Smart IoT-Based Seed Sowing System

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Abstract - *The following project involves the designing and development of an intelligent agricultural robot known as AgriBot for automation of vital agricultural activities like movement control, seeding, irrigation, soil adjustment, and soil separation. Conventional agricultural techniques demand a lot of manpower, constant monitoring of fields, and ineffectual use of resources such as water and seeds. All these factors contribute towards decreasing the yield of agriculture and increase the cost of operation. In order to overcome the above limitations, the proposed AgriBot system has been designed which will provide smart and economical solutions for precision agriculture. The proposed system can be operated using a smartphone through the Serial WiFi Terminal application with the help of Wi-Fi communication. As a result, the farmer can monitor and control the robot from far away places without his presence in the field. The robot employs the use of embedded controllers, motor drivers, and sensors for the effective accomplishment of various farming processes. The seeding module ensures uniform planting of seeds at a desired depth and interval thus minimizing seed wastage and crop growth. The automatic irrigation system provides water only when needed and hence saves water. As a result of the automation of these processes, the AgriBot will minimize labor, save time, reduce costs, and improve efficiency. The incorporation of wireless mobile control into the system makes it very user-friendly, versatile, and applicable in today's smart agriculture.*

Keywords: Seed sowing, Smart irrigation, NodeMCU (ESP8266), Remote control, Serial WiFi Terminal, Precision farming.

1.INTRODUCTION

Agriculture plays an important part in the development of many nations economically and socially since it offers food, jobs, and materials to industries. However, there are certain difficulties that farmers encounter, such as lack of labor, improper planting of seeds, excessive use of irrigation water, poor soil management, and rising costs of operation. Project AgriBot is the name of the proposed smart farming robot that will automate various farm functions like movement of the robot, seeding, irrigation, soil modification, and soil separation. This robot can be controlled via wireless technology using a Smartphone with the help of Serial WiFi Terminal application. NodeMCU ESP8266 microcontroller is used for the development of this project; it has an in-built Wi-Fi module to enable wireless communication. Using NodeMCU helps to simplify the hardware design since there is no need to use other Wi-Fi communication modules separately.

The AgriBot system design involves both hardware and software components which function in a coordinated way to perform automated agricultural operations. The hardware design includes the NodeMCU controller, L298N motor drivers, DC geared motors, water pump motor, seed dispensing module, soil adjusting module, soil separation module, battery-operated power source, and optional sensors. The software design is accomplished using embedded programming using the Arduino Integrated Development Environment (IDE) platform. This software analyzes the user instructions sent through Wi-Fi communication and controls all motors and modules accordingly.

This system is designed in order to address the main issues present in conventional farming practices. Conventional farming methods need more labor force and time; additionally, incorrect seed placement and uncontrolled irrigation decrease the output of crops. Modern advanced agricultural equipment is too costly for small and medium farmers. Hence, the AgriBot is designed as a cost-effective and user-friendly smart farming tool for performing agricultural operations.

Primary objectives for this project include reduction of manual effort, improvement in accuracy in agriculture, conservation of water, and increased efficiency in farming with the help of automation. The system also facilitates precision agriculture through improved seeding process, controlled irrigation, and soil management. Wireless control using the smartphone application allows farmers to operate the robot remotely from the field without being physically present.

The AgriBot system introduced here is an example of an intelligent and economic approach for agricultural automation. With the use of wireless control technology through the NodeMCU, motorized farming systems, and software technology, an integrated robotics system can be developed to facilitate efficient farming practices.

One of the key objectives is to cut down the number of efforts that would be put into the agricultural processes. Through automation of the processes performed, the robot will reduce the amount of manual labor and make the process faster. One more objective of the project is the enhancement of the accuracy of seeds planting. Through automated seeding procedure, the seeds will be planted accurately without waste, thus improving their productivity.

Another one of the key objectives is water conservation by means of controlled watering process. This feature provides the process of watering of the plants in case when it is required to provide the plants with the needed amount of water. Enhancing the soil preparation is another objective of the system implementation. Thanks to soil adjustment and soil separation features, it will be easier to remove unnecessary objects and prepare the soil.

One more objective is to provide wireless remote control of the robot. Thanks to the Wi-Fi feature of the NodeMCU board, the robot can be controlled via Serial WiFi Terminal mobile application.

Another objective of the project is to build an adaptable and scalable architecture that will be able to support technological advancements in the future. Incorporation of NodeMCU ESP8266 offers wireless connection capabilities and compatibility with IoT based solutions, making way for integration of smart sensors, cloud based monitoring system, GPS navigation and AI technologies in the future. This objective helps in creating a complete self-sufficient smart farming system in the future.

LITERATURE SURVEY

The advancement of the technologies of robotics, embedded system, and wireless communication has changed modern agricultural practice in recent years. There have been many innovations like smart agriculture systems that are developed in order to increase the effectiveness of farming practices, save labor, preserve natural resources, and increase the productivity of crops [1]. Agricultural automation through robotics allows farmers to conduct agricultural tasks like seed sowing, irrigation, soil treatment, and monitoring in a more precise way with minimal human efforts [2]. The combination of technologies such as microcontrollers, sensors, motor control system, and wireless communication allows developing agricultural robots that can help in conducting sustainable agriculture [3].

Precision agriculture has become a very popular topic as there is an increasing need for sustainable and efficient crop production with proper management of resources [4]. However, many agricultural machines available now are quite costly, complicated, and meant only for industrial farming practices [5].

2.1 Embedded Systems in Smart Agriculture

Embedded systems are important in automation in agriculture owing to their ability to offer real-time control and monitoring. There have been several researches done on the use of different microcontrollers including Arduino, NodeMCU, Raspberry Pi, and ESP8266 in the implementation of smart farming technology [1][2]. The microcontrollers have gained popularity because of their affordability, small size, ease in programming and communication capability.

The NodeMCU ESP8266 has gained popularity because of its Wi-Fi feature which enables wireless communication and IoT based agriculture applications [3]. Embedded systems have the ability to control motors, process sensory data and automate the agriculture process effectively.

Several applications utilizing ESP8266 and smartphone user interfaces have been implemented for the control of irrigation, greenhouse monitoring and robotic movement system [3][5]. These technologies enable the removal of human presence in agriculture fields.

Automated seed sowing and irrigation system have been found to be vital in smart agriculture technology because of their ability to optimize the use of resources and increase productivity. Research shows that automated seeding systems offer even seeding and reduces wastage of seeds unlike manual sowing [4][7]. In addition, the automation of irrigation system conserves water through efficient watering.

Adequate soil preparation is crucial for good crop development and increased agricultural productivity. Several researches have revealed that soil loosening, levelling, and unwanted particle extraction from the soil increases the rate of seed germination and nutrient uptake [6][8]. However, traditional soil preparation methods need more manual effort and time. For this reason, researchers have developed automatic soil preparation system by incorporating rotating blades and motorized mechanism.

Motor control forms a vital part of robotized agricultural systems. Research papers often employ L298N motor driver chips and PWM approach to control the speed and direction of DC motors [2][6]. PWM motor control increases the energy efficiency and stability of robots.

METHODOLOGY

3.1 Overview of methodology

The AgriBot System proposed uses a methodology that incorporates the use of embedded systems technology, wireless communication, motor control, and agricultural automation to produce an intelligent farming robot capable of executing various agricultural tasks effectively. The methodology has been developed to ease human work, increase accuracy, prevent wastage of resources, and implement precision agriculture practices.

The operation of the whole AgriBot starts with human interaction via the smartphone using a wireless interface. The farmer sends commands via the Serial WiFi Terminal application to the NodeMCU ESP8266 microcontroller using Wi-Fi communication. The NodeMCU becomes the main processor of the system and keeps on checking for any commands received from the smartphone.

The robot is capable of performing movement operations like moving forward, backward, turning left, and turning right. Additionally, the robot performs automated farm activities like seeding, watering, adjusting soil, and separating soil.

3.2 System Architecture

Firstly, the user interaction layer where the farmer interacts with the robot using the smartphone application. Commands given through the application are wirelessly sent via Wi-Fi communication. Such wireless control system helps in removing the need for any physical switches or wiring for the control and increases operational flexibility.

Secondly, the communication and processing layer where the NodeMCUESP8266 microcontroller plays a role. NodeMCU processes all the wireless command, processes the user instructions and controls the output devices accordingly. As the NodeMCU comes with the in-built Wi-Fi module there is no need for the hardware for wireless communication.

Thirdly, the motor control layer where L298N motor driver modules are employed to connect the NodeMCU with the DC motors. The function of these motor drivers is to amplify the low power signal of the microcontroller to provide enough current to the motors for operation. These driver modules work on the PWM signal given by the microcontroller for controlling the speed and motion.

Fourthly, the mechanical operation layer where the movement system of robot, seeding system, watering system, soil adjustment system and soil separation system work accordingly.

The next layer is the power management layer that consists of the rechargeable battery and voltage regulator. This layer takes care of power supply to all electronic and mechanical parts.

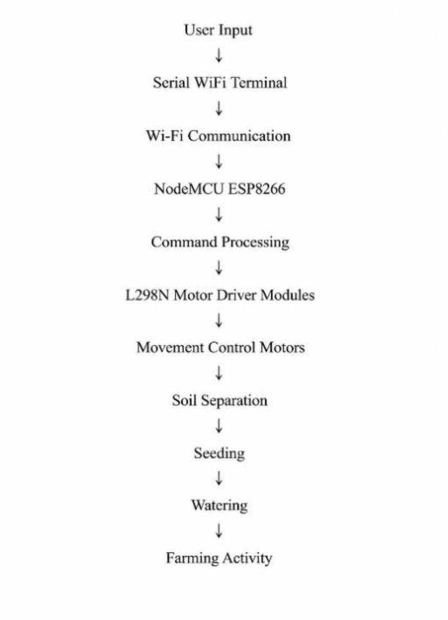

Fig 3.2: FlowChart

3.3.11 Circuit Diagram

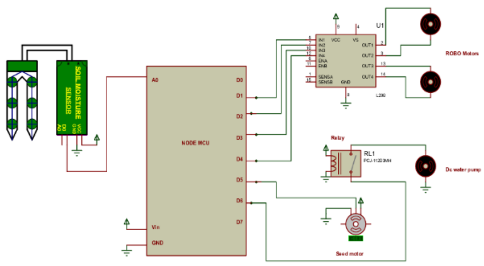

Fig 3.3.11Circuit Diagram

- NodeMCU ESP8266 microcontroller is the master controller of the AgriBot that controls all the operations of agriculture wirelessly.
- For monitoring the moisture in the soil and for automatic irrigation, the soil moisture sensor is interfaced with A0 pin of the NodeMCU.
- L298N motor driver is connected with NodeMCU microcontroller at digital pins D1, D2, D3, and D4 to control DC motors for movement of the robot.
- The DC motors with wheels help in moving the robot forward, backward, and sideways in the agricultural land.
- The relay module is interfaced with NodeMCU to control the DC water pump for the watering process.
- The water pump helps in providing water to the soil during the irrigation process.
- The seed motor is interfaced with NodeMCU at pins D5 and D6 and helps in controlling the seed dispensing system for automatic sowing of the seeds.

- The electrical power is provided to the controller, motors, relay, and pump by the 12V Li-ion battery power supply system.

3.4 Software Methodology

AgriBot uses an integration software methodology incorporating embedded programming, wireless communication, and motor control technology for agriculture automation purposes. Software is programmed using Embedded C/C++ programming on the Arduino IDE platform.

The methodology starts when a user provides command inputs from his smartphone application. Such commands are communicated wirelessly via Wi-Fi communication technology to the NodeMCU ESP8266 controller.

Implementation of Pulse Width Modulation (PWM) techniques for motor speed control and power efficiency is done through the software.

Software also helps in ensuring synchronized work of all modules of the software, avoiding signal conflict in case of simultaneous actions.

Workflow of the whole software system may be summarized in the following steps:

- User sends a command via smartphone application
- The command is sent through Wi-Fi communication
- Commands are received by the NodeMCU wirelessly
- The software processes the command
- Command outputs (motor driver control signals) are provided
- Motion or agricultural mechanism is started
- Agriculture operation is done
- Sends for the next command

IMPLEMENTATION OF MODULES AND SYSTEM INTEGRATION

4.1 Introduction to System Implementation

The implementation stage of the suggested AgriBot system involves the actual creation of the design of an intelligent agriculture robot, which will be able to execute several tasks of farming in real time. This particular stage is dedicated to integration of the embedded system, wireless communication, motor control system, and farming task system into one robotic entity. The main aim of the implementation stage is to create a reliable and convenient agricultural robot that could help increase productivity of farming.

4.2 Control Signal Processing and Data Flow

The control signal processing and data flow process constitute the basic pipeline that drives the AgriBot technology. It is through this process that wireless instructions from users are translated to practical agricultural activities through the robot system. Given that the system uses wireless controls in real time, effective signal processing and data flow are critical.

4.2.1 User Commands as Wireless Control Signals

Each command issued by the user using the Serial WiFi Terminal application functions as a remote control signal for the robotic machine. The commands include instructions on how to move as well as the operations to be done by the robot like:

- Moving forward
- Moving backward
- Turning left
- Turning right
- Sowing seeds
- Watering
- Soil modification
- Soil segregation

4.2.2 Embedded Command Processing Pipeline

Command Reception

NodeMCU keeps monitoring incoming wireless signals using its internal Wi-Fi connectivity module. Once a command is detected, it is temporarily stored for further processing.

Output Generation

The output signals after processing are fed into the L298N motor drivers that energize the motors and associated mechanical parts.
For instance:
Input:
“Forward”
Processing:
Wireless signal detection
Recognition of command as forward motion
Generation of PWM signals for left and right motion motors
Output:
Robot moving forward

4.2.3 PWM-Based Motor Speed Control

The NodeMCU produces PWM signal outputs with different duty cycles for the regulation of the speed of DC motors. The greater the duty cycle is, the higher the motor speed; otherwise, vice versa.

The PWM controlling technique ensures various benefits:

- Smoother robot movement
- Better robot orientation
- Lower energy consumption
- Motor efficiency
- Battery efficiency

The PWM signals are fed into L298N motor driver modules that regulate the movements of the motors.

4.3HardwareModule Implementation

The hardware module includes movement motors, agricultural motors, NodeMCU ESP8266 microcontroller, L298N motor drivers, power source, water pump system, seeding system, soil adjusting system, and soil separating system.

4.3.1 NodeMCU ESP8266 Implementation

NodeMCU ESP8266 is used as an embedded controller of the AgriBot. It receives wireless command signals and controls all the agriculture works.
It is chosen as the controller for the following reasons:

- The NodeMCU ESP8266 has:
- High affordability;
- Small dimensions;
- Low energy consumption;
- Integrated Wi-Fi module;
- Simply programmable.

4.3.2 Motor Driver Implementation

The AgriBot system employs L298N driver modules for controlling DC motors.

As the NodeMCU can not deliver enough current for motors, the L298N drivers work as amplifying interfaces for delivering current from the microcontroller to the motors.

Functions of motor drivers include:

- Direction controlling;
- Adjusting speed of motion;
- Motor motion in forward and reverse directions;
- Control of simultaneous motion of two motors.

4.3.3 Movement System Implementation

Left and right wheel motors can work independently; hence, the robot can:

- Move forward;
- Move backward;
- Turn left;
- Turn right.

Geared motors ensure a high torque that is necessary for agricultural surfaces and uneven grounds.

Wheel configuration provides stability during movement and helps in carrying agricultural machinery.

4.3.4 Seeding Mechanisms Implementation

Seeding mechanisms have been achieved by incorporating motor-based seed dispersing systems into the robotic platform.

On activation, the seed dispersing motor spins and ejects seeds after a certain period in the soil.

The mechanism will ensure:

- Even dispersion of the seeds
- Saving on the use of the seeds
- Farming precision
- Consistency in crop growth

4.3.5 Watering System Implementation

Watering mechanisms have been realized through a DC pump that is attached to the robotic platform.

Once the watering signal is received, the NodeMCU triggers the pumping action via the motor driver.
This mechanism will enable:

- Irrigation
- Water conservation
- Reduce efforts involved in manual irrigation
- Sustainability in farming

4.3.6 Soil Adjustment and Separation Mechanism Implementation

Soil separation mechanism is used to extract stones and other harsh materials from the soil for cultivation.

These mechanisms will ensure:

- Soil aeration
- Improvement in seed germination
- Quality cultivation
- High agricultural productivity

5.4 Implementation of Embedded Software

The program runs a continuous control loop that involves:

1. Receiving wireless signals

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2. Decoding user signals
3. Producing control signals
4. Driver motors and mechanism operations
5. Waiting for next command

Implementation of embedded software includes:

- Wi-Fi signal handling
- Motor control
- Speed control using PWM
- Control signals decoding
- Direction control
- Synchronization of agriculture mechanism

RESULTS DISCUSSION

5.2 Output Screens

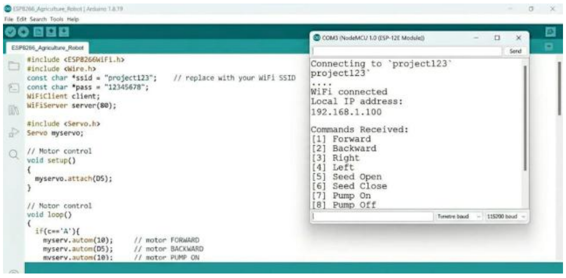

Fig 5.2 Output Screens

5.2.1 Soil Separation

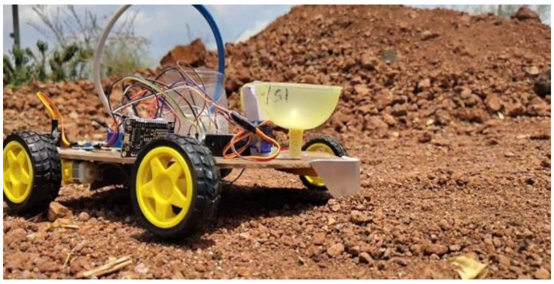

Fig 5.2.1 Soil Separation

5.2.2 Seeding

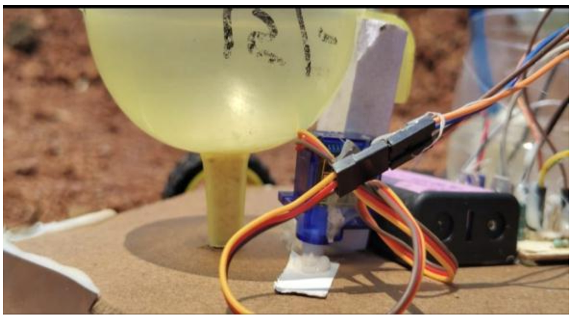

Fig 5.2.2 (a) Seeding

Fig 5.2.2 (b) Seeding

5.2.3 Watering

Fig 5.2.3 Watering

5.2.4 Soil Adjustment

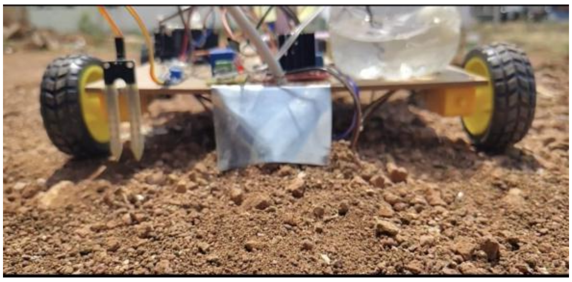

Fig 5.2.4 Soil Adjustment

5.3Evaluation of Model Performance and Performance Metrics Using Testcases

Performance evaluation of the proposed AgriBot is done in order to assess the efficiency, reliability, accuracy, and stability of the robotic platform in agricultural operations. It is an integral part of the development project since it checks whether the implemented system performs its intended agricultural functions.

The performance evaluation is done by testing the robot under various agricultural working conditions and analyzing its performance in the individual modules and the whole system. Several experiments are done for better consistency and reliability of results.

The main performance metrics that are taken into account in assessing the AgriBot system are:

- Movement Control Accuracy
- Wireless Communication Response Time
- Seeding Accuracy
- Watering Efficiency
- Soil Adjustment Performance
- Soil Separation Efficiency
- Battery Performance
- System Reliability

These performance metrics evaluate the effectiveness of the system in its agricultural automation activities.

Movement Control Accuracy

Accuracy of movement is determined by finding the ratio of the correctly executed movement commands to the total commands issued from the smartphone application.

The equation is as follows:

Movement Accuracy=(Correctly Executed Commands) / (Total Commands) x 100

Total commands issued = 100

Correct robot commands = 95

Then:

Movement Accuracy=95/100 x 100
Movement Accuracy = 95%
The robot managed to perform 95% of movement operations.

Wireless Communication Response Time
Wireless communication response time is the time that elapses from the moment the command is sent from the smartphone until its implementation by the robot.

Testing of the communication system is performed with several commands in different modes of operation.

The average value of the time taken during testing is:
Average Response Time = 1-2 seconds
Built-in Wi-Fi capabilities of the NodeMCU ESP8266 ensure reliable and fast wireless communication between the smartphone application and the robotic system.

Evaluation proves that the wireless control system is characterized by:

- Reliability
- Command implementation in real-time
- Stability of the communication distance
- Comfort of remote control
- Low response time makes the control of the robot more efficient.

5.3.3 Seeding Accuracy Evaluation

Seeding accuracy depends on the ratio of properly placed seeds to the total number of dispensed seeds in the process of testing.

The formula looks like this:

Seeding Accuracy=(Properly Placed Seeds)/(Total Seeds Released) x 100
Total seeds released = 50
Properly placed seeds = 46

Then:
Seeding Accuracy = (46/50) x 100
Seeding Accuracy = 92%
This increases the consistency of crop growth and agricultural productivity.

Watering Efficiency Analysis

Watering efficiency is determined by dividing the amount of useful water delivered by the system to the target soil area by the total amount of water pumped.

The calculation is done using this formula:

Watering Efficiency = (Useful Water Delivered / Total Water Pumped) x 100

Total water pumped = 1000 ml
Useful water delivered = 900 ml

Then:
Watering Efficiency = 900/1000 x 100
Watering Efficiency = 90%
This contributes to sustainability in agriculture by reducing water wastage.

Soil Adjustment Performance

Soil adjustment performance analysis determines how well the rotating soil adjustment mechanism does in the preparation of the soil surface.

The soil adjustment mechanism is tested for:

- Soil loosening capability
- Surface leveling performance
- Soil aeration improvement
- Rotating mechanical parts loosen and prepare the soil surface for cultivation.

The average soil adjustment efficiency recorded is:
Soil Adjustment Performance = 95%

The automation of the process reduces manual labor and enhances soil +preparation quality.

5.3.4 Soil Separation Efficiency

The efficiency of soil separation mechanism is determined through the efficiency of separation of unwanted material from the field of cultivation.

The process of testing includes:

- Stone separation ability
- Large particles separation
- Efficiency of soil cleaning

The mechanical separation mechanism allows filtering of unwanted particles from the soil and making cultivation conditions better.

Soil separation efficiency obtained through the tests is:
Soil Separation Efficiency = 95%

This implementation makes conditions for seeds germination better and makes agricultural mechanisms safe from damaging due to hard particles.

5.3.7 Battery Performance Evaluation

Evaluation of the battery performance determines the working time and power efficiency of the AgriBot system.
The robot is tested for continuous work in order to find out:

- Battery backup time
- The stability of power consumption
- The efficiency of voltage regulation

The battery system allows supplying power for all electronic and mechanical devices while operating.
The average time of continuous operation is:

Battery Backup Time = 3–4 hours
The mechanism of motor control based on PWM reduces unnecessary power consumption.

5.3.8 System Reliability

System reliability is determined on the basis of successful operations versus total test operations conducted.
The equation for system reliability is:

System Reliability = (Successful Operation/ Total Operations) x 100
Total operations = 100
Successful operations = 93

Thus,
System Reliability = 93/100 x 100
System Reliability = 93%
Modular approach, control system and wireless architecture are important for the stability of the system.

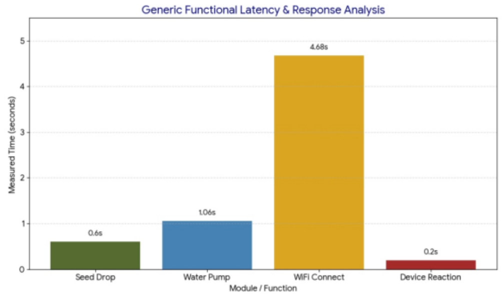

Figure 5.4 Graph of Accuracy and Response Times

Generic Functional Latency & Response Evaluation, provides an overview in numerical terms on the performance in time of various modules within an IoT or automated system. By measuring these specific benchmarks, you can determine which modules within your system operate effectively and which cause delays.

WiFi Connect (4.68s): This is the Handshake Latency. This is the largest bar in the graph as the process takes time as the NodeMCU searches for the signal, authenticates itself and receives an IP address from the router/hotspot.

Water Pump (1.06s): This is the Mechanical Activation Time. It covers the processing of the software and actual activation of the relay/motor driver which controls water flow.

Seed Drop (0.60s): This is the Servo-mechanical Response. Since servos work faster than water pumps, this module has shown good efficiency in performing precise operations like seeding.

Device Reaction (0.20s): This is the Internal Processing Latency. It covers the time taken by the microcontroller(NodeMCU) in receiving a command and passing it via GPIO pins.

FUTURE ENHANCEMENTS

Future Enhancements

The above AgriBot system can be improved further by adding IoT-based monitoring and remote agricultural management features for better automation, efficient operation, and smart farming practices. In future developments, the robot can be connected to cloud-based IoT platforms to monitor agricultural processes like the condition of the soil, irrigation status, movement of the robot, and performance of its battery.

IoT sensors like those measuring temperature, humidity, rainfall, and soil pH can also be added to gather data about the environment in the agricultural field. The data can

S.No	TestCase Description	Expected Output	Actual Output	Status
1	Move Forward Command	Moved to Forward	Moved to Forward	Passed
2	Move Backword command	Moved to Backword	Moved to Backword	Passed
3	Move Left Command	Moved to Left	Moved to Left	Passed
4	Move Right Command	Moved to right	Moved to right	Passed
5	Seeding Command	Seed Path Opened	Seed Path Opened	Passed
6	Watering Command	Pump Start Watering	Pump Start Watering	Passed

then be transmitted via wireless communication network to achieve real-time field monitoring.

The existing irrigation system can be improved to be an automated smart irrigation system, which works according to soil moisture and environmental conditions. GPS navigation and path tracking systems can also be added to achieve field coverage and automation in agricultural processes.

The AgriBot in the future can have live status monitoring, wireless alert notification, and data logging system for maintaining agricultural records and performance analysis. Solar-powered charging systems can also be integrated to improve energy efficiency and support long-duration field operation.

REFERENCES

[1] R. N. Rao et al., "IoT Based Smart Agriculture Robot for Automatic Seeding and Irrigation," International Journal of Engineering Research & Technology (IJERT), vol. 9, no. 6, pp. 1123-1127, 2020.

[2] S. Kumar and P. Singh, "Design and Development of Agricultural Robot for Smart Farming Applications," IEEE International Conference on Smart Technologies, 2021.

[3] A. Sharma et al., "Wireless Controlled Multipurpose Agriculture Robot Using NodeMCU," International Journal of Innovative Technology and Exploring Engineering (IJITEE), vol. 8, no. 11, pp. 245-250, 2019.

[4] M. Patel and K. Patel, "Smart Irrigation System Using IoT and Soil Moisture Sensor," International Journal of Advanced Research in Computer Science, vol. 10, no. 3, pp. 55-60, 2019.

[5] P. Ramesh et al., "Automated Seed Sowing Robot for Precision Agriculture," International Conference on Communication and Electronics Systems (ICCES), IEEE, 2020.

[6] D. Kumar and S. Verma, "Agricultural Field Monitoring and Irrigation Automation Using ESP8266," International Journal of Scientific Research in Engineering and Management, vol. 5, no. 4, pp. 1-6, 2021.

[7] V. Reddy et al., "Multipurpose Agricultural Robot for Modern Farming," International Journal of Mechanical Engineering and Technology, vol. 11, no. 7, pp. 78-K.B. Raja and M. Prakash, "IoT Based Smart Farming Robot with Mobile Control," International Journal of Recent Technology and Engineering (IJRTE), vol. 8, no. 5, pp. 2201-2205, 2020.

[9] S. Ahmed et al., "Embedded System Based Agricultural Robot for Automatic Farming," IEEE International Conference on Electronics and Sustainable Communication Systems, 2021.

[10] P.N. Rao and T. Venkatesh, "Design of Smart Agriculture Robot Using Wireless Communication," International Journal of Engineering Research and Applications, vol. 9, no. 2, pp. 40-46, 2019.

[11] R. Karthik et al., "Development of Autonomous Agricultural Robot for Seeding and Watering Operations," International Conference on Computational Intelligence and Computing Research, IEEE, 2020.

[12] A. Mishra and V. Gupta, "Soil Monitoring and Automatic Irrigation System Using NodeMCU," International Journal of Computer Applications, vol. 177, no. 15, pp. 12-17, 2020.

[13] M.S. Reddy et al., "Smart Farming Robot with Android Application Control," International Journal of Innovative Research in Technology, vol. 7, no. 8, pp. 85-91, 2021.

[14] N. Kumar et al., "IoT Enabled Agricultural Robot for Precision Farming," IEEE International Conference on Communication Systems and Network Technologies, 2022.

[15] S. Babu and K. Ramesh, "Automated Irrigation and Seeding Using Robotics and Embedded Systems,"

International Journal of Emerging Technologies and Innovative Research, vol. 6, no. 5, pp. 320–326, 2019

CONCLUSION:

The proposed AgriBot system manages to illustrate the use of intelligent agricultural robot system which can perform various agriculture operations with little human interaction. Embedded systems, wireless communication, motor control methods, and agriculture automation techniques are incorporated in one compact agricultural robot system. The proposed robot system manages to perform essential agriculture operations including movement, sowing of seeds, watering, soil separation, and soil adjustment.

NodeMCU ESP8266 microcontroller serves as the main control unit of the system while the Serial WiFi Terminal smart phone application facilitates wireless operation of the robot. The incorporation of the L298N motor driver, DC motors, relay module, water pump, soil moisture sensor, servo motor, and hydraulic plate system results in coordinated performance of the agriculture robot system.
Based on experiment and performance analysis, the AgriBot system is efficient in making operations more productive and saving manual labor used in traditional farming processes. The water dispensing mechanism enables water conservation due to controlled irrigation, while the seed planting mechanism ensures proper seeding and saves seeds from being wasted. Soil separating and adjusting mechanism is used to ensure improved soil preparation for cultivation of crops.

The designed system is an economical and portable solution for small to medium scale agricultural practices. Modular system design improves system flexibility, maintainability, and expandability in the future. Wireless communication technology used in the system also makes operation convenient as it enables farmers to control the robot from remote location.