



IoT-enabled Smart Irrigation and Parameter Monitoring in Polyhouse Farming Environment for Yield Improvement

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ABSTRACT

India is an agriculture dependent nation with almost 60 percent of land being utilized for agriculture. The growth of agriculture industry is bound to the two major parameters, quality and quantity of production. IoT based smart irrigation helps the farmers by supplying sufficient water to the plants without any manual work and the poly house farming is an excellent method which enables the production of crops with minimum resources, efforts and gives maximum yield by providing a controlled environment conditions. In the existing system we cannot monitor the environmental conditions in the house. Poly house is a methodology to grow crops under controlled environment with continuous monitoring and analyzing the parameter values such as temperature, humidity, soil moisture and rain fall by using sensors. We propose an automated IoT based smart irrigation and poly farming system in order to increase the yield and quality of crops.

Keywords: Rain sensor, Soil Moisture Sensor, DHT11-Humidity and Temperature Sensor, IoT ESP8266 Module, ARDUINO UNO, RPS, AC Pump, LCD Display, Shed.

1. INTRODUCTION

Modern agriculture has undergone significant transformation with the integration of cutting-edge technologies, particularly in controlled environments like polyhouse farming. These controlled environments provide an ideal setting for optimizing crop production and resource management. One of the pivotal aspects of polyhouse farming is the precise control of environmental factors, such as temperature, humidity, and irrigation, to ensure the well-being and growth of crops. In this context, the advent of the Internet of Things (IoT) has revolutionized agriculture by enabling the development of smart systems that automate and monitor various aspects of farming. The project explores the integration of Internet of Things (IoT) technology into polyhouse farming, a controlled environment for crop cultivation. The IoT-based smart irrigation and monitoring system discussed in this aims to enhance crop productivity and resource management. Key components of the system include automated shed control, rain sensors, soil moisture sensors, and temperature/humidity monitoring (using a DHT11 sensor).

The system's core functionality includes automated shed control, which responds to real-time rain sensor data to optimize irrigation. It opens the shed to allow natural rainfall irrigation and closes it when a specified rainfall threshold is reached to prevent over watering. Additionally, the system monitors soil moisture levels using sensors and adjusts irrigation accordingly, ensuring crops receive the right amount of water. The DHT11 sensor monitors temperature and humidity, helping maintain optimal growth conditions for various crops. The advantages of this IoT-based system in polyhouse farming include increased crop yields, efficient resource utilization, and reduced labor costs. It combines automation and real-time data analysis to create an ideal environment for crop growth while conserving vital resources.

2. LITERATURE SURVEY

This chapter addresses agricultural challenges by proposing an automatic watering system based on humidity and temperature sensors, complemented by rain sensors to protect crops during adverse



weather conditions. Drip lines ensure efficient water delivery to plant roots. The system incorporates a motion detection feature triggering a camera to capture images, facilitating real-time monitoring. The surveillance system aids in identifying and analyzing human or animal presence in agricultural fields, enhancing security and reducing monitoring costs. The technology employs image processing algorithms for object classification, providing a comprehensive solution for smart and efficient farming practices.[1] introduces an economical automatic irrigation system utilizing wireless sensors with GSM and Bluetooth for remote monitoring and control. Emphasizing cost-effectiveness and low power consumption, the system employs SMS through a GSM module and Bluetooth for short-range communication. It alerts farmers about abnormal conditions such as low moisture, high temperature, or CO₂ concentration via SMS or Bluetooth to their mobile devices. However, it is noted that the system may not be suitable for applications with stringent real-time requirements.[2] examines the crucial interplay between climate change and agriculture, particularly impacting developing nations heavily reliant on agriculture. Climate change affects farming practices due to their direct dependence on climatic conditions, with potential benefits in high-latitude areas. Agricultural activities also contribute to climate change through greenhouse gas emissions. Conversely, agriculture can be a climate change solution through mitigation practices like organic farming and agroforestry. However, the paper notes a limitation in controlling climate conditions in open-field agriculture.[3] underscores the multifaceted role of agriculture, not only as a vital source of food and raw materials but also as a significant contributor to livelihoods, national income, employment, and economic development. Focusing on Polyhouse farming, a greenhouse-based technique, the paper highlights its ability to precisely control environmental factors like temperature, humidity, and ventilation, offering advantages in crop cultivation. The research compares various Polyhouse cultivation techniques and introduces an RF-based hardware system that utilizes moisture and temperature sensors for remote monitoring via GSM, enabling mobile-controlled water flow and emergency alerts for field fires. The design prioritizes low power consumption, affordability, robustness, and versatility.[4] focuses on enhancing crop yield and quality through greenhouse cultivation, emphasizing the critical role of controlled environmental parameters like temperature, humidity, and air movement. The monitoring and control of these factors are essential for optimal plant development. The paper underscores the importance of nutrient-related parameters, specifically pH and electrical conductivity (EC), in preventing issues affecting plant health. Additionally, the irrigation system is highlighted for its crucial role in increasing crop yield, with the proposed approach using web technologies to autonomously maintain the necessary polyhouse environment based on soil moisture data, minimizing the need for human intervention.[5] This system is about the polyhouse which can be operated in very easy manner by using IOT that can be operated and monitored by the users from any distant place. This is a paper IoT based smart polyhouse is proposed and a prototype is designed as a proof of concept (PoC). The system monitors the inside polyhouse conditions for effective plant growth using various sensors and control the operations of watering, lighting and temperature maintaining systems. Also farmer is informed about the operating conditions in the polyhouse through a message. The drawback of this project is that the work should be controlled by the user manually.[6] focuses on implementing an IoT-based smart irrigation system for agriculture, offering cost-effective and labor-efficient solutions for farmers. Utilizing IoT sensors, the system monitors temperature, humidity, pH, and water levels in the fields, with data transmitted wirelessly to a web server database. The operations, including irrigation control based on rain conditions, can be remotely managed through smart devices or computers connected to the internet. While the paper introduces an innovative approach, a drawback is the limited provision of sufficient data.[7] highlights the advantages of modern agriculture employing polyhouse systems to enhance crop production. The controlled environment, regulated by factors such as temperature, humidity, and



moisture, protects crops from pests, adverse weather, and diseases. Integration of solar power addresses power consumption concerns, while suitable sensors monitor influential growth factors. The Raspberry Pi 3B+ microcontroller ensures optimal conditions within the polyhouse, employing a 24-hour temperature strategy. However, a drawback is noted due to the relatively high cost of the microcontroller used in this system.[8] is agricultural automation system leverages web and GSM technologies for cost-effective monitoring and control. Focused on optimizing water usage, the system employs soil moisture and temperature sensors, along with a water level sensor, to assess agriculture and tank conditions. Sensor data is accessible through a web page, and status information is communicated via SMS, utilizing GPRS for remote viewing. While the system aims for water efficiency, a potential drawback is the risk of misbehavior from prolonged sensor activation, causing operational issues.[9] The system was designed to monitor soil moisture levels and the project provided an opportunity to explore existing systems with their features and disadvantages. Depending on soil moisture levels, the proposed system can be used to turn on / off the water sprinkler, automating the irrigation process, which is one of the most time consuming farming practices. Agriculture is one of the most water-consuming activities. Soil moisture sensor data are used by the system to irrigate soil, which helps prevent crop damage from over irrigation or under soil irrigation. A website allows the owner of the farm to track the online activity.[10] is an area where any of the crops grown and a solution is found for an agriculture system by different deployment technique. The device will successfully help in growth of a plant by monitoring temperature, pesticides, humidity without human interference and can be implemented in half acre of land as a prototype model. The merit is agricultural growth of the plant without human interference. The demerits of this paper device if implemented in the large scale the overall cost can be brought down that is demonstrated using

3. EXISTING SYSTEM

The smart irrigation system can be monitored and controlled by using mobile application the irrigation under the polyhouse which is constructed with a thin polythene sheet arranged as a closed surface is designed which does not allow the rainfall into the farm. We can monitor and operate manually according to the conditions in the polyhouse system which continuously detects the parameter values, and it is sent to the application where the user can monitor those values. Poly house farming crops are grown throughout the year by providing control environmental factors such as temperature, humidity, fertilizer, CO₂ etc, these factors can extend the off season crop production. The rain water is essential to the plant health and the values or conditions in polyhouse should be displayed to user even to a larger distant place

4. PROPOSED SYSTEM

We propose an automatic shed controlled system to provide the required conditions for the maximum crop yield. To overcome the drawbacks in the existing system, we proposed a polyhouse in which an automated shed control is integrated with smart irrigation system where a shed is arranged on top of the house to open and close for rain water supply to the plants in the house to the crops. This rain water is essential for the hygienic growth of the plant and to maintain a good health of the plant. The monitoring of the parameter values, the user can operate from anywhere in the world as the system has IOT as a communication device. In poly farming yield is increased about 10 to 12 times compared to the traditional farming practice. The system monitors parameter values such as rainfall, temperature, humidity and soil moisture. The proposed system has a feature that detects the rainfall by which an automated shed control is operated. Here the rain sensor detects the water that comes short circuiting the tape of the printed circuits. Then the controller indicates the DC motor to run which opens the roof automatically when there is rainfall and closes automatically when the rain stops. The humidity and temperature sensor is to monitor the live temperature inside the house. The irrigation system has a soil

moisture sensor that indicates the moisture level in the soil which is connected to an AC pump. When the soil moisture sensor indicates dry then the pump will be turned and sensor indicates wet then the pump is in off condition automatically.

BLOCK DIAGRAM

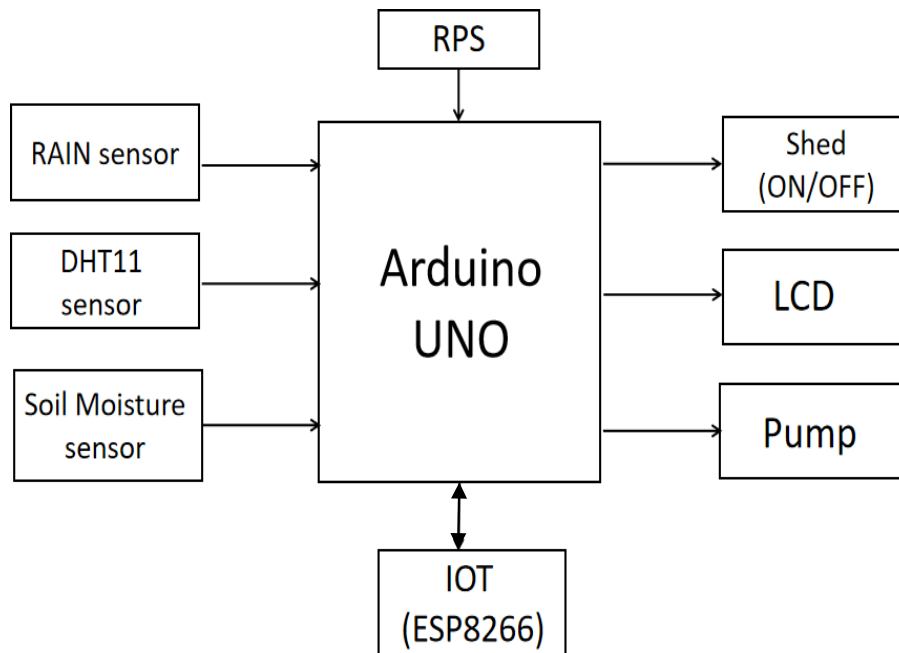


Fig. 1: Block diagram

SCHEMATIC DIAGRAM

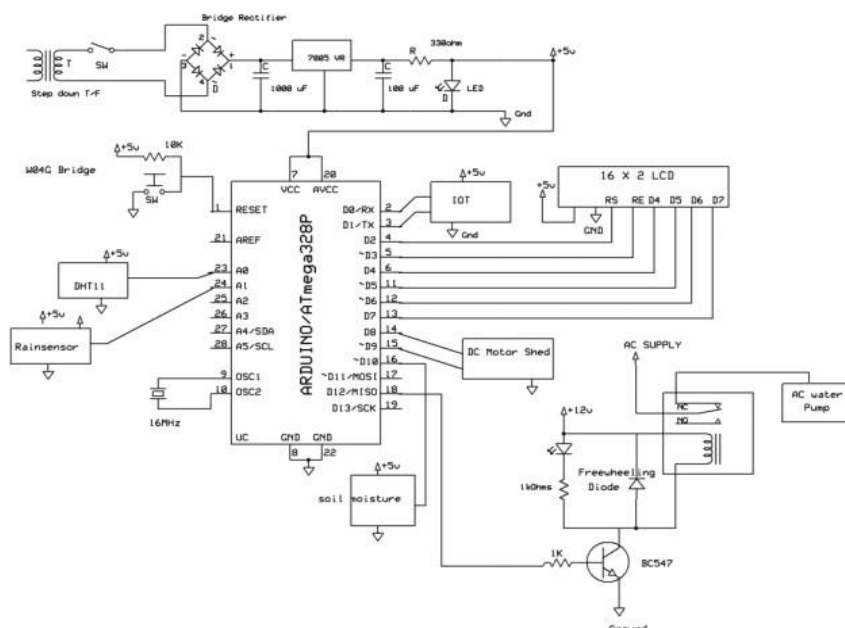


Fig. 2: Schematic diagram

The LCD display, which is a 16*2 LCD Monitor is connected to the digital pins : 2, 3, 4,5,6,7. WIFI is connected to digital Pins D0, D1 internal Transmitter and receiver pins.

DHT11 sensor is connected to A0 pins of the Arduino micro-controller. Rain sensor connected to digital pin A1.

Soil Moisture sensor connected to digital pin 10. Pump connected to digital pin 12.

Dc motor shed connected to 8,9 digital pins of an Arduino controller.

FLOW DIAGRAM:

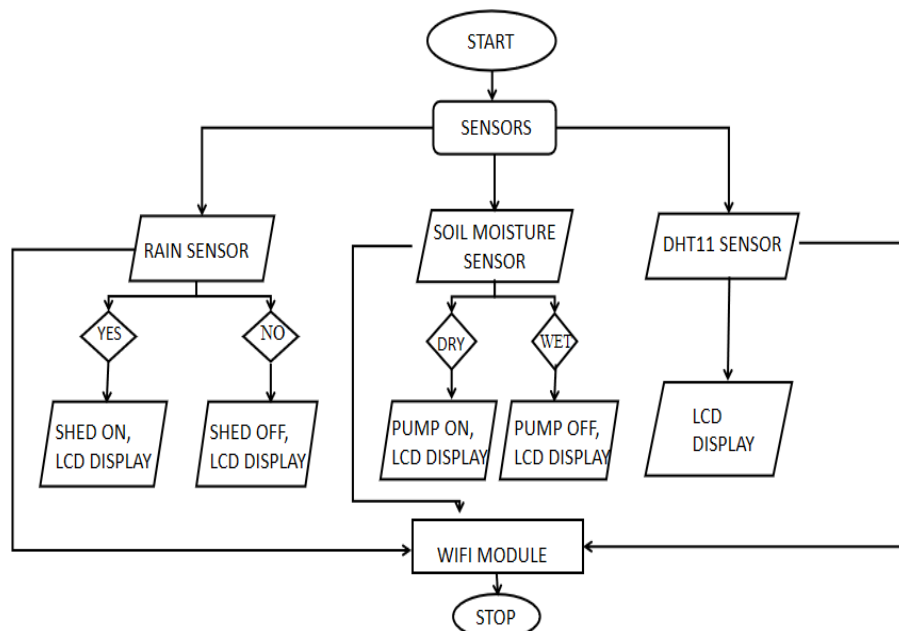


Fig. 3: Flow diagram

Logic Explanation:

IoT-based smart irrigation and monitoring polyhouse farming system, that monitors various parameters like temperature, humidity, soil moisture (presumably measured by the "mos" pin), and rain detection (possibly measured by the "rain" pin). It communicates with a server using Wi-Fi and GSM for data uploading and possibly receiving commands.

Declaration Section: Include the necessary libraries for Liquid Crystal, Software Serial, Wire, and the custom "dht" library.

- Setup Section: Set up pins for various sensors, actuators, and the display.
- Initialize serial communication at 9600 baud rate.
- Initialize the Liquid Crystal display with a welcome message and delay.
- Call the wifinit() function to connect to the Wi-Fi network.
- Logic Section: Read temperature and humidity values using the DHT11 sensor and display them on the LCD.

If temperature or humidity exceeds certain thresholds, a "beep" is triggered, and data is uploaded to the server.

Monitor the state of the "mos" sensor (soil moisture). If it's low (wet), you turn on the pump and upload data to the server.

If the "mos" sensor is high (dry), you turn off the pump.



Monitor the state of the "rain" sensor. If it detects rain (LOW), you trigger a series of actions: turning on motors, beeping, and uploading data to the server. You also prevent repeated actions by using the "sts1" and "sts2" variables.

Update the LCD display with various values and counters.

Server Functions:

Have functions to upload data to the server (upload()), read data from the server (readserver()), and clear data on the server (clearserver()). However, the actual implementation of these functions is not included in the code snippet.

- Wi-Fi Initialization Function: The wifinit () function attempts to connect to a Wi-Fi network using provided credentials.
- Buzzer Alert Function: The beep() function triggers the buzzer for a short duration.
- Analog-Digital Conversion Functions: There are two functions (converts() and convertl()) for converting integer values to strings and displaying them on either the serial port or the LCD.

WORKING

IoT-based smart irrigation and monitoring in polyhouse farming involve integrating sensors, actuators, and communication technologies to optimize agricultural practices. Sensors (e.g., soil moisture, temperature, humidity, light) are placed throughout the polyhouse to gather real-time data on environmental conditions. Sensors collect data continuously, providing information on soil moisture levels, temperature, humidity, and light intensity. The collected data is transmitted wirelessly, typically using IoT protocols (e.g., MQTT or HTTP), to a central control system. The central system processes and analyzes the incoming data to derive insights into the polyhouse environment. Based on the analyzed data, the system makes decisions regarding irrigation scheduling, adjusting parameters to optimize crop growth. Actuators, such as automated irrigation systems or climate control mechanisms, are activated or adjusted based on the decisions made by the central system. Farmers can remotely monitor the polyhouse environment through a user interface (web or mobile app) and make manual adjustments if need Smart systems often aim for energy efficiency by incorporating renewable energy sources, like solar panels, to power sensors and actuators. The system can send alerts to farmers in case of unusual conditions or when manual intervention is required, ensuring proactive management. Historical data is stored for long-term analysis, helping farmers make informed decisions, optimize resource usage, and improve crop yield over time. Some systems integrate weather forecasts to anticipate upcoming conditions and adjust irrigation and climate control accordingly. The system can be scaled to accommodate larger agricultural setups, and additional sensors or actuators can be added to enhance functionality.

5 HARDWARE IMPLEMENTATION

Fig 4 represents the Polyhouse farming system which is with sensors and the smart irrigation system runs under the polyhouse farm.

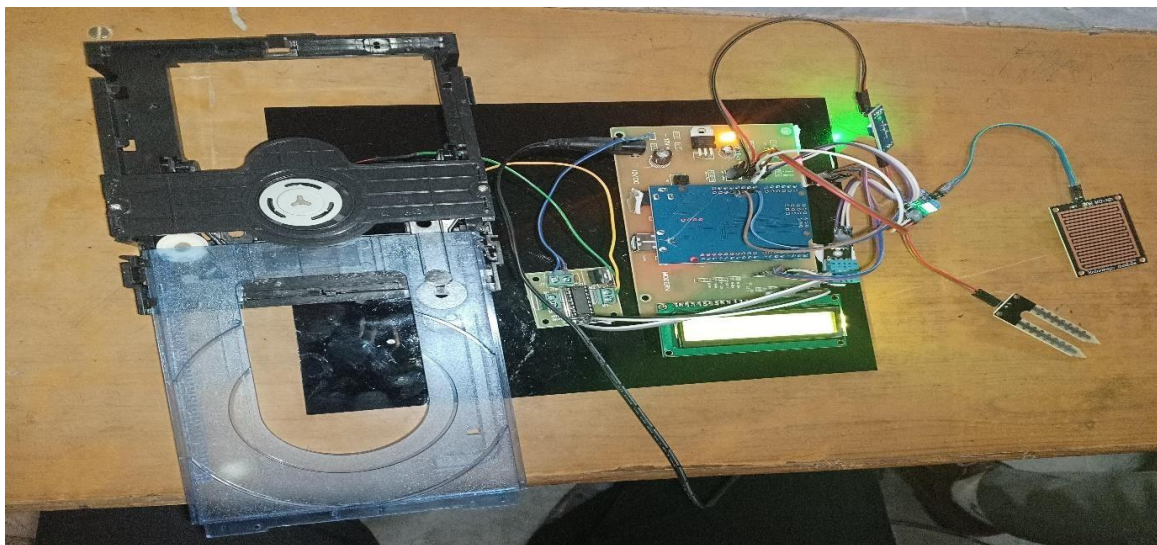


Fig. 4: polyhouse farming system LCD as shown in below fig 8.2 displays the sensor values.



Fig. 5: LD display

T - Temperature value M - Soil Moisture value

H - Humidity value R - Rain value

The below fig 6 shows the opening of a shed when a rain sensor detects the rain.



Fig. 6: Shed control

The values shown below fig 6 of temperature, humidity, soil moisture, rainfall can be monitored on a website by using our credentials from anywhere in the World

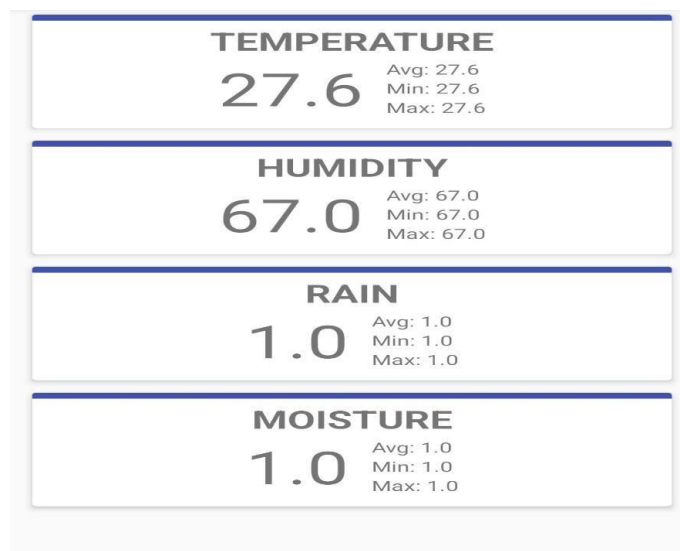


Fig. 7: Sensor values



Fig. 8: Graphical representation of temperature and humidity.

6. CONCLUSION

We designed and implemented Agri polyhouse system fields from heavy rain falls. We implemented using ARDUINO, rain sensor and shed with IOT module-based alert. The Automatic shed control system has been achieved successfully using a micro-controller unit. The circuit has been tested and verified. We developed shed programmed by using the micro-controller. The program has been successfully tested and verified for several specified conditions. The switching mechanism can be done automatically with the help of micro-controller using DC motor. This project offers numerous advantages, including controlled environmental conditions, increased crop yield, reduced pest and disease pressure, and extended growing seasons. However, it also requires a significant initial investment and ongoing maintenance. Overall, polyhouse farming can be a sustainable and profitable agricultural practice when properly managed and adapted to specific crops and region

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