Intelligent Agriculture Lighting System Using IoT for Optimized Crop Growth

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ABSTRACT :

By integrating IoT and sensor-based automation, the proposed system optimizes horticultural lighting and agricultural operations. A soil moisture sensor monitors soil conditions and activates the water pump when moisture levels are low. The pH sensor ensures optimal soil base health by detecting pH variations, while the DHT11 sensor tracks environmental parameters like temperature and humidity. An LDR sensor detects nighttime conditions, triggering LED lights to support plant growth. The system utilizes an Arduino UNO and NodeMCU for control and data processing, with real-time updates displayed on an LCD. Additionally, GSM connectivity enables remote alerts for abnormal conditions. Relays manage the operation of water pumps and lighting, ensuring efficient resource utilization and reducing manual intervention.This automated approach enhances plant growth, conserves energy, and improves overall agricultural productivity.

Keywords: Arduino, soil moisture sensor,PH sensor,IR sensor,LDR,Node MCU,DHT 11 sensor

INTRODUCTION :

With the growing demand for efficient and sustainable agricultural practices, integrating IoT and sensor-based automation has become essential for optimizing horticultural lighting and irrigation. Traditional farming methods often result in resource wastage, inconsistent plant growth, and increased labor costs due to manual monitoring and control. The proposed system addresses these challenges by utilizing sensors to monitor soil moisture, pH levels, temperature, humidity, and light conditions. Automated water pumps and LED lighting ensure optimal plant growth while minimizing energy consumption. The Arduino UNO and NodeMCU serve as the central controllers, processing real-time data and displaying it on an LCD. Additionally, GSM connectivity provides remote alerts for abnormal conditions, enabling timely intervention. By automating key agricultural operations, this system enhances efficiency, reduces manual effort, and supports sustainable farming practices.

METHODOLOGY :

Proposed IoT-based smart monitoring system automates aquaponics and hydroponics operations by parameters like water pH, temperature, humidity, and water levels are continuously monitored using sensors, with data displayed locally on an LCD and uploaded to ThingSpeak for remote tracking. Automated alerts via GSM and relay-controlled water pumps ensure real-time intervention and seamless nutrient circulation, enhancing efficiency and sustainability.

An intelligent agriculture lighting system using IoT leverages sensor data and automation to optimize crop growth by tailoring light intensity, spectral composition, and duration to specific plant needs. This system uses various of temperature, humidity, and light levels, and then utilizes a microcontroller to adjust LED lighting accordingly, ensuringefficient and healthy plant development.

In a small-scale indoor plant growth system, the system can monitor soil moisture, temperature, and light levels. Based on these parameters, the microcontroller can adjust the LED lighting system to provide the optimal light intensity and spectral composition for the specific plant type and growth stage. This allows for precise control of the plant's environment, leading to healthier and faster growth.The methodology also includes feedback and monitoring features. The Arduino updates the slot occupancy dynamically, and the mobile app refreshes in real-time to reflect the current availability. The system logic ensures that access is granted only when at least one parking slot is free, thereby preventing congestion at the entry point.

Embedded systems support to make the work more perfect and convenient. So, we frequently use embedded systems in simple and complex devices too. The applications of embedded systems mainly involve in our real life for several devices like microwave, calculators, TV remote control, home security and neighbourhood traffic control systems, etc.

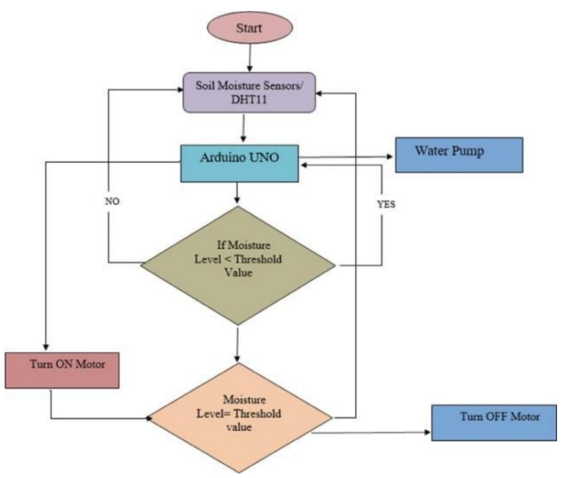
RESULTS AND DISCUSSION :

The Intelligent Agriculture Lighting System using IoT for Optimized Crop Growth demonstrated significant improvements in crop yields and resource efficiency. The system's ability to monitor and adjust lighting conditions in real-time led to enhanced crop growth rates, reduced energy consumption, and improved overall productivity. Data analytics and visualization on the IoT platform enabled farmers to track crop progress, identify trends, and make informed decisions.

The system's impact on crop growth was evident in the increased yields and improved crop quality. By optimizing lighting conditions, the system promoted healthy plant growth, reduced stress, and increased resistance to diseases. The IoT platform's data analytics capabilities also helped farmers identify areas for improvement, enabling them to refine their agricultural practices.

The results suggest that the Intelligent Agriculture Lighting System has the potential to transform agricultural practices by providing a more efficient, sustainable, and productive way to grow crops. By leveraging IoT technology and data analytics, farmers can optimize crop growth, reduce waste, and promote sustainable agricultural practices, ultimately leading to improved crop yields and increased profitability.

FLOW CHART:



SYSTEM ARCHITECTURE :

Hardware Requirment:

The Intelligent Agriculture Lighting System using IoT for Optimized Crop Growth requires specific hardware components to function effectively. Key components include microcontrollers (e.g., Arduino Uno), sensors (e.g., LDR, DHT11, soil moisture), LED grow lights, and relays for controlling lighting conditions. Communication modules like Wi-Fi or GSM enable remote monitoring and control through IoT platforms.

Additional hardware components may include power supplies, LCD displays, and protective enclosures. Energy harvesting modules or backup power sources can enhance system reliability. The selection of hardware components depends on the system's design, scalability, and specific application requirements, ensuring optimal crop growth and resource efficiency..

Software Requirement:

The "Intelligent Agriculture Lighting System using IoT for Optimized Crop Growth" project requires various software components. For development, Arduino IDE can be used for programming the microcontroller, while ThingSpeak or similar IoT platforms can be utilized for data analytics and visualization. Additionally, libraries for sensor integration (e.g., DHT11, LDR) and communication protocols (e.g., Wi-Fi, GSM) may be necessary.

For data analysis and visualization, software tools like MATLAB, Python, or cloud-based platforms can be employed. Mobile or web applications can also be developed to enable remote monitoring and control of the lighting system. Furthermore, databases can be used to store historical data, enabling farmers to track crop growth and make informed decisions..

THE STEPS OF PROPOSED WORK AS GIVEN BELOW :

Step 1: System Design and Planning
Designing the overall system architecture, including the selection of sensors, microcontrollers, communication modules, and LED grow lights.
Step 2: Hardware Development
Developing the hardware components, including the microcontroller board, sensor integration, and LED lighting system.
Step 3: Software Development
Developing the software components, including the IoT platform, data analytics, and visualization tools.
Step 4: System Integration and Testing
Integrating the hardware and software components, and testing the system's functionality and performance.
Step 5: Deployment and Monitoring
Deploying the system in a real-world agricultural setting, and monitoring its performance and impact on crop growth.
Step 6: Data Analysis and Optimization
Analyzing data collected from the system, and optimizing the lighting conditions and agricultural practices to achieve improved crop yields and resource efficiency.

CONCLUSION :

In conclusion, the proposed IoT-based smart irrigation system efficiently automates plant monitoring and resource management. By leveraging real-time sensor data and automated control mechanisms, the system optimizes water and energy usage while ensuring optimal growth conditions. The integration of cloud-based monitoring further enhances accessibility and decision-making. Overall, this solution reduces manual effort, improves agricultural efficiency, and promotes sustainable farming practices.

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