Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 13 Issue 11, November 2024

Smart Polyhouse Irrigation Management System

Akshay Kumar H, Chiranjeevi U B, Jeevan K G, Prajwal S Das
Department Of ECE AIET, Mijar

ABSTRACT
The goal of the Smart Polyhouse Irrigation Management System is to maximize water usage efficiency in regulated farming settings. Based on real-time soil moisture data, the system uses an ESP8266 microcontroller, a water pump, a DHT11 sensor, a relay module, and soil moisture sensors to automate watering. Plant health is further enhanced by a soil NPK sensor, which makes sure the soil maintains the proper nutrient balance. Precise control over the distribution of water and nutrients is made possible by the system's connection to a web interface that records plant profiles, including optimal moisture and nutrient levels.

The technology dramatically minimizes water waste by automating watering only when necessary, ensuring that plants receive the proper amount of water at the correct time. This method of focused irrigation preserves water while encouraging healthy plant development. The system is a sustainable option for polyhouse farming, particularly in areas where water is scarce, because it can monitor and modify irrigation in real-time, improving water-use efficiency.

KEYWORDS: **Water Usage Efficiency, Smart Irrigation, Polyhouse, ESP8266, Soil Moisture Sensor, NPK Sensor, Automated Irrigation, Precision Agriculture, Water Conservation, IoT in Agriculture.**

INTRODUCTION:

A major trend toward smart farming techniques has been observed in the agricultural industry in recent years, driven by the demand for improved crop output and more effective resource management. Optimizing irrigation and managing nutrients is a crucial area of attention, particularly in controlled environments like polyhouses. Conventional irrigation methods frequently cause either excessive or insufficient watering, which wastes water, promotes poor plant development, and lowers soil fertility. The need for smart irrigation systems which can accurately monitor and control the flow of water and nutrients based on real-time environmental data is developing in response to these issues.

The creation of a Smart Polyhouse Irrigation Management System, which uses the Internet of Things (IoT) to automate and improve irrigation, is presented in this research study. The foundation of the system is an ESP8266 microprocessor, which incorporates a number of sensors to track and monitor critical environmental variables, including as soil temperature, humidity, and nutrient levels (nitrogen, phosphorus, and potassium; or NPK). The system is made to meet the unique requirements of many plant species, the profiles of which are kept in an online interface. These profiles offer the proper amounts of nutrients and moisture needed for healthy growth.

The gathered information is sent to a cloud-based server, where it is processed and shown on an easy-to-use webpage. Farmers may remotely monitor and control the conditions of their polyhouses with the help of this website. Based on the current soil conditions and plant requirements, the system automatically decides when to activate the water pump and modify irrigation by comparing real-time sensor data with the plant profiles. By connecting the relay module to the water pump, you may prevent over- and under-irrigation by ensuring accurate water delivery.

This technique not only uses less water but also maintains the right balance of nutrients in the soil, which encourages healthy plant growth and raises crop output. This project intends to create a scalable solution for modern agriculture, contributing to resource efficiency and sustainability by merging IoT with polyhouse farming. The Smart Polyhouse

Irrigation Management System's system design, sensor integration, web interface development, and performance analysis will all be covered in detail in the ensuing sections of the article.

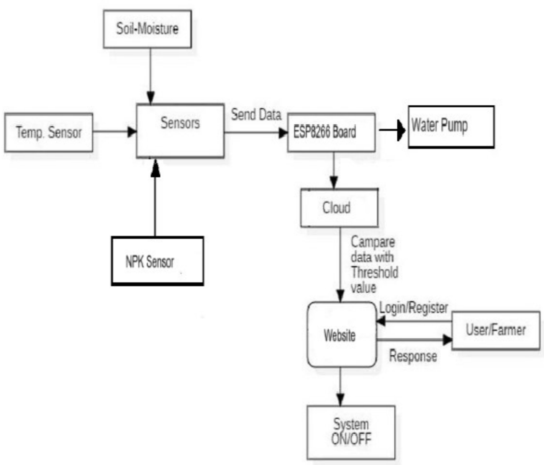

Fig 1: Block Diagram of Smart polyhouse irrigation management system

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 13 Issue 11, November 2024

ESP8266 Microcontroller

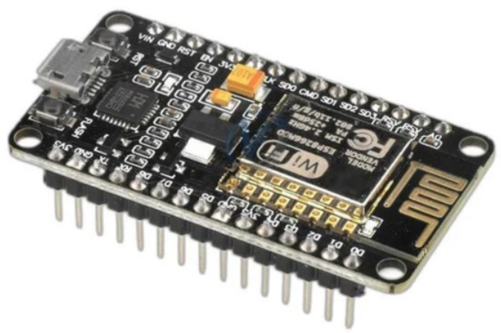

Fig 2:- ESP8266 Microcontroller

The Smart Polyhouse Irrigation Management System's brains are a low-cost, Wi-Fi-enabled microcontroller called the ESP8266. It gathers sensor data and uses its integrated Wi-Fi module to send it to a website or cloud-based server. It is perfect for Internet of Things applications like remote monitoring and automation because of its low power consumption, ease of programming, and wireless connection capabilities.
A low-cost, highly integrated Wi-Fi microcontroller that makes seamless connectivity possible for Internet of Things applications is the ESP8266. The ESP8266 is perfect for smart farming solutions because of its small size and integrated Wi-Fi capabilities, which enable devices to connect to the internet and interact with cloud services. It has a 32-bit microcontroller, lots of GPIO pins to connect actuators and sensors, and multiple communication protocols supported. The ESP8266 is programmable for both novice and expert developers, using well-known environments like the Arduino IDE.

- Operating Voltage: 3.3V
- Input Voltage: 7-12V

Soil Moisture Sensor

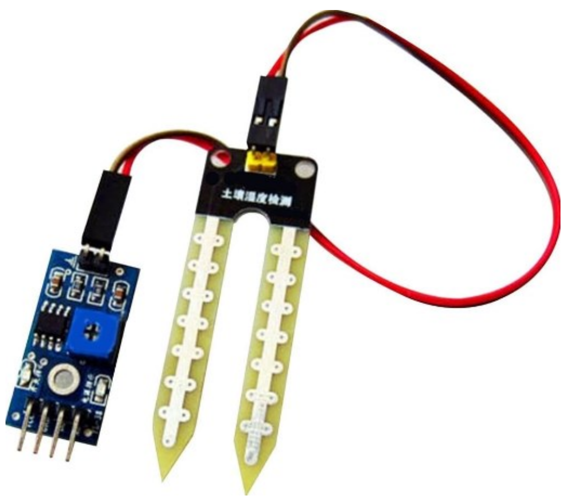

Fig 3:- Soil Moisture Sensor

In order to detect the volumetric water content of the soil, a crucial part of irrigation and precision farming systems is the soil moisture sensor. Usually, resistive or capacitive technology is used to operate it. When two electrodes are placed into the soil in a resistive sensor, the resistance between them varies according to the moisture content; a lower resistance denotes a higher moisture content. The dielectric constant of the soil, which changes with moisture content, is measured by capacitive sensors.
By giving the irrigation system up-to-date information on soil moisture, the sensor helps it decide when to turn on the water pump. The soil moisture sensor is essential for conserving water, promoting plant health, and increasing agricultural output since it prevents over- or under-irrigation. Its use into intelligent irrigation systems allows for automated reactions to shifting soil conditions, maximizing the use of resources in farming operations.

DHT11 Sensor (Temperature and Humidity Sensor)

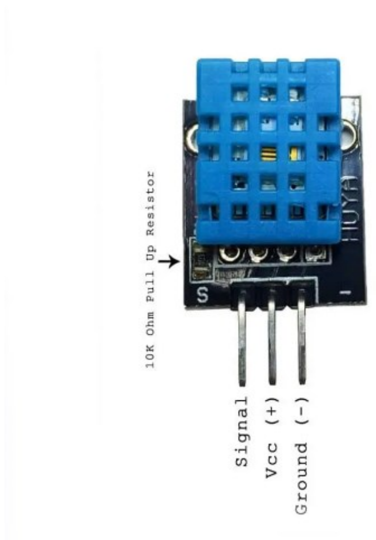

Fig 4:- DHT 11 Sensor

A cheap digital sensor called the DHT11 is used for measuring temperature and humidity in a variety of applications, such as environmental monitoring and smart farming. Because it uses a single-wire protocol, integrating it with microcontrollers such as the ESP8266 is simple. The DHT11 is capable of measuring humidity levels from 20% to 80% with an accuracy of ±5% relative humidity and temperature from 0 to 50°C with a precision of ±2°C. It is perfect for incorporation into automated systems due to its small size and low power consumption. In these systems, it may give real-time data to improve growth conditions for plants. The DHT11 sensor assists in monitoring the microclimate in a smart polyhouse irrigation management system, enabling prompt adjustments to irrigation and environmental controls that eventually promote better crops and improve yield.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 13 Issue 11, November 2024

Soil NPK Level Sensor

Fig 5:- Soil NPK Level Sensor

The Soil NPK Level Sensor is an indispensable tool in precision farming, intended to gauge the levels of three vital nutrients in the soil: potassium (K), phosphorus (P), and nitrogen (N). These nutrients are essential to plant growth, having an impact on everything from root formation to yield as a whole. The sensor provides real-time data to the microcontroller by measuring the amounts of nutrients in the soil using capacitive sensing techniques or electrochemical principles. The sensor allows for accurate soil fertility monitoring and management by incorporating this data into the Smart Polyhouse Irrigation Management System.

The device can initiate automated actions, including nutrient replenishment or irrigation practice adjustments, when nutrient levels drop below ideal thresholds. By avoiding overfertilization and reducing environmental effect, this capacity not only guarantees that plants receive the proper balance of nutrients, but it also encourages sustainable farming practices.

Relay Module

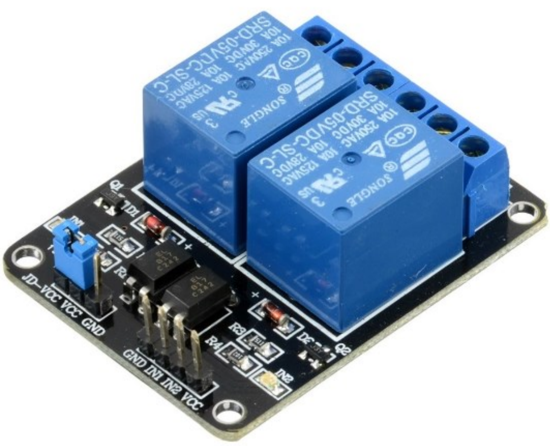

Fig 6:- Relay Module

A crucial electronic part of an automated system, the relay module serves as a switch to regulate high-power equipment like water pumps. It makes it possible to turn on or off a high-voltage device using a low-power control signal from a microcontroller, such as the ESP8266, without having to link the two directly. The relay module of the Smart Polyhouse Irrigation Management System gets signals based on data from sensors that are updated in real time, including soil moisture levels. The relay turns on the water pump to irrigate the plants when it detects that the soil is dry.

On the other hand, the relay turns off the pump's electricity when it detects an appropriate level of moisture. This feature separates the high-voltage activities from the low-power control circuitry, ensuring both safety and accurate and efficient watering. Thus, the relay module is essential for improving resource management, automating irrigation procedures, and encouraging strong plant growth.

Water Pump

Fig 7:- Water Pump

The Smart Polyhouse Irrigation Management System's water pump, which delivers water to plants depending on their actual moisture needs, is an essential part of the system. Water is efficiently moved from a source, such as a tank or well, directly to the irrigation system via an electric pump. A relay module, which gets signals from the ESP8266 microprocessor based on input from the soil moisture sensors, controls the pump. Effective plant irrigation is facilitated by the microcontroller's activation of the relay, which turns on the pump when soil moisture levels fall below a predetermined threshold.

In addition to guaranteeing timely watering, this automation helps avoid over-irrigation, which conserves water resources while fostering the best possible health and growth for plants. The irrigation system's entire performance in a regulated environment depends heavily on the water pump's dependability and efficiency.

METHODOLOGY:

The Smart Polyhouse Irrigation Management System automates irrigation based on current environmental data to maximize the use of water and nutrients. System architecture design, sensor integration, data processing, and control mechanisms are some of the methodology's primary aspects.

Design of System Architecture

The ESP8266 microcontroller, which acts as the focal point for control and data collecting, lies at the heart of the system architecture. The system is equipped with a number of sensors, such as a soil NPK sensor, a DHT11 temperature and humidity sensor, and soil moisture sensors. Additionally, the relay module that manages the water pump in response to sensor input is interfaced with by the ESP8266. Users can obtain sensor data and remotely adjust irrigation settings with the use of a web-based interface designed for monitoring and control.

Sensor Integration

Installed in the soil, soil moisture sensors keep an eye on the moisture content all the time. These sensors give precise information on the water requirements of the plants in real time.

The DHT11 Sensor monitors the environmental factors that impact plant growth by taking measurements of the polyhouse's temperature and humidity. The amounts of potassium, phosphorus, and nitrogen are measured by the Soil NPK Sensor, which offers information on the balance of nutrients in the soil. This enables the application of fertilizer to be adjusted as necessary.

Data Processing and Control

In order to make irrigation decisions in real time, the ESP8266 analyses sensor data. The ESP8266 signals the relay module to turn on the water pump when the soil moisture falls below the set threshold for a certain plant profile. In a similar vein, the analysis of nutrient levels obtained from the NPK sensor guarantees that the soil remains at ideal fertility levels. The system can automatically or advise supplementing with nutrients if necessary.

Web Interface and Plant Profiles

To store plant profiles, each with unique moisture and nutrient requirements, a web-based platform is built. Each plant is given the appropriate amount of water and nutrients by means of the platform's collection of sensor data, which is then compared to these predetermined profiles. Through the interface, users can also remotely monitor and manage the polyhouse environment, changing things like nutrient levels and irrigation schedules.

Automated Irrigation Control

The NPK readings and soil moisture levels are used by the relay module, which is managed by the ESP8266, to run the water pump. By ensuring that water is only applied, when necessary, the system conserves water while preserving the perfect environment for plant growth. Reducing resource waste and increasing water use efficiency depend on this automation.

Testing and Calibration

For precise data collection, the system is put through a rigorous testing process to calibrate the sensors. The particular plant profiles are used to determine the soil moisture thresholds, and the water pump's performance is adjusted to prevent over- or under-irrigation. The calibration of NPK sensors guarantees precise measurements of soil nutrient levels, which are then contrasted with established benchmarks for plant development.

Performance Evaluation

The water use, overall efficiency, and plant health are used to assess the system's effectiveness. In order to assess how well the system optimizes irrigation and nutrient supply, data gathered from the sensors and the web interface is examined with an emphasis on water conservation and increasing crop output.

In a polyhouse setting, this methodology guarantees a methodical approach to developing an automated irrigation management system that optimizes water efficiency and improves plant health.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 13 Issue 11, November 2024

LITERATURE SURVEY:

This research describes the placement of temperature, humidity, and soil moisture sensors in the root zone of plants, which then provide data to an Android application. water quantity controlled by a microcontroller that was programmed with the threshold value of a soil moisture sensor. The Android application shows the values of temperature, humidity, and soil moisture [1]. This analysis, which was completed without the need for human labour, will increase the effectiveness of energy conservation by turning on a buzzer automatically [2]. This system claims to prolong system life by cutting power use, which lowers power consumption. It is thought to be utilized for appropriate irrigation in public garden areas, golf and cricket stadiums, and public spaces [3].

This intelligent drip irrigation system turns out to be a helpful tool because it automatically controls and monitors the watering without the need for human interaction. The system can be programmed to send emails automatically, but sending emails manually gives the system control over whether or not to run in response to the weather [4]. This hardware and software combination provide an incredibly user-friendly irrigation controller that can be implemented at a reasonably modest cost [5]. This study suggests using IoT in a poly home. Since a poly house is completely covered, external variables have very little effect on it. For example, insects cannot harm the crop because they cannot enter, hence less insecticide will be needed. An suitable decision can be made in an agricultural field with internet connectivity by employing sensors [6]. This irrigation system uses a Bluetooth module to turn the drip ON and OFF. This method uses fewer personnel and a smaller data storage device to regulate a drip [7]. In order to maximize water utilization and minimize waste, this study proposes an automated irrigation system to water the crop. The system will require less human interaction if the user has access to an Android application that allows them to monitor and control the amount of water needed on the farm [8]. I It provides the notion of keeping an eye on the temperature and moisture content of the soil in a farming region, and it allows the user to regulate the irrigation system with an Android device that has Wi-Fi access [9]. Since agriculture provides the raw materials for all other sectors, it is essential to minimize and maintain the water level required for cultivation, which varies depending on the season [10].

CONCLUSION:

The Smart Polyhouse Irrigation Management System is an example of how IoT technologies can be used to improve sustainability and efficiency in contemporary agriculture. The system efficiently monitors and controls the irrigation and nutrient supply for a variety of plants in a polyhouse setting by utilizing parts like the ESP8266 microcontroller, soil moisture sensors, DHT11 temperature and humidity sensors, soil NPK level sensors, a relay module, and a water pump.

The device makes sure that plants get the nutrients they need to grow healthily and optimizes water use by gathering data in real-time and using automatic control. In addition to facilitating remote monitoring, the web-based interface makes it simple for users to control and modify settings in accordance with particular plant profiles, increasing the polyhouse's overall productivity.

By addressing major issues with conventional farming methods including nutrient imbalances and water waste, the installation of this smart irrigation system opens the door for more environmentally friendly farming techniques. Future improvements might include adding more sensors to monitor the environment more thoroughly and enhancing the system's capacity to support a larger range of crops. In summary, this study demonstrates how technology in agriculture has the ability to revolutionize the industry and improve resource efficiency and food security in a world where demands are rising.

REFERENCES:

[1] Manjunath Deshpande1, Shraddha Patil2, Priyanka Kanaka3, Diksha V M4 “Automatic Plant Irrigation Based on Soil Moisture and Monitoring Over IOT” International Journal of Innovative Research in Computer and Communication Engineering an ISO 3297: 2007 Certified Organization Vol.5, Special Issue 4, June 2017

[2] Pavankumar Naik, Arun Kumbi, Vishwanath Hiregoudar, Chaitra N K, Pavitra H K, Sushma B S, Sushmita J H, Praveen Kuntanahal “Arduino Based Automatic Irrigation System Using IoT” International Journal of Scientific Research in Computer Science, Engineering and Information Technology © 2017 IJSRCSEIT | Volume 2 | Issue 3 | ISSN: 2456-3307

[3] Dr. N. K. Choudhari1, Mayuri Harde2 “Automated Plant Irrigation System Based on Soil Moisture and Monitoring Over IOT” Volume 5 Issue VI, June 2017 ICValue:45.98 ISSN: 2321-9653

[4] Nikhil Agrawal Engineeing Manager, Siemens, Noida, Smita Singhal ASET, Amity University, Noida “Smart Drip Irrigation System using Raspberry pi and Arduino” International Conference on Computing, Communication and Automation (ICCCA2015)

[5] Abhinav Rajpal, Sumit Jain, Nistha Khare and Anil Kumar Shukla “Microcontroller based Automatic Irrigation System with Moisture Sensors” Volume 5 Issue VI, June 2015

[6] Lorvanleuang, S. and Zhao, Y.D. “Automatic Irrigation System Using Android” Open Access Library Journal 2015, Volume 5, e4503 ISSN Online: 2333-9721 ISSN Print: 2333- 9705

[7] Mayuri R. Harde, Dr. N. K. Choudhari “A Review Paper On Wireless Sensor Network And Gprs Module For Automated Irrigation”, International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 01 Jan -2017

[8] Souvanxay Lorvanleuang*, Yandong Zhao,” Automatic Irrigation System Using Android 2018, Volume 5, e4503

[9] N Seenu, Manju Mohan, Jeevanath V S,“Android Based Intelligent Irrigation System”, International Journal of Pure and Applied Mathematics, Volume 119 No. 7 2018, 67-71

[10] Anand Dhore1, Arti Sanganwar2, Kapil Chalkhure3, Shivani Jijankar4, Prof. Vikramsingh R. Parihar5, ―Automatic Irrigation System Using Android Mobile, International Journal of Advanced Research in Computer and Communication Engineering ISO 3297:2007 Certified Vol. 6, Issue 9, September 2017

[11] Wikipedia search “Agriculture in India”.

[12] Google Search “ESP8266, Temperature sensor, Soilmoisture sensor, Water-flow sensor

[13] Google search “Features of Soil-moisture, Temperature, Water-flow sensor”