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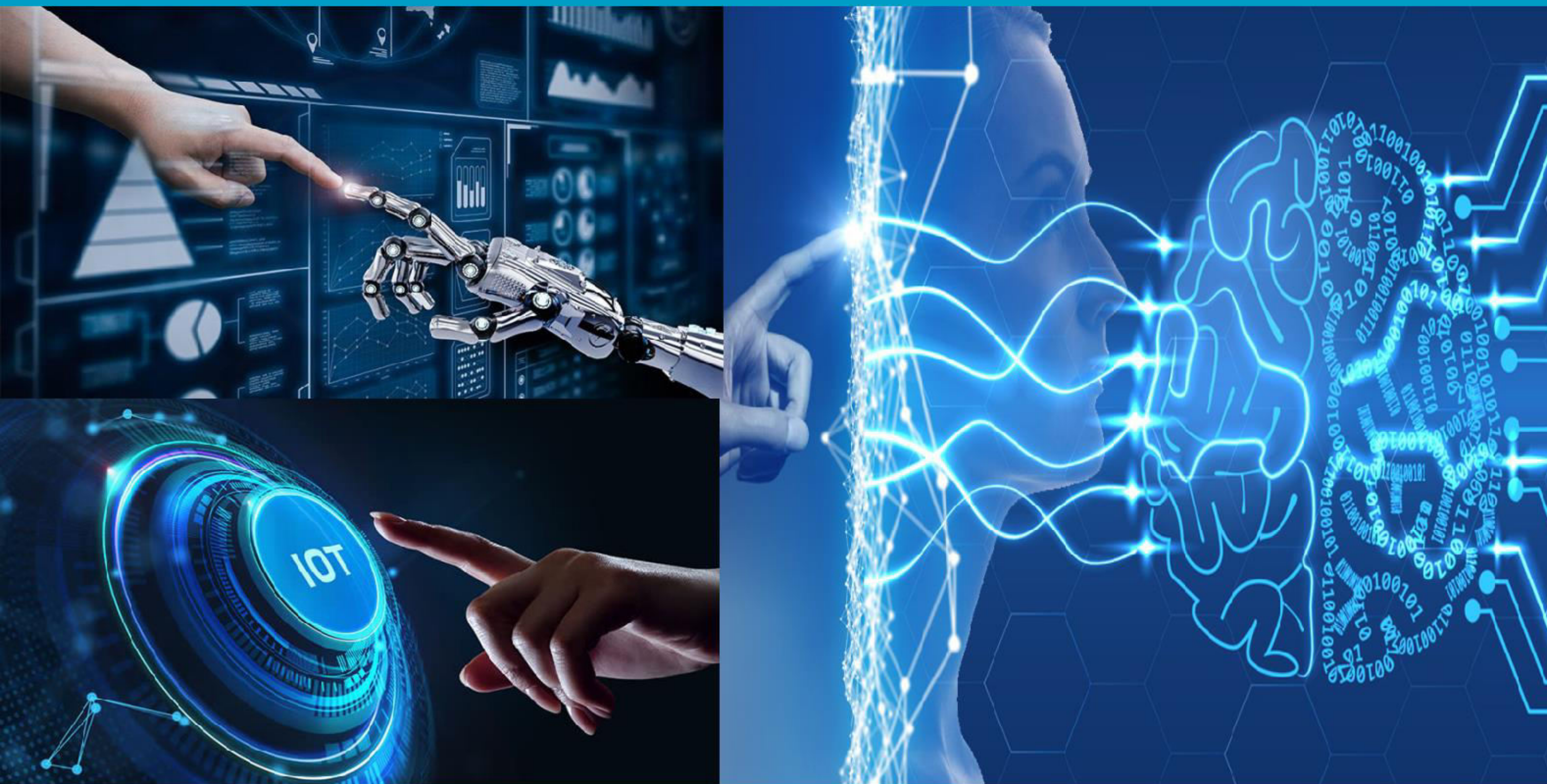

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Automation Irrigation System for Home Garden

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ABSTRACT: Traditional methods of garden watering often involve manual labor, imprecise timing, and a considerable degree of water wastage. These methods are not only inefficient but can also lead to overwatering, which may harm plant health and contribute to water scarcity. This is where smart irrigation systems come into play, addressing several critical needs in modern gardening and landscaping. Smart irrigation systems have revolutionized the way watering the gardens, making it more efficient, convenient, and environmentally friendly. In paper proposes the usage of IOT to design the Automation Irrigation System for Home Gardening.

KEY WORDS: Wireless Sensor Network, Humidity, Watering, IOT, Garden

I. INTRODUCTION

Agriculture is the backbone of Indian economy. It is the major source of food production to the growing demand of human population. Also, agriculture is graphically the broad- est economic sector and contributes more towards the GDP of the country.

Irrigation forms an important part in agriculture that influences crop production. Farmers mostly depend on rainfall for water supply for irrigation purposes. When rainfall is scarce, they make use of available water resource storing at their fields. Some farmers switch on the pump overnight and do not switch it off even after gets sufficient water, which leads to wastage of water. Also, farmers need to visit their fields periodically to check if the required amount of water is being supplied. This is a time-consuming process especially if a farmer need stoirrigate multiple fields located in different areas.

Society is based on agriculture, which is also essential to maintaining global economies and guaranteeing food security. A growing need for food, changing climatic trends, and resource limits call for creative solutions that improve the sustainability and efficiency of agricultural processes. Integrating Wireless Sensor Networks (WSN) with Automated Irrigation Systems(AIS)is one such approach that is gaining popularity.

Traditional irrigation techniques frequently depend on preset timetables or manual evaluations, which can lead to excessive irrigation, inadequate watering, and poor water use that could harm crop health. The AIS, which provides real-time monitoring and control of environmental elements crucial to crop growth, marks a paradigm leap in precision agriculture. It is powered by the synergy of WSN.

Wireless Sensor Networks provide a dynamic and responsive way to gather data from the agricultural field. They are made up of spatially dispersed sensor nodes. To measure important parameters like humidity, ambient temperature, and soil moisture content, these sensor nodes are positioned strategically. The AIS's brain, a centralized Arduino module.

Receives the data it has gathered via wireless transmission. In order to make wise irrigation decisions, the microcontroller analyzes this data in real-time using sophisticated algorithms and user defined thresholds. Furthermore, WSN's built-in wireless communication capabilities free traditional wired systems from their limitations and provide a scalable, readily deployable alternative. This makes the installation procedure easier and makes it possible to expand the irrigation network to cover more land for agriculture.

II. LITERATURE SURVEY

Since there is no effective technology to help farmers, this chapter summarizes the various publications that have been recommended for automated irrigation and agricultural field design. It is necessary to put new strategies into practice. Following the formulation of the project idea, design possibilities were decided upon.

Utilizing ideas from the publication[1], "An Intelligent Irrigation Scheduling System Using Low-Cost Wireless Sensor Network Toward Sustainable and Precision Agriculture", in particular the use of Wireless Sensor Networks (WSNs) for irrigation management, we applied them to our project. The research emphasizes how important WSNs are to real- time control and monitoring, which has a direct impact on how systems are designed. Wireless Sensor Networks(WSNs) are made up of geographically dispersed sensor nodes that wirelessly gather and send data to a central base station. These nodes usually consist of temperature, humidity, and soil moisture sensors when it comes to irrigation. These sensors' real-time data collection allows for accurate soil and environmental condition monitoring, ensuring that irrigation is timed to precisely match crop needs. This data-driven strategy maximizes water use while also improves crop health and yield.

In order to maximize water use in agricultural contexts, [2] Gutiérrezet al.'s research suggests an automated irrigation system that makes use of General Packet Radio Service (GPRS) and Wireless Sensor Networks(WSN).The system's numerous Wireless Sensor Units (WSUs) keep an eye on the temperature and moisture content of the soil to provide accurate watering control. Every Web Support Unit (WSU) has sensors installed at the plant's root zone to collect vital data, which is subsequently sent to a Web Information Unit(WIU) for instantaneous analysis and decision-making. In order to ensure that water is only utilized when necessary, the WIU synchronizes data from all WSUs and turns on irrigation depending on predetermined moisture and temperature criteria. Every hour, the gathered data is upload ed to a web server, enabling monitoring and supervision from a distance using an intuitive graphical user interface.

In order to effectively manage water flow in agricultural fields, the project of Mallikarathne et al. [3] offers a smart irrigation system that combines Wireless Sensor Networks (WSN) and Internet of Things(IoT) technologies. This method introduces technical innovations for farming activities in an attempt to alleviate the underdevelopment in Sri Lanka's agriculture sector. It has an effective drip irrigation system that automatically modifies water flow according to the current moisture content of the soil. The system uses a number of sensors to continuously monitor field conditions, including as sensors for temperature, humidity, and soilmoisture. Through IoT-based communication capabilities, thesesen- sors are remotely connected to a central system via radio transmitters, enabling remote irrigation monitoring and administration.

The AREThOU5A IoT platform [4], which integrates cutting-edge technology to revolutionize conventional irrigation techniques, marks a substantial development in precision agriculture. In order to optimize water usage in agricultural fields, this platform uses the Internet of Things (IoT) to gather and interpret data from satellite sources and wireless sensor networks(WSNs).It is composed of several subsystems, each of which is essential to the plat form's operation. These subsystems include the measurement, routing, user interface, and server subsystems. Farmers can engage with the system through the user-interface subsystem, the routing subsystem efficiently delivers data to the server, the measurement subsystem uses sensors to collect data, and the server subsystem processes, saves, and analyzes the data to provide insights that can be put to use.

In addition, the AREThOU5A[4] plat form uses cloud computing to process and monitor data in real-time, allowing for prompt decision-making depending on crop irrigation requirements. Scalability is supported by the cloud-based system, which can manage numerous sensor nodes and massive amounts of data from vast agricultural regions. In order to estimate irrigation needs, machine learning algorithms evaluate the gathered data. They take into account crop types, weather patterns, and soil moisture levels to establish the best irrigation schedules. This accurate and effective approach to water management reduces water waste and guarantees crops get the right amount of water for healthy growth.

In order to address the requirement for effective water management in urban areas, the document [5] "SWAP: Smart Water Protocol for the Irrigation of Urban Gardens in Smart Cities" offers a comprehensive solution for smart irrigation systems within the frame work of smart cities. SWAP is a protocol that makes it easier for devices to communicate with each other when utilizing WiFi and LoR a wireless technologies. This is particularly useful in urban gardens, where there can be obstacles due to different wireless environments. The suggested architecture consists of actuators, gateways, aggregators for environment monitoring, cluster heads, soil monitoring nodes, and actuators that cooperate to guarantee ideal irrigation. Soil monitoring nodes gather information on pH, temperature, and humidity of the soil and send it over WiFi to cluster heads. The cluster heads use LoRa to connect to the environment monitoring aggregators over greater distances. These aggregators gather additional environmental data such as air temperature and humidity, which is then sent to the data center for analysis and storage, enabling real-time monitoring and decision-making for irrigation needs.

The [5] study highlights the value of employing smart water management technology in addition to architecture to save water usage and improve urban green spaces. Through the integration of many sensor types and the use of WiFi and LoRa in tandem for data transmission, the SWAP protocol is able to minimize packet loss and provide dependable network communication. Through experiments using inexpensive devices in urban environments, the study shows the protocol's efficacy and highlights its potential for widespread use in smart city initiatives. Moreover, the protocol's architecture takes into account the particular difficulties presented by metropolitan settings, including network interference from various sources and the accessibility of electricity and internet infra-structure.

III. SYSTEM OVERVIEW

The system overview section provides a comprehensive understanding of the automated irrigation system, detailing its components, functionalities, and overall architecture. This section serves to lay the foundation for the subsequent chapters by describing the system's design, implementation methodology, and key technological aspects.

3.1 BLOCK DIAGRAM

The automated irrigation system offers a productive and long-lasting precision agriculture solution by leveraging Wireless Sensor Networks(WSNs) and cloud connectivity. Figure 3.1 The system architecture is built to efficiently manage water distribution, make educated irrigation decisions, and continuously monitor environmental conditions. The parts of the system and how they interact, as shown in the provided figure, are described in depth below.

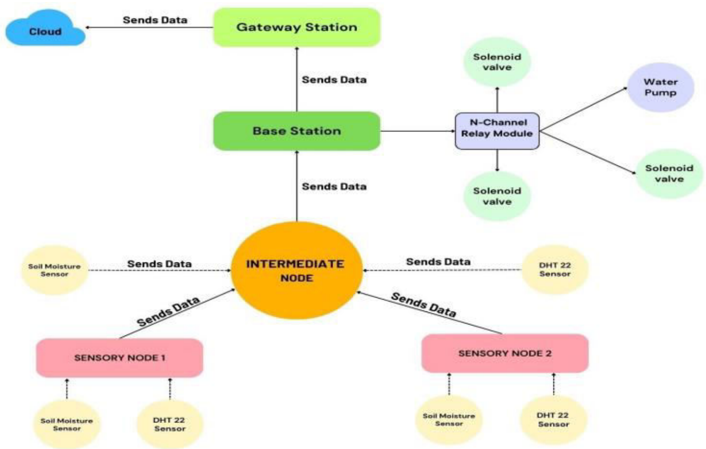

Figure 3.1:Block Diagram of Automated Irrigation System

3.2 SYSTEM COMPONENTS

The automated irrigation system comprises several key components, each playing a crucial role in its functionality:

Sensory Nodes

- ***Components****: Each sensory node includes as oil moisture sensor and a DHT22 sensor (for temperature and humidity).*
- **Function**: Sensory nodes collect real-time data on soil moisture and atmospheric conditions. This data is crucial for determining when and how much water should be applied.
- **Data Transmission**: The sensory nodes send collected data to the intermediate node.

Intermediate Node

- **Function**: Acts as a local hub that aggregates data from multiple sensory nodes. It processes this data and forwards it to the base station.
- **Data Management**: Ensures efficient data flow and preliminary processing to reduce the load on the base station.

Base Station

- **Function**: Receives data from the intermediate node and acts as a central control unit.
- **Data Processing**: Analyzes the aggregated data to make irrigation decisions. Itdeter- mines the activation of solenoid valves and the water pump based on the moisture levels and environmental conditions.
- **Relay Control**: Sends signals to the N-Channel Relay Module to control the solenoid valves and water pump.

N-Channel Relay Module

- **Components**: Includes multiple relays to control water pump and various solenoid valves.
- **Function**: Receives control signals from the base station to turn the solenoid valves and water pump on or off, there by managing water flow to different parts of the field.

Water Pump

- **Function**: Pumps water from the source to the irrigation system. Its operation is con-trolled by there lay module to ensure water is delivered efficiently when needed.

Gateway Station

- **Function**: Acts as a bridge between the base station and the cloud. It sends the processed data from the base station to the cloud for storage and further analysis.
- **Cloud Connectivity**: Ensures that data is available remotely, enabling farmers to monitor the irrigation system from anywhere.

Cloud

- **Function**: Stores the data sent from the gateway station and provides a platform for data analysis and remote access.
- **Data Access**: Allows farmers to view real-time and historical data on soil moisture and environmental conditions, making it easier to manage the irrigation system effectively.

3.3 FIGURE EXPLANATION

The provided diagram illustrates the flow of data and control signals with in the system:

- Sensory Nodes collects oil moisture and environmental data and send it to the Intermediate Node.
- The Intermediate Node aggregates and for wards this data to the Base Station.
- The Base Station processes the data and sends control signals to the N-Channel Relay Module.
- The N-Channel Relay Module operates the Solenoid Valves and the Water Pump based on the received signals.
- Data from the Base Station is also sent to the Gateway Station, which uploads it to the Cloud for remote access and monitoring.

This system ensures efficient and precise irrigation by continuously monitoring environmental conditions and making real-time adjustments.

3.4 EVALUATION ASPECTS

- **System Accuracy:** The precision of soil moisture, temperature, and humidity readings.
- **Water Usage Efficiency:** The amount of water used per irrigation cycle in com parison to traditional methods.
- **Reliability:** The consistency of the system's performance over an extended period.

These aspects are critical in determining the effectiveness and efficiency of the automated irrigation system. Accurate data readings ensure the correct amount of water is applied, while quick response times and high reliability are essential for real-time applications. Water usage efficiency directly impacts the sustainability of agricultural practices.

3.5 COMPARISON CASES

- **Different Sensor Types:** Performance metrics of various oil moisture and environmental sensors.
- **Different Irrigation Schedules:** Comparison of crop health and water usage under different irrigation scheduling algorithms.

3.6 PERFORMANCE METRICS

- Accuracy: Measured as the deviation of sensor readings from reference values.
- Water Usage: Total volume of water used per irrigation cycle.

3.7 EXPERIMENTAL SET UP

A. *Parameters Under Study:*

- Soil moisture levels
- Environmental temperature and humidity
- Water usage per irrigation cycle

B. *Setup Details:*

- Soil moisture sensors and DHT22 sensors were placed at various points in the field.
- Data was collected at interval sof 10 minutes and transmitted to the intermediate node.
- Irrigation cycles were activated based on predefined soil moisture thresholds.

1. **First parameter (Soil Moisture):** Range 10%-60%, chosen to cover dry to optimal moisture levels.
2. **Second parameter (Temperature):** Range 10°C-40°C, reflecting the typical temperature range in the testing environment.

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3.8 SNAPSHOTS

The results are presented as graphs, which are fully explained to identify trends in the data. Figures 3.2 to 3.7 illustrate data trends captured on the Thing Speak cloud plat form. Trends in the data are found and explained in the graphs. What the system is supposed to establish is supported by the data. The trends that have been seen indicate that automated irrigation efficiently uses less water while preserving ideal soil moisture levels. If the results could not be explained, more research into ambient conditions and sensor calibration was advised. The system's ability to improve water use efficiency and support sustainable agriculture practices is demonstrated by this thorough analysis.

Figure 3.2:Soil Moisture Levels Over Time(Node1)

Figure 3.3:Soil Moisture Levels Over Time(Node2)

Figure 3.4:Humidity Levels Over Time(Node1)

Figure3.5:Humidity Levels Over Time(Node2)

Figure 3.6:Temperature Levels Over Time(Node1)

Figure 3.7:Temperature Levels Over Time(Node2)

IV. CONCLUSION

A major achievement in precision agriculture is the creation of an automated irrigation system that make suse of Wireless Sensor Networks(WSNs) and cloud connectivity. This system successfully blends cutting-edge technology with conventional farming methods to produce a solution that boosts crop health, increases water use efficiency, and encourages sustainable agricultural practices.

A strong framework designed for intelligent water management by using the ESP32 microcontroller, which processes real-time data from soil moisture sensors and regulates irrigation through relays. WSNs' real-time data collection enables ongoing soil condition monitoring, guaranteeing that water is provided exactly when and where it is needed. This method guarantees that crops get the right amount of moisture while also conserving water, which results in higher yields and healthier plants.

By allowing remote monitoring and control, the incorporation of cloud connectivity significantly expands the possibilities of the system. It is now easier for farmers to respond to changing conditions and make well-informed decisions because they can access data and manage their irrigation systems from any location. Large or isolated agricultural areas where manual monitoring and management would be prohibitive would benefit greatly from this capability.

The benefits of incorporating WSNs and IoT technologies into agricultural systems are illustrated by experiment. It demonstrates show intelligent irrigation systems may cut expenses, dramatically minimize water use, and boost agricultural yield. This system is appropriate for a wide range of agricultural applications, from small family farms to large commercial enterprises, due to its adaptability and scalability.

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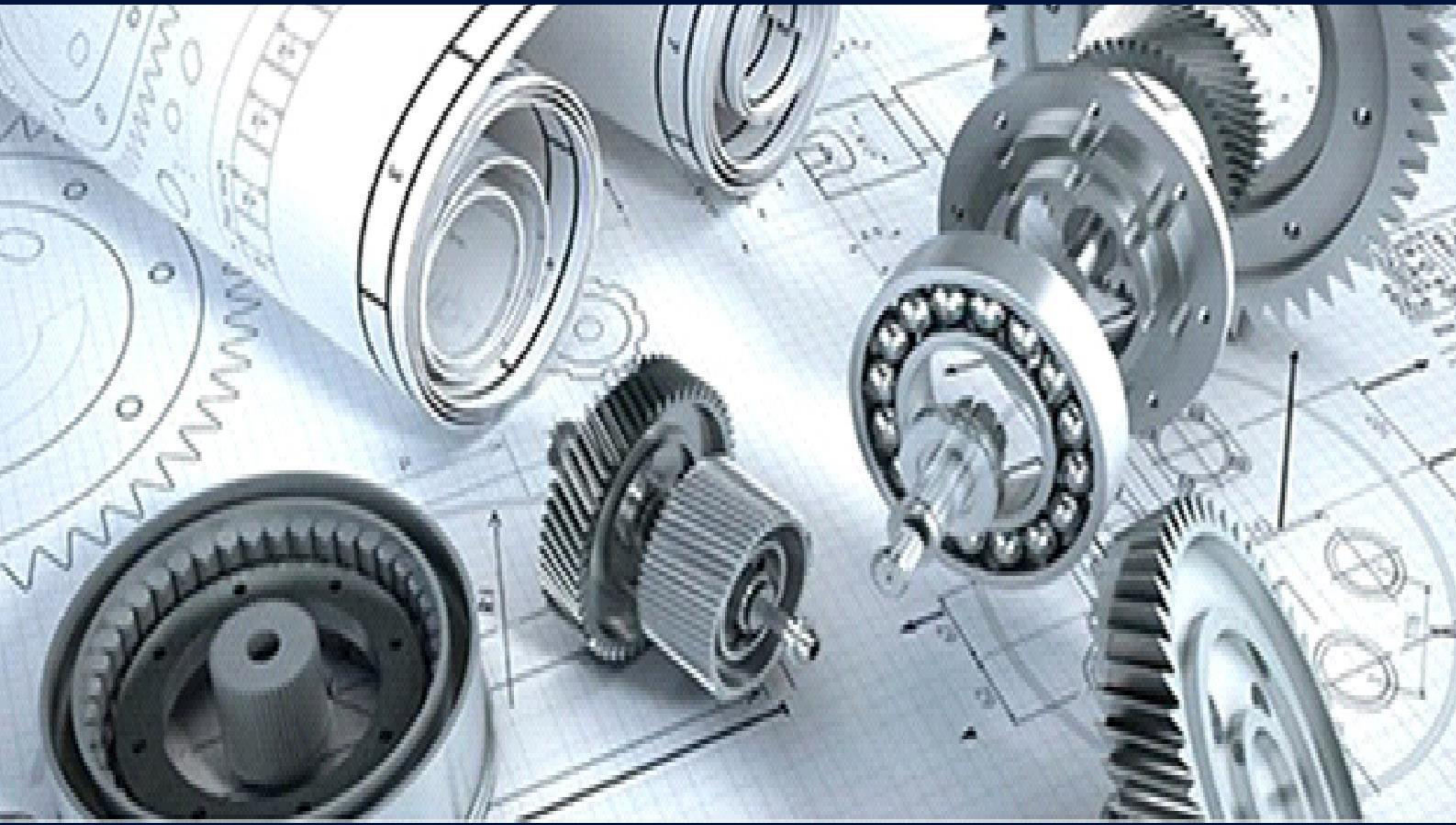

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