International Journal for Modern Trends in Science and Technology
Volume 12, Special Issue 01, pages 778-785.
ISSN: 2455-3778 online
Available online at: http://ijmtst.com/ICRCSET2026.html
DOI: https://doi.org/10.5281/zenodo.19567133

Automated Agricultural Field Monitoring and Control of Drip Irrigation and Seeding System

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To Cite this Article
Dr. D Naga Ravikiran, Morla Sireesha, Shaik Asma Navaz, Siliveri Vignesh & Thati Vamsi Saikrishna (2026). Automated Agricultural Field Monitoring and Control of Drip Irrigation and Seeding System. International Journal for Modern Trends in Science and Technology, 12(SI01), 778-785. https://doi.org/10.5281/zenodo.19567133

Article Info
Received: 02 March 2026; Revised: 01 April 2026; Accepted: 04 April 2026.

KEYWORDS

Automated Agriculture System; Arduino UNO; Soil Moisture Sensor; Seeding and Irrigation; Agricultural Robotics

ABSTRACT

In this work, an automated system is proposed for seeding as well as irrigation process in agriculture which reduces the labor cost. This system aims to increase the efficiency of the seeding process without affecting the nature of soil. The proposed system is equipped with Arduino UNO which acts as the main control unit while ultrasonic and soil moisture sensors are used to detect the obstacles and soil moisture level, respectively. The robot consists of a funnel like arrangement to perform the seeding procedure. The field is equipped with moisture sensors placed at different areas that monitors the moisture level of the soil on a regular interval for irrigation purposes. The proposed system will be of great benefit to the future endeavor of agricultural business as well as it will be able to optimize the seeding and irrigation.

I. INTRODUCTION

With the exponential growth of world population, according to the UN Food and Agriculture Organization, the world will need to produce 70% more food in 2050, shrinking agricultural lands, and depletion of finite natural resources, the need to enhance farm yield has become critical. Limited availability of natural resources such as fresh water and arable land along with slowing yield trends in several staple crops, have further aggravated the problem. Another impeding concern over the farming industry is the shifting structure of agricultural workforce. Moreover, agricultural labor in most of the countries has declined. As a result of the declining agricultural workforce, adoption of internet connectivity solutions in farming practices has been triggered, to reduce the need for manual labor. IoT solutions are focused on helping farmers close the supply demand gap, by ensuring high yields, profitability, and protection of the environment. The approach of using IoT technology to ensure optimum application of resources to achieve high crop yields and reduce operational costs is called precision agriculture. IoT in agriculture technologies comprise specialized equipment, wireless connectivity

Figure 1: IoT based smart agriculture will be the future

Smart farming based on IoT technologies enables growers and farmers to reduce waste and enhance productivity ranging from the quantity of fertilizer utilized to the number of journeys the farm vehicles have made, and enabling efficient utilization of resources such as water, electricity, etc. IoT smart farming solutions is a system that is built for monitoring the crop field with the help of sensors (light, humidity, temperature, soil moisture, crop health, etc.) and automating the irrigation system. The farmers can monitor the field conditions from anywhere. They can also select between manual and automated options for taking necessary actions based on this data. For example, if the soil moisture level decreases, the farmer can deploy sensors to start the irrigation. Smart farming is highly efficient when compared with the conventional approach. IoT have the potential to transform agriculture in many aspects and these are the main ones. Data collected by smart agriculture sensors, in this approach of farm management, a key component are sensors, control systems, robotics, autonomous vehicles, automated hardware,this data can be used to track the state of the business in general as well as staff performance, equipment efficiency. The ability to foresee the output of production allows to plan for better product distribution. Agricultural Drones Ground-based and aerial-based drones are being used in agriculture in order to enhance various agricultural practices: crop health assessment, irrigation, crop monitoring, crop spraying, planting A smart remotely controlled GPS robot may conduct tasks such as spinning, sprinkling, humidity detecting, birding, animal scarring, alertness, etc., among other features of a project. Second, intelligent irrigation focused on precise real-time field results, with outstanding architecture and intelligent decision-making. Thirdly, effective logistics monitoring that covers temperature regulation, humidity management and plant crime reduction. Both these activities are managed by every superb web-linked commodity machine or unit, and procedures are carried out using microcontroller.

2.LITERATURE REVIEW

Thepaper [1] provide to develop a smart agriculture system using IoT. Smart agriculture is a unique concept in which IoT sensors offer information about agricultural regions and then act on it in response to human input. The purpose of this study is to develop a smart agricultural system that makes use of cutting-edge technologies such as wireless sensor networks, the Internet of Things, and Arduino. Through automation, the research takes advantage of emerging technologies such as smart agriculture and the Internet of Things (IoT). Monitoring environmental variables can enhance crop efficiency. The purpose of this study is to develop a system that can use sensors to analyze temperature, humidity, wetness, and even the movement of animals in agricultural areas that could harm crops. If an error happens, the system will send an SMS message to the farmer's smartphone as well as a notification to the app developed for it through Wi- Fi/3G/4G. An Android app can be used to inspect and change the watering schedule of the system's duplex communication channel, which is based on a cellular Internet interface. Because of its energy independence and inexpensive cost, the gadget has the potential to be useful in water-scarce, distant locations.

In this survey [2], challenges and applications in agriculture examined. Precision agriculture is the use of information technology in agriculture as a result of increased food consumption, customer demand for high-quality food, and agricultural environmental effects. The Internet of Things (IOT) is a rapidly evolving technology that has various advantages for agriculture. Because of the varied and large amount of datacollected by IoT sensors, cloud computing is critical to the future of internet of things (IoT) agricultural applications. Microcontrollers will simultaneously enhance the capabilities of the internet of things (IoT). The IOT applications in agriculture, as well as the research trend, concepts, and basic IOT components, are assessed in this paper. First, an appraisal of the number of publications published in this field. Second, an overview of IOT definition and architecture, covering levels. The main difficulties in IOT and precision agriculture (PA) are then addressed, followed by a comparison of some IOT-related technologies.

In this paper [3] , survey on bring out emerging trends in both applied IoT techniques and agriculture is carried out. As a result of the Internet of Things (IoT) age, our modern world has experienced a revolution. Precision agriculture will eventually become a practical, cheap, and sustainable technique of increasing agricultural yields and quality with the ongoing deployment of IoT methods in agriculture. In order to facilitate implementation, we use records from 3168 documents and their 100,205 references inWeb of Science to build a visualization assessment of the farm IoT literature over the preceding ten years.The dynamics of research fronts and intellectual bases reveal emerging trends in both applied IoT technology and agriculturally linked areas of concern. The amount of contributions in cooperative networks is used to identify outstanding nations, institutions, and authors. Furthermore, from 2009 to 2018, the citation networks identified notable papers and authors, indicating hot topics and trends in the farm IoTliterature. We also make future recommendations as part of the review, such as building infrastructure for the Internet of Things in agriculture, data security and sharing, sustainable energy solutions, economic analysis and operation management in the Internet of Things in agriculture, and IoT-based financing and e-business models. These findings will be useful to researchers and industry professionals in their future efforts to develop IoTbased precision agriculture.

This paper [4] discusses security and privacy research problems in the context of IoT-based green agriculture. We begin by summarizing current smart agriculture surveys and outlining a four-tier green IoT-based farm architecture. The threat models against IoT-based green agriculture are then classified into five categories, with intrusions into authentication, confidentiality, availability, and integrity aspects being included in each. Furthermore, we provide a taxonomy and a side-by-side comparison of the most sophisticated methods to secure and privacy-preserving IoT technologies, as well as how they will be adjusted for environmentally friendly IoT-based agriculture. Furthermore, we investigate privacy-focused blockchain-based solutions and IoT application consensus approaches, as well as how they will be adjusted for long-term IoT-based agriculture. Based on the results of the current survey, we address prospective future research directions in the security and privacy of green IoT-based agriculture, highlight open research topics, and emphasize these challenges.

It [5] contributes towards recent IoT technologies in agriculture sector along with development of hardware and software systems. Because of population growth, the agricultural industry's need has expanded dramatically. With the advancement of technology, this decade has seen a shift from traditional to cutting-edge ways. Because of the Internet of Things (IoT), the agriculture sector has altered in terms of both quality and quantity. The farms' real-time monitoring and species hybridization enabled resource optimization. Scientists, research groups, academics, and the majority of governmentsworldwide are moving towards the practice and execution ofjoint efforts in order to explore the potential of this sector to serve humanity. The IT industry is competing to provide even better solutions. Combining IoT with cloud computing, big data analytics, and wireless sensor networks can provide you ample room to predict, process, and analyze events while also improving your real-time operations. The notion of device heterogeneity and interoperability is also presenting new possibilities in this domain by delivering adaptive, scalable, and durable techniques andmodels.As a result ,together with the growth of hardware and software systems, this study contributes to modern IoT technologies in the agriculture business. The projects and businesses developed by the public and private sectors around the world to provide smart and sustainable precision agriculture solutions are also discussed. A brief assessment of the current situation, applications, research potential, restrictions, and future aspects is provided. A precision agriculture framework basedonIoTconcepts is also proposed in this research.

3.EXISTING SYSTEM

Smartphone Irrigation Sensor An advanced irrigation network to be used in agricultural crops is being built and introduced. The package contains a handheld app that captures and stores digital photographs of soil directly to the crop's root zone and tests the moisture levels visually. In this survey, automate production of crops and stop intrusion using deep learning is carried out. Irrigation is a fundamental problem that scientists and farmers encounter while attempting to automate agricultural production; this concept has been around since the early 1990s. Irrigation is a dynamic system that is heavily influenced by external events. The method discussed in this article employs a specially constructed mathematical model to manage data from wireless sensors on Google Cloud in order to create a smart system. a design that can be scaled up to big farms and is IoT enabled. According to Holistic Agricultural Studies, 35 have been harmed by both animals and humans. This intelligent system employs tensor flow and deep learning neural networks to identify animals based on their hazard level as well as unauthorized human visitors to the farm and instantly notify the farmer. The device comes with an Android app that allows for remote access and live video streaming surveillance.

Drawbacks

- High Initial Cost
- Complex Maintenance
- Dependence on Internet Connectivity
- False Alerts or Detection Errors

4.PROPOSED SYSTEM

The proposed system aims to develop an automated and intelligent solution for monitoring and controlling agricultural activities, particularly irrigation and environmental condition analysis. This system integrates hardware components such as sensors, microcontrollers, and communication modules to ensure efficient and real-time decision-making. The working of the system follows a structured sequence as represented in the flowchart, which begins with initialization and continues in a cyclic manner for continuous monitoring.The flowchart of the proposed system is shown in figure 2.

- **Power Supply and Regulation**

The system is powered using a 9V DC adaptor, which acts as the primary power source. Since different components require different voltage levels for proper functioning, the input power is regulated using two voltage regulators. The **7805 voltage regulator** is used to provide a stable 5V supply to the Arduino microcontroller, DHT22 sensor, soil moisture sensor, LCD display, and water pump system. On the other hand, the **1117 voltage regulator** is used to step down the voltage to 3.3V, which is suitable for the ESP8266 Wi-Fi module. This regulated power distribution ensures stable and efficient operation of all components without damage due to voltage fluctuations.

- **System Initialization**

As per the flowchart, the system operation begins with the initialization phase. During this stage, all hardware components including sensors, display unit, and communication modules are configured and made ready for operation. The Arduino microcontroller initializes input and output pins, establishes communication with the ESP8266 module via UART protocol, and prepares the LCD for displaying information. Once initialization is complete, the system enters into the monitoring phase.

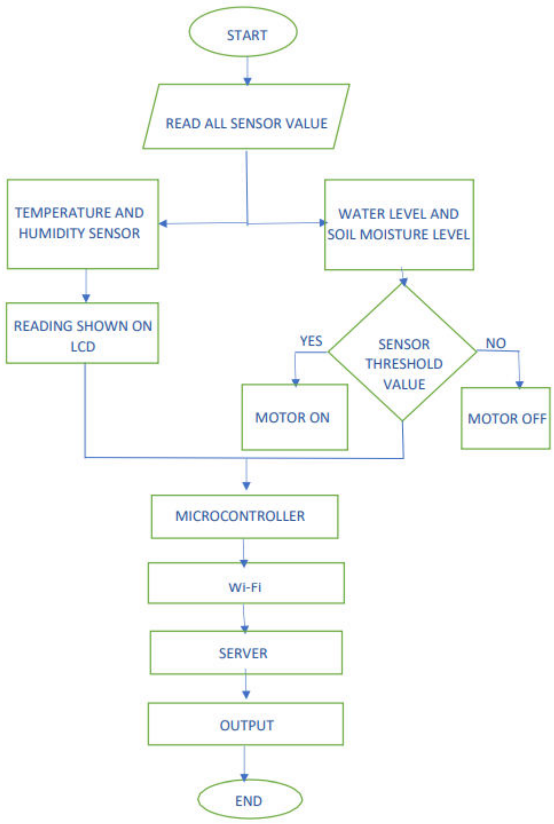

Figure 2: Flowchart of the proposed system

- **Data Acquisition Using Sensors**

The system continuously collects environmental data using sensors. The **soil moisture sensor** is responsible for measuring the moisture content in the soil, which is a critical parameter for irrigation management. It provides analog signals corresponding to the water content present in the soil.

Simultaneously, the **DHT22 sensor** measures temperature and humidity levels in the environment. These parameters are essential for understanding climatic conditions that affect crop growth. The sensor provides digital output data, which is directly read by the Arduino controller.

The collected sensor data is sent to the Arduino, where it is processed for further decision-making.

- **Data Processing and Decision Making**

After acquiring data from the sensors, the Arduino microcontroller processes the information. The flowchart indicates a decision-making step based on predefined threshold values.

- If the soil moisture level falls below a specified threshold, it indicates that the soil is dry and requires irrigation.
- If the moisture level is adequate, irrigation is not required.

This decision-making logic forms the core of the automation process, eliminating the need for manual monitoring and intervention.

- **Irrigation Control Mechanism**

Based on the decision, the system controls the water pump using an **NPN transistor**, which acts as a switching device. When irrigation is required, the Arduino sends a signal to the transistor, which in turn activates the pump. The pump supplies water to the field, thereby increasing soil moisture.

Once the moisture level reaches the desired threshold, the system automatically turns off the pump. This ensures optimal water usage, prevents over-irrigation, and conserves resources.

- **Display and User Interface**

The system includes an **LCD display module** that provides real-time information to the user. The measured values of temperature, humidity, and soil moisture are displayed continuously. This allows farmers or users to monitor environmental conditions directly from the device without requiring additional tools.

- **Data Transmission and Cloud Integration**

In addition to local monitoring, the system supports remote monitoring through the **ESP8266 Wi-Fi module**. The Arduino sends processed data to the ESP8266 using UART communication. The ESP8266 then uploads this data to a cloud platform via internet connectivity.

This feature enables users to access real-time agricultural data from anywhere using smartphones or computers. It also supports advanced data analysis and decision-making based on historical records stored in the cloud.

- **Continuous Monitoring and Automation**

The system operates in a continuous loop as shown in the flowchart. It repeatedly performs data acquisition, processing, decision-making, and control actions. This ensures that the field conditions are constantly monitored and appropriate actions are taken automatically without human intervention.

The integration of sensing, processing, communication, and control makes the system highly efficient and reliable. It reduces labor effort, saves time, and improves agricultural productivity.

Advantages of the Proposed System

- Reduces manual effort in irrigation management
- Ensures efficient use of water resources
- Provides real-time monitoring of environmental conditions
- Supports remote access through cloud connectivity
- Improves crop yield and overall productivity
- Minimizes human errors through automation

4. RESULTS& DISCUSSION

The developed system for agricultural field monitoring and controlling of drip irrigation and seeding mechanism was tested to evaluate its efficiency in water management and crop planting. The monitoring sensors successfully measured key environmental parameters such as soil moisture, temperature, and humidity, enabling the system to make automated decisions. The drip irrigation system activated when the soil moisture level dropped below the predefined threshold, ensuring that crops received adequate water while minimizing wastage. The automated seeding mechanism demonstrated accurate seed placement and consistent spacing between seeds, which is essential for uniform crop growth. The integration of sensors with the control unit improved the overall efficiency of field operations and reduced the need for manual intervention. Experimental results showed that the system helped conserve water, improved irrigation accuracy, and ensured better seed distribution. the proposed system enhances precision agriculture practices by combining real-time monitoring, automated irrigation, and efficient seeding, which can lead to improved crop productivity and sustainable agricultural resource management.

The hardware setup consists of a microcontroller board, soil moisture sensor, temperature and humidity sensor, motor driver module, water pump, LCD display, and battery supply. The sensors collect field data and send it to the controller, which processes the information and activates the irrigation system automatically

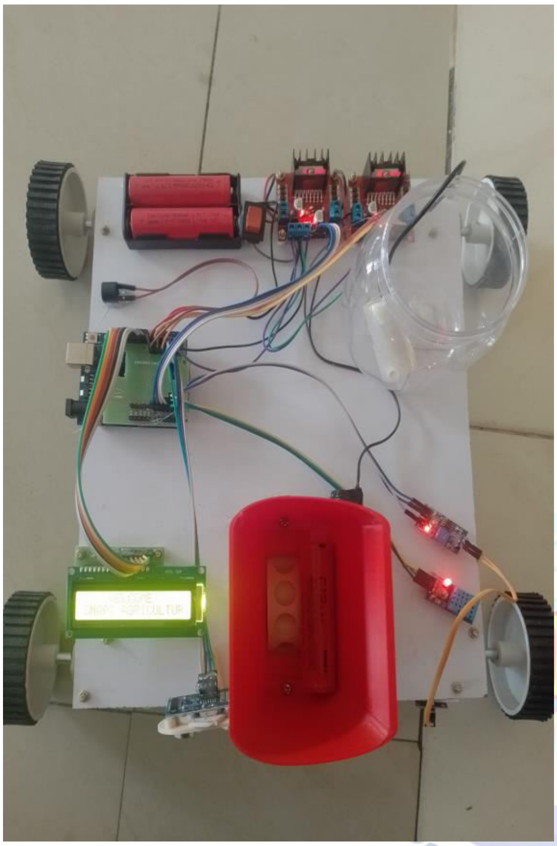

Figure 3: Hardware implementation

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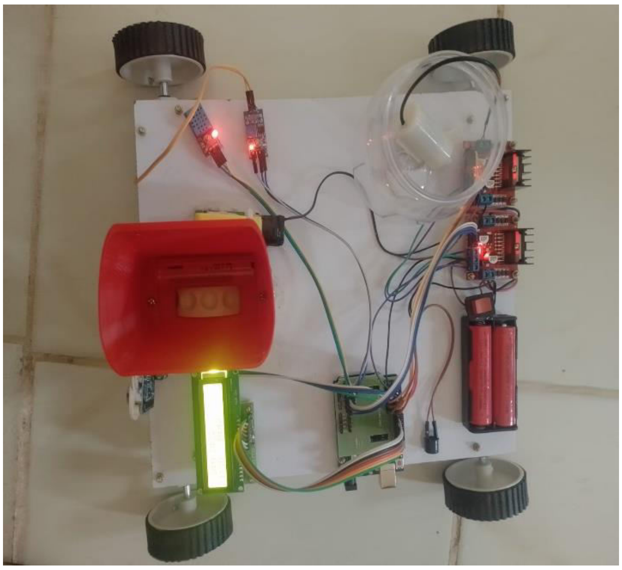

Figure 4: Measuring Temparature and Humidity

This system measures environmental conditions using a DHT11 Temperature and Humidity Sensor. The sensor collects real-time temperature and humidity data from the surroundings and sends it to the Arduino Uno microcontroller for processing.

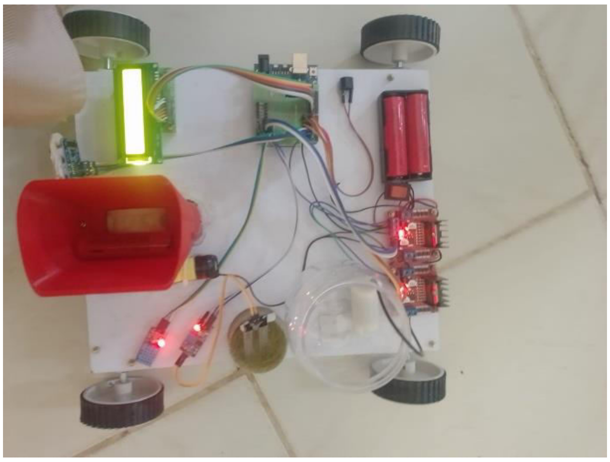

Figure 5: Automatic soil moisture monitoring

This system automatically monitors soil moisture and humidity using sensors connected to a microcontroller. The soil moisture sensor checks the water level in the soil, while the humidity sensor measures the moisture in the air. Based on these readings, the system can automatically control irrigation to maintain proper conditions for plant growth.

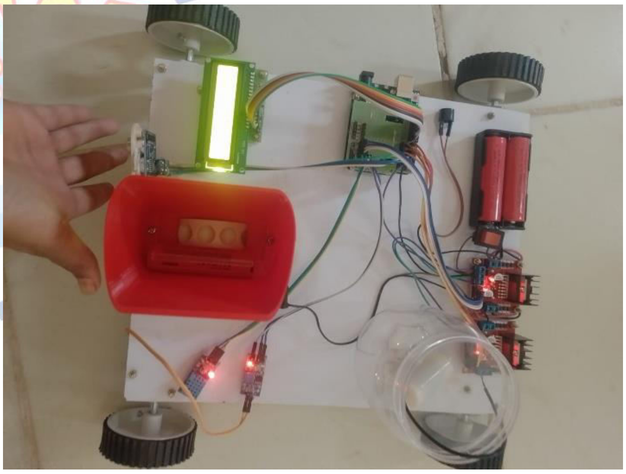

Figure 6: Seeding Mechanism

The seeding mechanism using a DC motor automatically dispenses seeds in the field at regular intervals. The DC motor rotates the seed container, allowing seeds to drop through small holes into the soil while the robot moves forward. This helps in uniform seed distribution, reduces manual labor, and improves efficiency in agricultural planting.

5. CONCLUSIONS

The developed Agrobot can reduce human efforts and attention which was essential in conventional farming, hence it helps to overcome the problems that may occur due to the unavailability of labours and high labour costs. Implementation of this robot in the field of agriculture not only helps in improving the yield of production but also provides comfort for the farmers by converting the tedious procedures in the agricultural sector to easier. This robot helps in achieving uniform seed planting with accuracy Unlike tractors, Agrobot causes zero pollution and it is cost-effective. Agrobot is particularly designed for small and medium scaled applications. For large scale applications, many Agrobots can be used to cover a large area.

FUTURE SCOPE

The output of the ultrasonic sensor is not always accurate and stable, and irregular shape and undulating surface of the field affect the performance of the robot. These problems can be solved with the incorporation of efficient sensors and modern technologies like Artificial intelligence, Image processing etc. There is no provision is provided for knowing the realtime operating status of this robot. This can be overcome by using GSM technology. so that the user will get notified of the operation status of the robot.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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