They are also handy for household tasks such as draining pools or transferring water. When choosing a mini water pump, it's essential to consider factors like flow rate, head height, and compatibility with the water type to ensure optimal performance and longevity.

Fig.3.9: Mini water pump

3.5. Software Requirements

3.5.1. Arduino IDE

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programmed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board. Arduino provides a standard form factor that breaks the functions of the microcontroller into a more accessible package. Arduino is a prototype platform (open-source) based on an easy- to-use hardware and software. It consists of a circuit board, which can be programmed (referred to as a microcontroller) and ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board.

The Arduino IDE software consists of two main parts, Editor and compiler. An editor area in the software is used to write the required code for the project.

The Arduino IDE software consists of three sections,

(1) Menu bar: The bar located at the top of the window is the menu bar. This contains five options, File, Edit, Sketch, Tools, Help. In this, the file option contains twelve options New, Open, Open recent, Sketchbook, Examples, Close, Save, save as, Page set up, Print, Preferences, Quit. The menu bar also has an option called the Serial monitor which is used to debug the written code of the respective project. To use the serial, monitor option, the Arduino board should be connected with the computer.

(2) Text editor: The area below the menu bar is a text editor.

(3) Output pane: the bar located at the bottom of the software is the output pane. This bar displays the error messages if there are any.

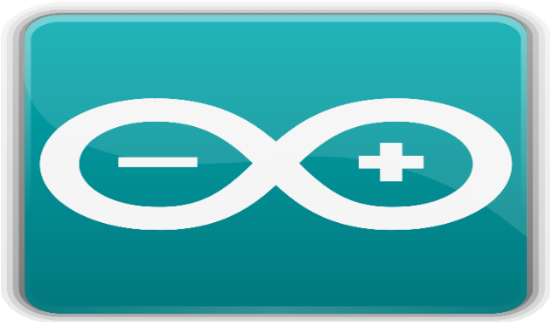

Fig. 3.10: Arduino IDE icon

3.5.2. Serial Bluetooth Terminal

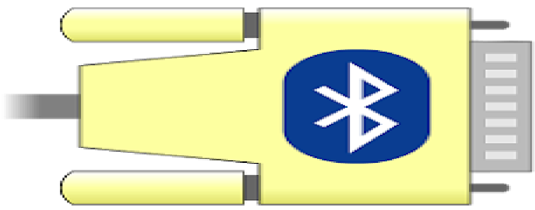

Fig. 3.11: Serial Bluetooth terminal app

A serial Bluetooth terminal is a software application or device that facilitates wireless communication between a computer, smartphone, or other digital devices and a Bluetooth-enabled serial device. This terminal uses the Bluetooth Serial Port Profile (SPP) to establish a connection, allowing users to send and receive data over Bluetooth. It is commonly used in applications involving microcontrollers, embedded systems, or other devices that support serial communication. The serial Bluetooth terminal provides an interface for monitoring and controlling these devices remotely, offering convenience and flexibility in managing data transfer and system operations without the need for physical cables.

3.6. Flow Chart

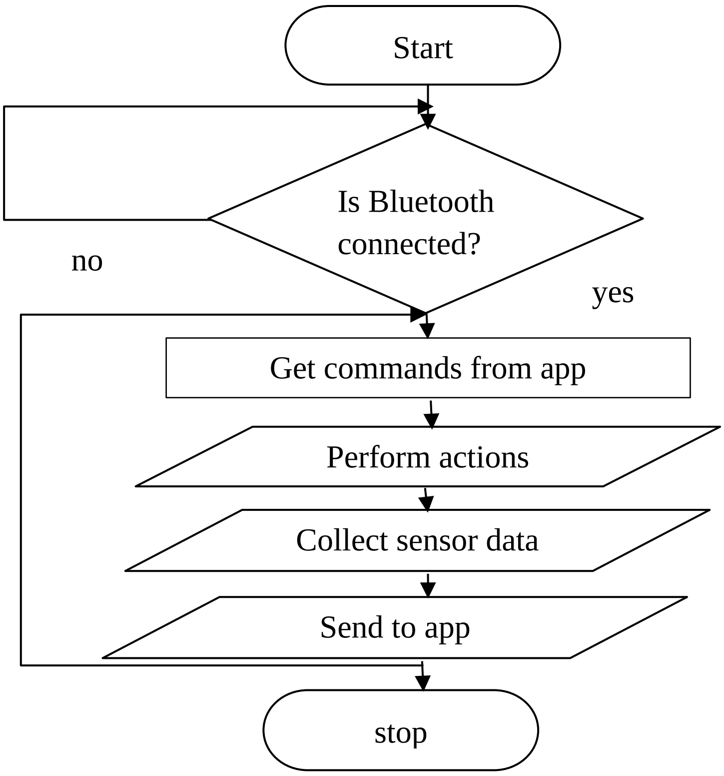

Fig.3.12: Flow chart of working model

The flowchart depicts a simplified process that outlines the interaction between a device or system and an associated app.

Initiation: The process begins at the "Start" point. This indicates the beginning of the system's operation.

Bluetooth Connectivity Check: The system first determines if the bluetooth connection is established. This step is crucial as it likely requires a network connection for the subsequent actions. If Bluetooth is not connected, the process might involve waiting for a connection or attempting to establish one before proceeding. If Bluetooth is connected, the process moves forward.

Command Reception: Once connected to Bluetooth, the system enters a state where it can receive commands from an external app. These commands are likely instructions for the system to perform specific actions.

Action Execution: Based on the received commands, the system carries out the specified actions. The nature of these actions is not detailed in the flowchart and could range from simple tasks to complex operations depending on the system's capabilities.

Sensor Data Collection: Concurrently or after completing the actions, the system gathers data from its sensors. This data could include various parameters depending on the system's purpose (e.g., temperature, humidity, motion, etc.).

Data Transmission: The collected sensor data is then sent back to the app. This information can be used by the app for analysis, display, or further processing.

Termination: The process concludes at the "Stop" point, indicating the end of the current cycle or a potential shutdown of the system.

3.7. Summary

In this chapter we detailed the integration of hardware and software components essential for the robot's functionality. The hardware setup includes sensors, microcontrollers, and power units, organized in a block diagram to illustrate their interaction. The selection of these components was based on criteria like cost, durability, and performance. On the software side, we discussed the architecture, including control algorithms for navigation and task execution, data processing techniques, and the design of user interfaces. A flow chart was used to map the robot's workflow, covering steps such as sensing, data processing, decision-making, and task execution. Challenges encountered during development included hardware limitations and software bugs, with current system limitations noted in terms of task range and environmental adaptability.

CHAPTER 4

RESULT ANALYSIS

4.1. Introduction

In this chapter, we delve into the evaluation of the multitasking agriculture robot's performance based on the experimental data and observations collected during the testing phase. This chapter aims to provide a comprehensive assessment of how effectively the robot meets its design goals and performs the intended agricultural tasks. By systematically analyzing the results, we will highlight the strengths of the robot's hardware and software systems, identify any discrepancies between expected and actual performance, and discuss the implications of these findings.

4.2. Results

- Chassis and wheels: The chassis serves as the primary structural framework, providing stability and housing essential components such as sensors, control units, and batteries. The wheels are a crucial part of the robot's locomotion system, designed to travel various agricultural terrains. They are often equipped with treads or specialized coatings to enhance traction, ensuring the robot can navigate soil, grass, and other surfaces commonly found in farming environments.
- Seeding mechanism: A funnel is attached to a servo motor at the front side of the robot which holds the seeds and when the seed sowing mechanism is on the servo is rotated at 30 degree which lets it to open the funnel end to pass the seeds.
- Ploughing mechanism: A plough is attached to the back side of the robot to a servo motor which when the commands are given it rotates to 180 degree and is able to plough the land.
- Watering mechanism: A mini water pump is submerged in a water bottle and is connected to the L293D motor driver, which when the commands are given it starts watering the fields.
- Soil sensing mechanism: A soil sensor is fixed to monitor the soil and it notifies the farmer whether the soil is dry or wet, and this makes it simple for the farmer to know whether there is need for watering or not.

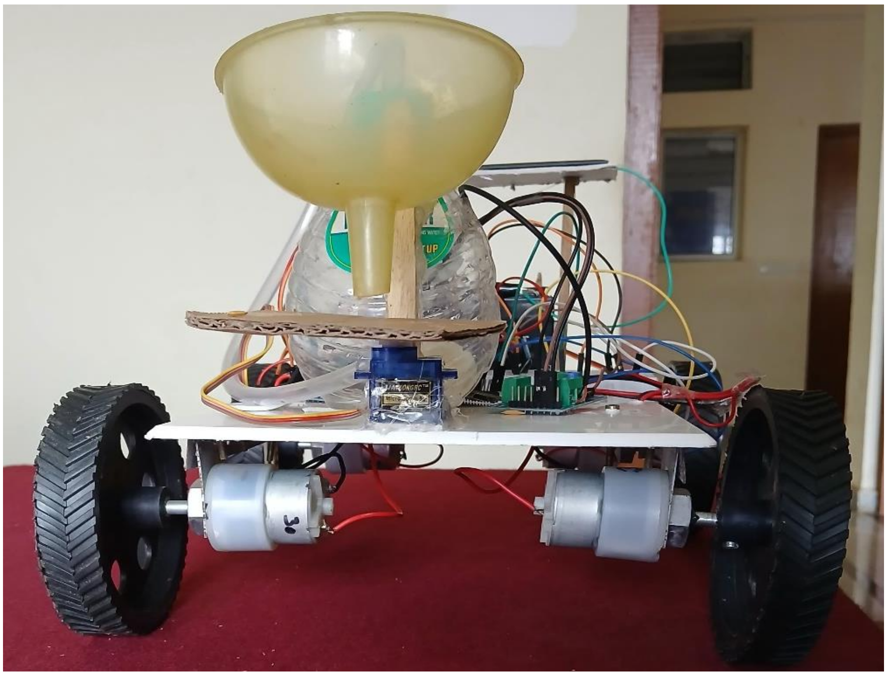

Fig. 4.1: Front View of robot

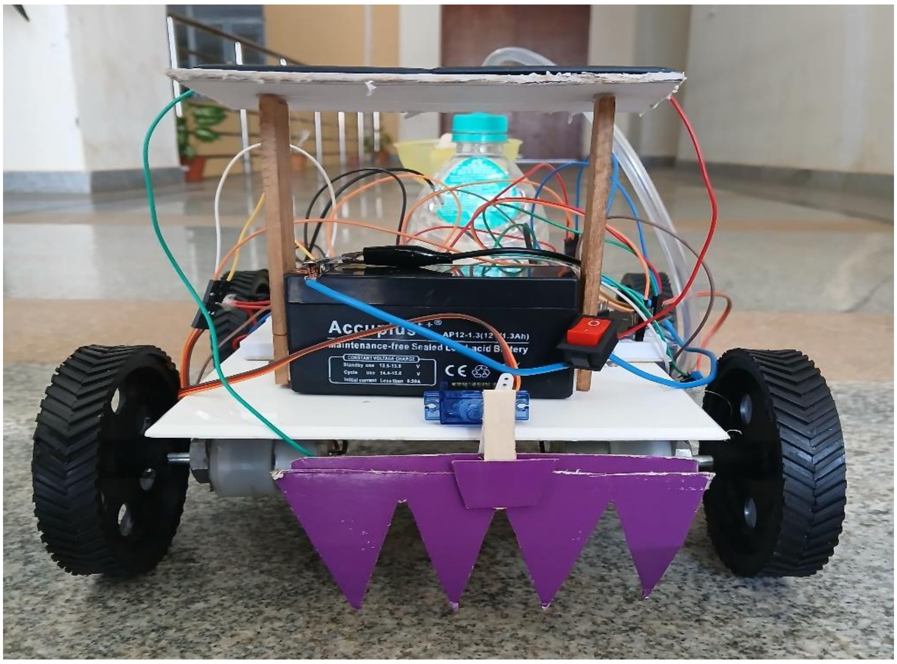

Fig. 4.2: Back View of robot

The front side of the robot is specified for the seeding mechanism. This technique can be used instead of traditional seed sowing where the farmers unevenly sow the seeds manually. This prototype can be implemented by making a larger model which can be actually used in fields. The back side of the robot is fixed with a plough which will be used in ploughing mechanism at the initial stages.

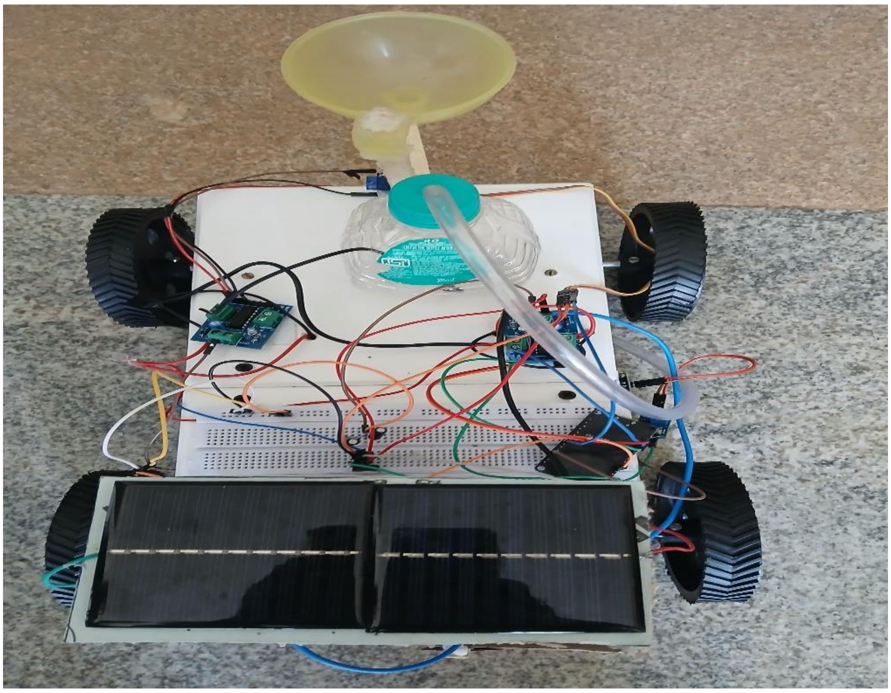

Fig. 4.3: Top view of robot

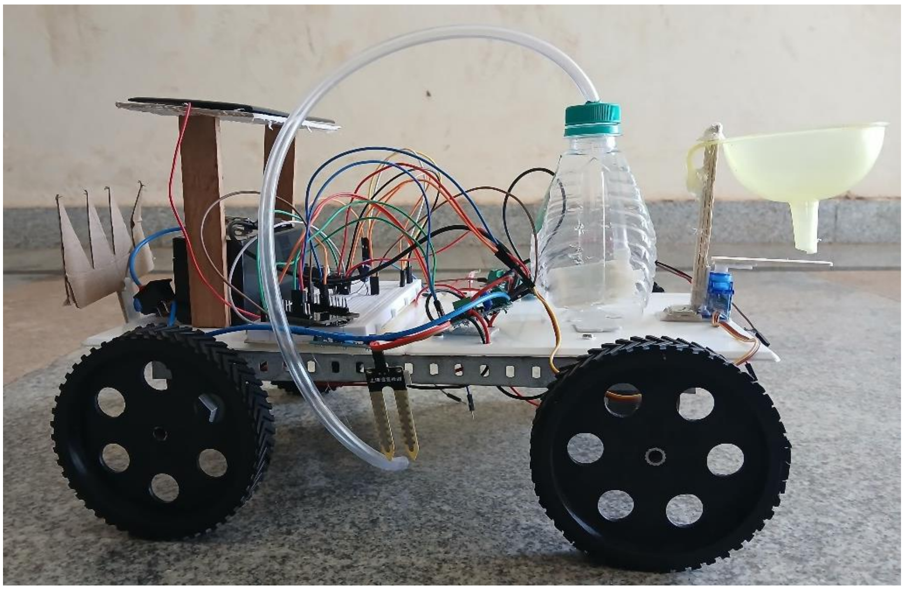

Fig. 4.4: Side view of robot

At the top the solar panel is placed which is connected to the battery. With the help of the solar energy the battery is been charged. Soil sensor is placed at the side end of the robot where it can easily sense the soil and notify the farmer about the soil condition. This process can be very useful in extreme summers to sense the soil and notify the farmer by which there is no condition of soil to be dried out.

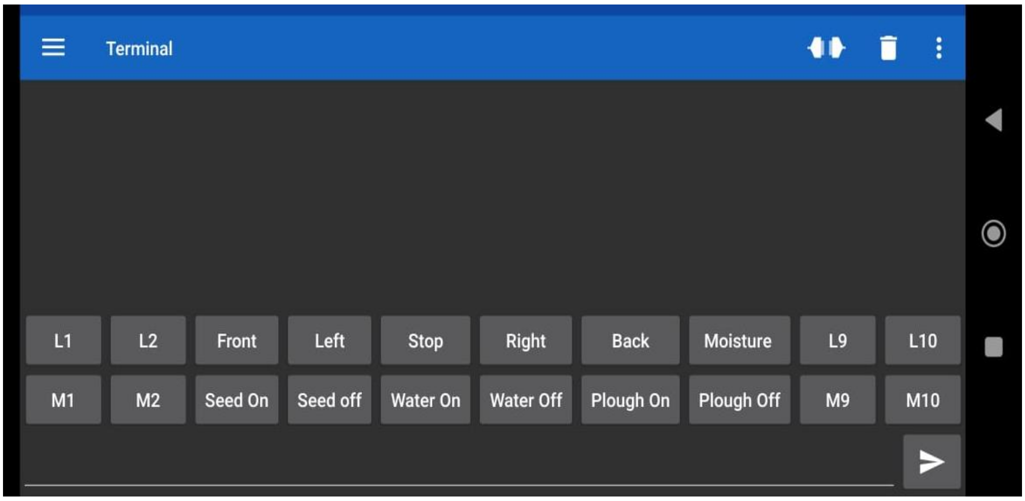

Fig. 4.5: Serial bluetooth terminal app

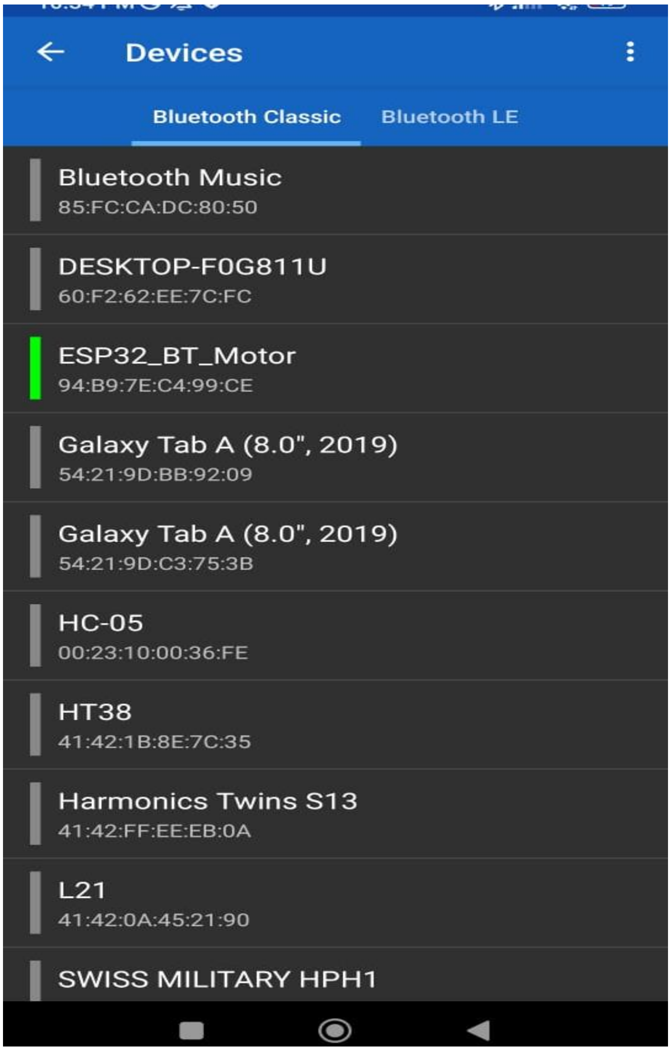

Fig.4.6: List of devices connected with bluetooth

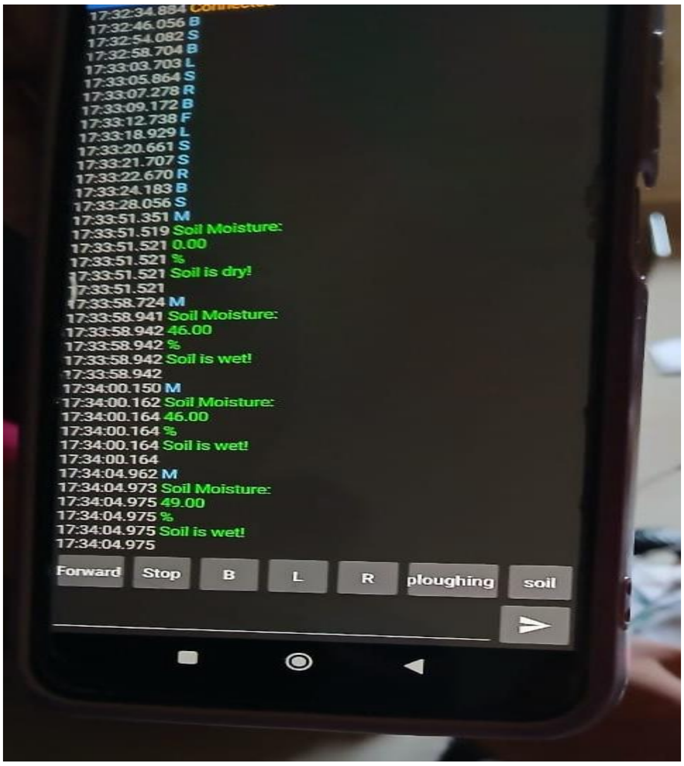

Fig.4.7: Output on serial terminal

This app is used to control our robot to do all the actions. It is initailly connected with the bluetooth of the esp32 microcontroller later on the commands are been given to do set of actions as per the requirement of the user.

4.3. Summary

In this chapter, we evaluated the performance of the multitasking agriculture robot in executing ploughing and seeding tasks, which were controlled via a mobile app interface. The results demonstrate the robot's capability to effectively perform these tasks with a high degree of accuracy and efficiency. During the ploughing operation, the robot maintained consistent depth and spacing, meeting the expected agricultural standards. The seeding process was similarly precise, with the robot accurately dispensing seeds at the designated intervals. The integration of the mobile app allowed for seamless remote control and real-time monitoring, proving to be user-friendly and reliable. This chapter highlights the robot's strengths in task execution and control responsiveness while also discussing any observed deviations or areas where performance could be improved. Overall, the results affirm the robot's potential to enhance agricultural productivity through automation and remote operation.

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1. Conclusion

The development of the multitasking agricultural robot represents a significant advancement in modern farming practices, offering a versatile and efficient solution to various agricultural tasks. Through the integration of advanced hardware and software components, including sophisticated sensors, and a user-friendly mobile app interface, the robot has demonstrated its capability to perform essential activities such as ploughing, seeding, and more with high precision and reliability. The potential for future enhancements, such as modular tool systems, IoT integration, and energy-efficient designs, further underscores the robot's promise in transforming agriculture. This technology not only improves productivity and reduces labour costs but also supports sustainable farming practices. As the robot continues to evolve, it holds the potential to become an indispensable tool for farmers worldwide, capable of adapting to diverse crops and environmental conditions, ultimately contributing to a more efficient, data-driven, and sustainable agricultural future.

In agriculture, by using the solar operated multi-purpose agriculture robot. We can easily reduce the man power, farming tools and time. The machine required less farmers and less time compared to the old working methods. Keeping all this valuable limitation and benefits in mind our multipurpose agriculture robot works on 4 in one operation and given commands. Achieving all the five application of ploughing, sowing, irrigation, soil sensing and solar power in one robot has drastically reduced the negative aspects in viewing agricultural efforts.

5.2. Future Scope

The future scope for the multitasking agriculture robot is vast and promising, driven by the increasing demand for sustainable and efficient farming practices. Potential advancements include the integration of more sophisticated sensors and AI algorithms to enhance the robot's ability to detect and respond to varying soil conditions, crop types, and growth stages. The development of modular attachments could enable the robot to perform a broader range of tasks, such as irrigation, crop monitoring, and pest control, further reducing the need for manual labor.

Integrating Internet of Things (IoT) technologies can facilitate comprehensive farm monitoring and data analytics, providing farmers with actionable insights and allowing for remote monitoring and control via smartphones or computers. The incorporation of renewable energy sources, such as solar panels, can enhance the robot's sustainability and operational range, while autonomous charging stations can enable continuous operation with minimal human intervention.

Cost reduction through scalability and mass production can make these robots more accessible to small and medium-sized farms, not just large agricultural enterprises. Comprehensive training and support services can aid farmers in effectively integrating these robots into their operations. Collaborative robotics, where multiple robots work together, and swarm technology, enabling groups of smaller robots to share data and optimize task completion, can further enhance efficiency. Finally, integrating the robot into a smart farming ecosystem, alongside other smart devices like weather stations and soil sensors, can optimize resource use and improve overall farm management.

Robots like these are brilliant replacements for manpower to a better extent as they deploy unmanned sensors and machinery systems. The agricultural benefits of development of these autonomous and intelligent robots are to improve repetitive precision, efficiency, reliability and minimization of soil compaction and chemical utilization. The robots have the potential of multitasking, sensory measures, idle operation as well working in odd operating conditions.

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APPENDIX-A

```
#include <BluetoothSerial.h>
#include <ESP32Servo.h>
BluetoothSerial SerialBT;
const int motor1Pin1 = 2;    // Motor 1 (Front Left) IN1
const int motor1Pin2 = 4;    // Motor 1 (Front Left) IN2
const int motor2Pin1 = 15;    // Motor 1 (Front Left) IN1
const int motor2Pin2 = 21;
const int soilMoisturePin = 34; // Soil moisture sensor pin
bool moveServo = false;
// Servo motor for ploughing mechanism
Servo myServo;
const int PloughservoPin = 26; // Pin connected to the servo motor
Servo seedServo;
const int seedservoPin = 25;
const int motorEN = 5; // EN1 on the L293D
const int motorIn1 = 18; // IN1 on the L293D
const int motorIn2 = 19; // IN2 on the L293D
void setup() {
  // Initialize the serial communication with the Bluetooth terminal
  Serial.begin(115200);
  SerialBT.begin("ESP32_BT_Motor"); // Bluetooth name
  // Set motor pins as outputs
  pinMode(motor1Pin1, OUTPUT);
  pinMode(motor1Pin2, OUTPUT);
  pinMode(motor2Pin1, OUTPUT);
  pinMode(motor2Pin2, OUTPUT);
```

```
  pinMode(motorEN, OUTPUT);
  pinMode(motorIn1, OUTPUT);
  pinMode(motorIn2, OUTPUT);
  // Start with the motor stopped
  digitalWrite(motorIn1, LOW);
  digitalWrite(motorIn2, LOW);
  digitalWrite(motorEN, LOW);
  digitalWrite(motor1Pin1, LOW);
  digitalWrite(motor1Pin2, LOW);
  digitalWrite(motor2Pin1, LOW);
  digitalWrite(motor2Pin2, LOW);
  // Initialize soil moisture sensor pin
  pinMode(soilMoisturePin, INPUT);
  pinMode(seedservoPin,OUTPUT);
  pinMode(PloughservoPin, OUTPUT);
  // Attach the servo motor to the servo pin
  myServo.attach(PloughservoPin);
  seedServo.attach(seedservoPin);
}
void loop() {
  if (SerialBT.available()) {
    char command = SerialBT.read();
    if (command == '1') {
      // Start moving the servo
      moveServo = true;
      Serial.println("Servo movement started");
    } else if (command == '0') {
      // Stop moving the servo
```

```
    moveServo = false;
    Serial.println("Servo movement stopped");
  }
  else if (command == '3'){
    myServo.write(180);
    Serial.println("Servo at 180 degrees");
  }
  else if (command == '4'){
    myServo.write(0);
    Serial.println("Servo at 180 degrees");
  }
  else if (command == 'F')
  { // Forward command
    digitalWrite(motor1Pin1, HIGH);
    digitalWrite(motor1Pin2, LOW);
    digitalWrite(motor2Pin1, HIGH);
    digitalWrite(motor2Pin2, LOW);
    Serial.println("Motor moving forward");
  }
  else if (command == 'B') { // Stop command
    digitalWrite(motor1Pin1, LOW);
    digitalWrite(motor1Pin2, HIGH);
    digitalWrite(motor2Pin1, LOW);
    digitalWrite(motor2Pin2, HIGH);
    Serial.println("Motor moving backward");
  }
  else if (command == 'L'){
    digitalWrite(motor1Pin1, LOW);
```

```
    digitalWrite(motor1Pin2, HIGH);
    digitalWrite(motor2Pin1, HIGH);
    digitalWrite(motor2Pin2, LOW);
    Serial.println("Motor moving left");
  }
  else if (command == 'R'){
    digitalWrite(motor1Pin1, HIGH);
    digitalWrite(motor1Pin2, LOW);
    digitalWrite(motor2Pin1, LOW);
    digitalWrite(motor2Pin2, HIGH);
    Serial.println("Motor moving right");
  }
  else if (command == 'S'){
    digitalWrite(motor1Pin1, LOW);
    digitalWrite(motor1Pin2, LOW);
    digitalWrite(motor2Pin1, LOW);
    digitalWrite(motor2Pin2, LOW);
  }
  else if (command == 'M') { // Soil moisture sensing
    int sensorValue = analogRead(soilMoisturePin); // Read the analog value from the sensor
    float percentage = 100-map(sensorValue, 0, 4095, 0, 100); // Convert the analog value to a percentage (0-100)
    SerialBT.println("Soil Moisture: ");
    SerialBT.println(percentage);
    SerialBT.println("%");
    if (percentage<=30) {
      SerialBT.println("Soil is dry!\n");
```

```
    }
    else {
      SerialBT.println("Soil is wet!\n");
    }
  }
  if (command == '7')
  {
  digitalWrite(motorIn1, HIGH);
  digitalWrite(motorIn2, LOW);
  digitalWrite(motorEN, HIGH);
  }
  else if (command =='8') {
  digitalWrite(motorIn1, LOW);
  digitalWrite(motorIn2, LOW);
  digitalWrite(motorEN, LOW);
  }
 }
 if (moveServo) {
  for (int pos = 0; pos <= 50; pos++) {
    seedServo.write(pos);
    delay(20); // Delay to control the speed of the servo
  }
  for (int pos = 50; pos >= 0; pos--) {
    seedServo.write(pos);
    delay(20); // Delay to control the speed of the servo
  }
 }
}
```

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