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IOT BASED SMART AGRICULTURE IRRIGATION SYSTEM

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ABSTRACT:- Efficient water management is crucial for agriculture today, and the integration of Internet of Things (IoT) technology can revolutionize irrigation practices. This paper presents a smart IoT-based agricultural irrigation system designed to control groundwater level according to the specific requirements of crops. The system uses sensors to monitor moisture, humidity and temperature and uses the Internet of Things to send data to an online platform for real-time analysis. Essentially, the system automatically controls water pumps to ensure crops receive the right amount of water, thus increasing yields while saving resources. Components such as Node MCU, DHT22 sensor, humidity sensor, relay module and OLED display work smoothly.

Keywords: Node MCU, OLED, DHT22sensor, IOT, Relay etc.

INTRODUCTION:

❖ Overview of the importance of water management in agriculture:

Water management is very important in agricultur e. It helps plants grow well and produce more nutr ients. When farmers use water efficiently, they ca n grow crops without wasting water. This also pro tects the environment and makes agricultural lands more resilient to climate change. By managing w ater efficiently, farmers can save money, comply with water regulations, and protect their farms in t he long term.

❖ Role of IoT technology in enhancing irrigation systems:

IoT technology plays a crucial role in enhancing irrigation systems by providing real-time data monitoring, automation, and precision control. Here's how:

- **Real-time Monitoring:** IoT-enabled sensors measure various parameters such as soil moisture, humidity, temperature, and weather conditions. This real-time data allows farmers to accurately assess the water needs of their crops, ensuring that irrigation is applied precisely when and where it's needed.

- **Data-driven Decision Making:** IoT devices collect large amounts of data from the field, which can be analyzed to gain insights into crop health, soil conditions, and water usage patterns. Farmers can make informed decisions about irrigation scheduling, water allocation, and crop management based on this data, leading to optimized yields and resource efficiency.

- **Automation and Remote Control:** IoT technology enables automation of irrigation systems, allowing farmers to remotely monitor and control irrigation equipment. This automation eliminates the need for manual intervention, reduces labor costs, and ensures consistent and timely irrigation, even in large-scale agricultural operations.

- **Precision Irrigation:** IoT-based irrigation systems can deliver water precisely to specific areas of the field based on crop requirements, soil moisture levels, and environmental conditions. This precision irrigation minimizes water wastage, reduces runoff and leaching, and promotes uniform crop growth, resulting in higher yields and water savings.

- Scalability and Flexibility: IoT-enabled irrigation systems are scalable and adaptable to different farm sizes, crop types, and geographic locations. Farmers can easily expand or modify their irrigation infrastructure and customize settings to meet changing agricultural needs, maximizing operational efficiency and productivity.
- Integration with Other Technologies: IoT technology can be integrated with other agricultural technologies such as drones, satellite imagery, and predictive analytics to enhance irrigation management further. These integrated systems provide comprehensive insights into crop health and environmental conditions, enabling proactive decision-making and risk mitigation.

❖ Objectives focusing on adaptive water management based on crop requirements:

- Utilize IoT technology to monitor crop-specific parameters such as soil moisture, temperature, and humidity in real-time.
- Develop algorithms to analyze data and determine precise water requirements for different crops.
- Implement automation to adjust irrigation schedules and water delivery systems based on crop needs and environmental conditions.
- Optimize water usage to ensure crops receive adequate moisture while minimizing waste.
- Enhance crop health, yield, and quality through tailored irrigation management strategies.
- Improve resource efficiency and sustainability by aligning water usage with crop requirements.
- Foster resilience to climate variability and optimize agricultural production in changing environmental conditions.

LITERATURE REVIEW :

❖ Existing irrigation systems and their limitations

- **Unequal distribution of water:** Conventional water practices such as irrigation or ponding often result in unequal water distribution in the field. This can lead to excess water in some areas, leading to the potential for waste and water, while in other areas there may be insufficient water, affecting crop growth and yield.

- **Water loss:** In traditional irrigation systems, large amounts of water are lost due to evaporation, runoff and deep seepage. These losses reduce water efficiency, causing damage and harm to the environment.

- **Maintenance:** Many pipes require care and maintenance, which can be laborious and time-consuming. The impact of this guidance increases the risk of human error and inconsistent water use, resulting in inadequate water use.

- **Control and flexibility:** Traditional water systems often do not have the ability to adjust water use according to changing environmental or crop needs. This lack of flexibility can lead to under- or over-irrigation, affecting crop health and yield.

- **Electricity:** Some water systems, such as center pivot and outlet lines, require significant amounts of energy to operate, usually in the form of electricity or gas. High energy consumption leads to high operating costs and environmental impacts, especially in regions where access to affordable electricity is limited.

- **Soil Erosion and Water Pollution:** Poor water practices, such as excessive runoff and overwatering, can cause soil erosion and nutrient leaching. This reduces the quality of the soil, pollutes the water body with sediments and agricultural chemicals, and damages the aquatic ecosystem.

- **Limited access to water sources**: In areas where water is scarce or unreliable, it can be difficult for traditional irrigation systems to irrigate crops. This situation limits agricultural production and increases food security, especially in arid and semi-arid regions.

❖ Relevant methodologies and technologies for smart irrigation

Smart irrigation methods incorporate a range of cutting-edge technologies and methodologies aimed at optimizing water usage and enhancing crop productivity in agricultural settings. These methodologies leverage a combination of sensor-based monitoring, data analytics, and IoT connectivity to create intelligent irrigation systems. At the core of these systems are various sensors, including soil moisture sensors, weather stations, and humidity sensors, which provide real-time data on environmental conditions and soil moisture levels. This data serves as the foundation for informed decision-making regarding irrigation scheduling and water application.

Data analytics and decision support systems play a crucial role in analyzing the sensor data and historical weather patterns to develop predictive models for irrigation scheduling. These models enable farmers to generate optimized irrigation schedules tailored to the specific needs of different crops and prevailing environmental conditions.

Furthermore, IoT connectivity allows for seamless communication between sensors, controllers, and centralized platforms, enabling remote monitoring, control, and data analysis. Farmers can manage irrigation operations from anywhere using web-based or mobile applications, ensuring timely and efficient water delivery to crops.

Automation and control systems are key components of smart irrigation methods, regulating water flow based on preset parameters such as soil moisture thresholds. This ensures precise and efficient water distribution while minimizing wastage and runoff.

Additionally, the integration of weather forecast data into irrigation scheduling algorithms allows farmers to adjust irrigation plans based on predicted weather conditions. By considering future rainfall, temperature, and humidity forecasts, farmers can optimize irrigation timing and conserve water resources.

In conclusion, smart irrigation methods harness the power of advanced technologies and methodologies to optimize water management practices in agriculture. By improving water use efficiency, enhancing crop yields, and promoting sustainable agricultural practices, these methods play a crucial role in addressing water scarcity challenges and ensuring food security in a changing climate.

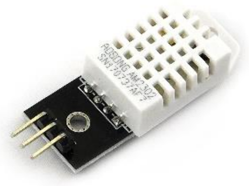
SYSTEM ARCHITECTURE :

❖ Components and their functions in the system

The Smart IoT-based Agriculture Irrigation System comprises various components, each serving specific functions to ensure efficient water management and crop health. Here's an overview of the components and their respective functions:

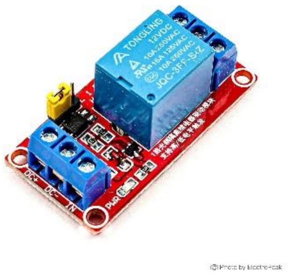
1. Arduino or NodeMCU: These microcontroller units serve as the central processing units of the system. They collect data from sensors, process information, and control the irrigation system's operation based on predefined algorithms and user inputs.

2. DHT22 Sensor: The DHT22 sensor measures temperature and humidity levels in the environment. This data is crucial for understanding atmospheric conditions, which influence crop water requirements and irrigation scheduling.



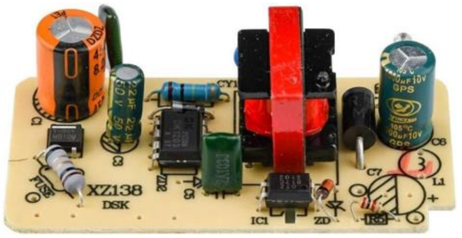
3. Soil Moisture Sensor: Soil moisture sensors measure the moisture content in the soil. They provide real-time information about soil moisture levels, enabling the system to determine when irrigation is needed and how much water should be applied to maintain optimal soil moisture for crop growth.

4. Relay Module: The relay module acts as a switch, controlling the operation of the water pump or irrigation valves. Based on data from sensors and predefined thresholds, the relay module activates or deactivates the irrigation system to deliver water to the crops as needed



5. OLED Display: The OLED display provides a visual interface for users to monitor system status, sensor readings, and irrigation schedules. It offers real-time feedback on environmental conditions and irrigation activities, allowing farmers to make informed decisions and adjust settings as necessary.

6. Power Supply: The system requires a reliable power source to operate, typically through batteries, solar panels, or mains electricity. A stable power supply ensures continuous monitoring and control of the irrigation system, even in remote agricultural areas.



7. Water Pump: The water pump is responsible for delivering water from the source (such as a well or reservoir) to the irrigation system. Controlled by the relay module and microcontroller, the water pump activates when irrigation is required, pumping water through the irrigation lines to the crops. The pump's flow rate and duration of operation are regulated based on soil moisture data and crop water requirements, ensuring efficient water delivery while minimizing wastage.

HARDWARE DESIGN:

❖ System Architecture:

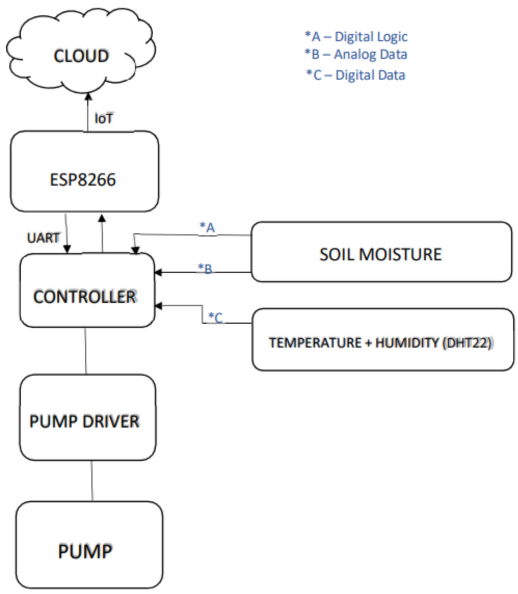
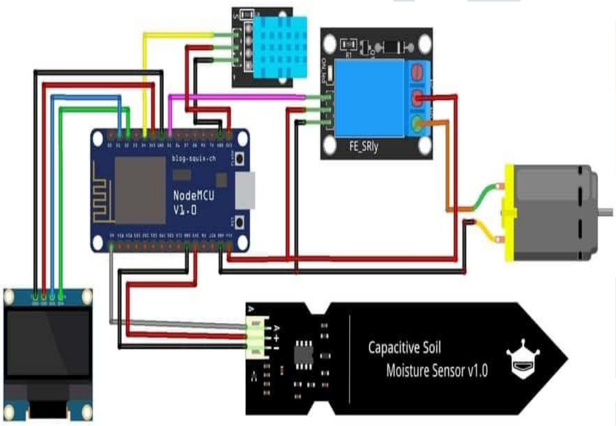


Fig. 6 Block diagram

The system architecture has many important featur es to support smart irrigation and crop manageme nt. At its core is the NodeMCU, which acts as th e central processor and manages the operations of the entire system. DHT22 sensors are used to mon itor environmental conditions such as temperature and humidity, providing important information for irrigation decisions. In addition, a soil moisture se nsor that measures soil moisture is integrated to pr ovide irrigation according to the specific needs of your products. The system uses an OLED display to display real-time and process information to users, providing i nformation about the environment and water quali ty. Additionally, the DC motor controlled by Node MCU can be used as a pump to move water from t he source to the well. The data collected by the se nsors is sent to the IoT cloud for remote monitorin g and control of water flow. This architecture facil itates permaculture practice by enabling efficient water management, planning of water changes and increasing productivity.

IMPLEMENTATION:

- **Description of system setup and configuration**



This research paper discusses the design of a smar t water system designed to transmit data to an IoT network for monitoring and analysis. At the heart of the system is the NodeMCU ESP8266 microco ntroller unit, which is the main function of various products and the IoT platform. Connections of se nsors such as DHT22 sensors for temperature and humidity measurement, humidity sensors for soil moisture measurement, relay modules for water p ump control are made via the digital and analog pi ns of the NodeMCU. Sensors built on constant po wer provide up-to-date information important for water decisions

Additionally, NodeMCU facilitates efficient com munication with the IoT network via Wi-Fi connectivity. NodeMCU uses Wi-Fi functionality to continuously transmit sensor da ta to the IoT platform designed to achieve remote monitoring and analysis. This gives stakeholders a ccess to important information regarding environ mental and water activities, making it easier to ma ke decisions and intervene when necessary.

Additionally, the research paper introduces web in tegration of data visualization tools in IoT, allowin g users to view sensor readings, state layer, and w ater duration. This improves data accessibility and usability, allowing stakeholders to gain better insi ght into water use patterns, crop health and overall performance.

The architecture outlined in this research article re presents a significant advance in smart water syste ms and provides solutions for data collection, tran smission and analysis. The system facilitates remo te monitoring and decision-making by sending data to the IoT network, ultima tely helping to improve crops, water conservation and permaculture practices.

RESULT :

- **Performance evaluation based on crop yield and water consumption**

To understand how well our smart irrigation system works, we need to look at two main things: how much our crops grow and how much water we use. First, we'll compare the yield of crops grown using our smart system with those grown using regular methods or no irrigation at all. We'll measure things like how many fruits or vegetables we get from each plot. By doing this, we can see if our system helps crops grow better.
Secondly, we'll check how much water our system uses compared to traditional methods. We'll measure how much water we put on the crops and see if our system is more efficient in using water.
We'll also consider other factors like the quality of the crops and how moist the soil is. All this information will help us understand if our smart irrigation system is doing a good job in helping crops grow while using water wisely.

Overall, by looking at crop yield and water usage, we can see if our smart irrigation system is making a positive difference in farming and helping conserve water resources.

CONCLUSION:

In summary, smart agricultural monitoring based on the Internet of Things offers farmers a practical and effective solution to monitor and optimize cro p growth. By collecting and analyzing information on various environmental factors such as tempera ture, humidity, humidity and light intensity, the sy stem provides farmers with useful information abo ut the health and growth of crops. Through the use of sensors, the system detects problems such as p ests, diseases and malnutrition, allowing farmers t o quickly take action to prevent or reduce the prob lem. The system also enables farmers to benefit fr om various activities such as irrigation and fertiliz ation, saving time and resources while increasing t he yield. Looking to the future, smart farming tech nology has great potential for further development . For example, integrating artificial intelligence an d machine learning algorithms can improve the ac curacy of data analysis,crop growth, and yield prediction. Additionally, aerial monitoring of crop s using drone technology can provide more detailed information about crop health and growth.

FUTURE SCOPE :

According to the recommendations, further resear ch and development is focused on making agricult ural technologies more accessible and affordable f or small farmers without capital to invest in expen sive equipment. Additionally, efforts should be m ade to address privacy and security issues related t o the collection and storage of sensitive agricultur al data. Overall, smart agricultural monitoring bas ed on the Internet of Things has the potential to re volutionize our agriculture and food systems, enab ling more efficient agricultural processes.

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