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IoT- Based Smart Agriculture Using Solar Energy

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A B S T R A C T

IoT (Internet of Things) based smart agriculture refers to the use of advanced technologies such as sensors, data analytics, and automation in agriculture to improve crop yields, reduce costs, and increase efficiency. This approach involves collecting and analyzing data on various factors such as soil moisture, temperature, humidity, and plant growth, and then using this information to optimize farming processes. Smart agriculture systems also provide real-time alerts and recommendations to farmers, enabling them to make informed decisions about irrigation, fertilization, and pest management. By leveraging the power of IoT, smart agriculture has the potential to transform the farming industry, making it more sustainable, productive, and profitable

Keywords: IoT (Internet of Things), Smart Agriculture (SA), Wireless Sensor Networks (WSN's), Information Communication Technology (ICT).

1. Introduction.

IoT based smart agriculture is a revolutionary approach to farming that utilizes the power of technology to optimize the agricultural process. The traditional method of farming relied heavily on manual labor and traditional techniques that were often time-consuming and inefficient. With the introduction of IoT, agriculture is transformed into a modern, data-driven industry that maximizes yields, reduces costs, and conserves resources. IoT based smart agriculture involves the use of sensors, drones, and other advanced technologies to collect and analyze data on various factors that affect crop growth, such as soil moisture, temperature, and humidity. This data is then processed using analytics tools to provide farmers with real-time insights and recommendations, enabling them to make informed decisions about irrigation, fertilization, and pest management.

Smart agriculture has the potential to revolutionize the farming industry by making it more sustainable, productive, and profitable. By optimizing the use of resources such as water and fertilizer, farmers can reduce waste and minimize environmental impact. Additionally, IoT-based smart agriculture can help increase crop yields and improve the quality of produce, leading to increased profits for farmers. Overall, IoT-based smart agriculture represents a major shift in the way agriculture is practiced, and has the potential to help farmers meet the growing demand for food while minimizing the impact on the environment.

1.1. Background

A. WIRELESS SENSOR NETWORKS.

Wireless sensor networks (WSNs) are a key component of IoT-based smart agriculture. They consist of a large number of small, low-cost sensors that are distributed throughout a farm and wirelessly connected to a central server or cloud-based platform. These sensors can measure various environmental parameters such as temperature, humidity, soil moisture, and sunlight, as well as track the location of livestock or machinery. WSNs enable real- time monitoring of the agricultural environment and provide farmers with a wealth of data that can be used to make informed decisions about crop management. For example, by monitoring soil moisture levels, farmers can determine the optimal time to irrigate their crops and minimize water usage. Similarly, by tracking the location of livestock, farmers can ensure that their animals are grazing in the right areas and avoid overgrazing. WSNs also enable precision agriculture, which involves the use of data analytics and automation to optimize crop yields and reduce costs. By analyzing data collected from WSNs, farmers can identify areas of their farm that require attention and target resources such as fertilizer or pesticides more effectively. This can help reduce waste and increase crop yields, resulting in greater profitability for farmers. Overall, wireless sensor networks are an essential component of IoT-based smart agriculture, providing farmers with real-time data that enables them to make more informed decisions and optimize their operations.

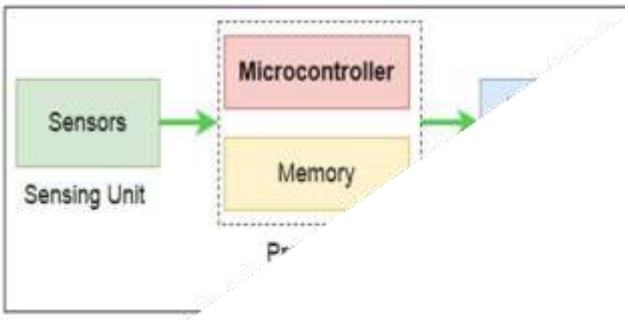

FIG 1. General architecture of a wireless sensor node.

B. INTERNET OF THINGS (IoT)

The Internet of Things (IoT) refers to a network of physical devices, vehicles, buildings, and other objects that are embedded with sensors, software, and network connectivity, allowing them to collect and exchange data with each other and with other systems over the internet. IoT enables these devices to communicate and interact with each other, creating a network of interconnected "things" that can be remotely monitored, controlled, and managed. This network can be used to collect and analyze data from various sources, such as sensors and cameras, in real-time, providing insights and enabling decision-making in a range of industries, including agriculture, healthcare, transportation, and manufacturing. In agriculture, for example, IoT can be used to monitor and manage crop growth, soil conditions, and water usage. Connected sensors can collect data on factors such as temperature, humidity, and moisture levels, which can be used to optimize irrigation and fertilization, resulting in improved crop yields and reduced waste. Similarly, in healthcare, IoT can be used to remotely monitor patients and provide personalized care, while in transportation, IoT can be used to optimize vehicle performance and reduce fuel consumption. Overall, IoT has the potential to transform various industries by enabling greater efficiency, automation, and optimization through the collection and analysis of real-time data.

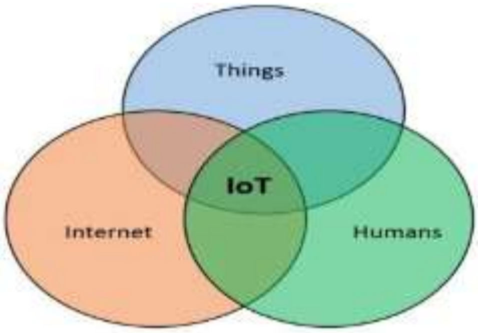

FIG 2. Tri- sectional relationship between three components of IoT

C. IoT IN SMART AGRICULTURE

The Internet of Things (IoT) is increasingly being adopted in smart agriculture to enhance crop production, reduce costs, and conserve resources. IoT devices, such as sensors, drones, and automated equipment, can collect and analyze data on various factors such as soil moisture, temperature, humidity, and plant growth, enabling farmers to make informed decisions about irrigation, fertilization, and pest management. Here are some examples of how IoT is used in smart agriculture

1. Soil monitoring: IoT sensors can be used to monitor soil moisture, temperature, and nutrient levels. This data can be used to optimize fertilizer application and irrigation, resulting in more efficient use of resources and improved crop yields.

2. Crop monitoring: IoT devices such as drones can be used to monitor crop growth and identify potential issues such as disease or nutrient deficiencies. This can help farmers take proactive steps to address these issues, resulting in improved crop quality and yield.

3. Livestock management: IoT sensors can be used to monitor the health and location of livestock. This can help farmers detect early signs of illness and prevent disease outbreaks. Additionally, IoT devices can help farmers optimize feed and water usage, resulting in reduced costs and improved animal health.

4. Weather monitoring: IoT weather stations can be used to monitor temperature, humidity, and other weather conditions. This data can be used to predict weather patterns and optimize crop planting and harvesting schedules.

Overall, IoT has the potential to transform the agriculture industry by enabling farmers to make data-driven decisions, optimize resource usage, and improve crop yields and quality.

2. SYSTEM DESIGN AND ARCHITECTURE.

Our proposed system consists of several main elements.

1. Data Acquisition: It is a Wireless Sensor Network that senses the environment data and sends it to the gateway.[1]
2. Wireless Actuator Network (WAN): It consists of actuators carrying out decisions issued by the BDAP by switching on /off the water pumps and the lighting bulbs.[1]
3. Renewable Energy: These are solar panels that constitute the renewable power source for the farm and battery.[1]
4. Storage Unit: The element responsible for storing extra electrical energy produced by the solar panels and reusing it when needed to operate the water pumps and lighting. It consists of a Lithium battery.[1]
5. Control Unit: It decides whether to forward the produced electricity to the Smart Farm or store it in the batteries for future use.[1]

The proposed system architecture includes a monitoring system, NodeMCU, GSM module, controller, battery, solar panels, soil moisture sensor, temperature sensor and humidity sensor. The sensors are used to collect data on soil moisture content, air temperature and humidity. The NodeMCU is used to wirelessly transmit the data collected by the sensors to the controller. The GSM module is used to send alerts and notifications to the user's mobile phone in case of any issues with the system. The controller processes the data received from the sensors and sends commands to the actuator modules based on pre-defined rules. The battery and solar panels are used to power the system. Additionally, the system can be used to detect changes in the environment over time. The data collected by the system can be used to inform decisions about land use and management practices. This type of system can be used for smart agriculture applications such as irrigation control. Below given FIG.3 is the overall system architecture

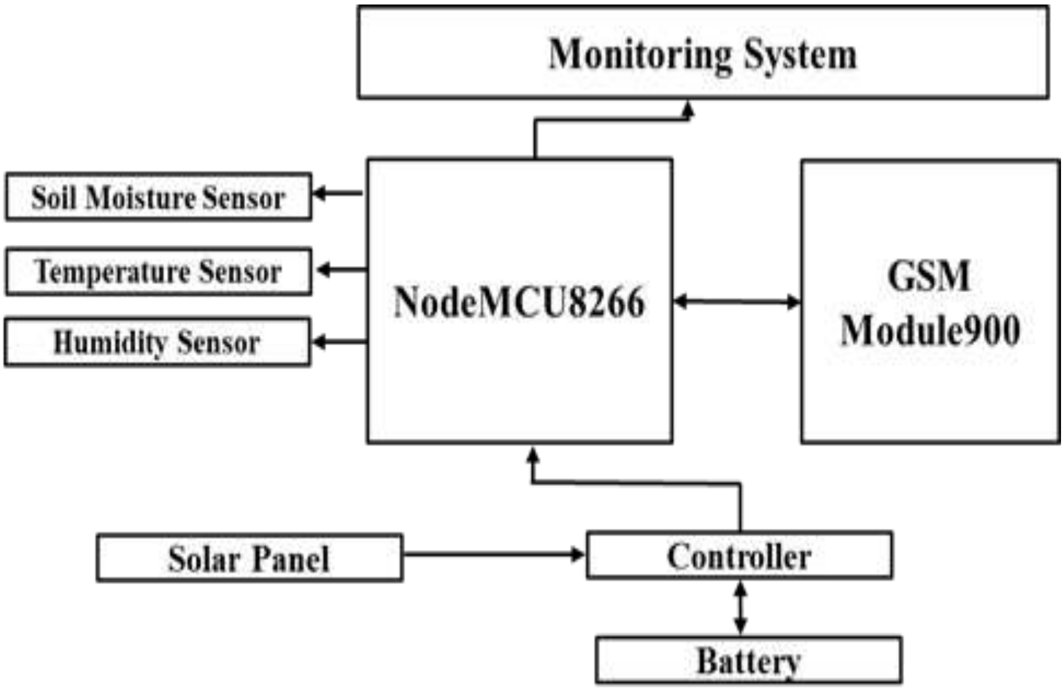

FIG.3 System Architecture.

2.1 USER CASE DIAGRAM.

A use case diagram is a visual representation of the interactions between users and a system. In this case, the system is a greenhouse or smart farming system that includes app control, soil moisture, humidity, and temperature control. The diagram would show the different actors or users involved in the system, such as farmers or greenhouse managers, and the different use cases or actions they can perform with the system. These might include monitoring soil conditions like moisture and temperature controlling those conditions, adjusting water levels based on soil moisture and air humidity levels designing low-cost capacitive-based soil moisture sensors and monitoring various factors that affect soil moisture performance. The use case diagram would help to clarify how these different components interact with each other within the larger system.

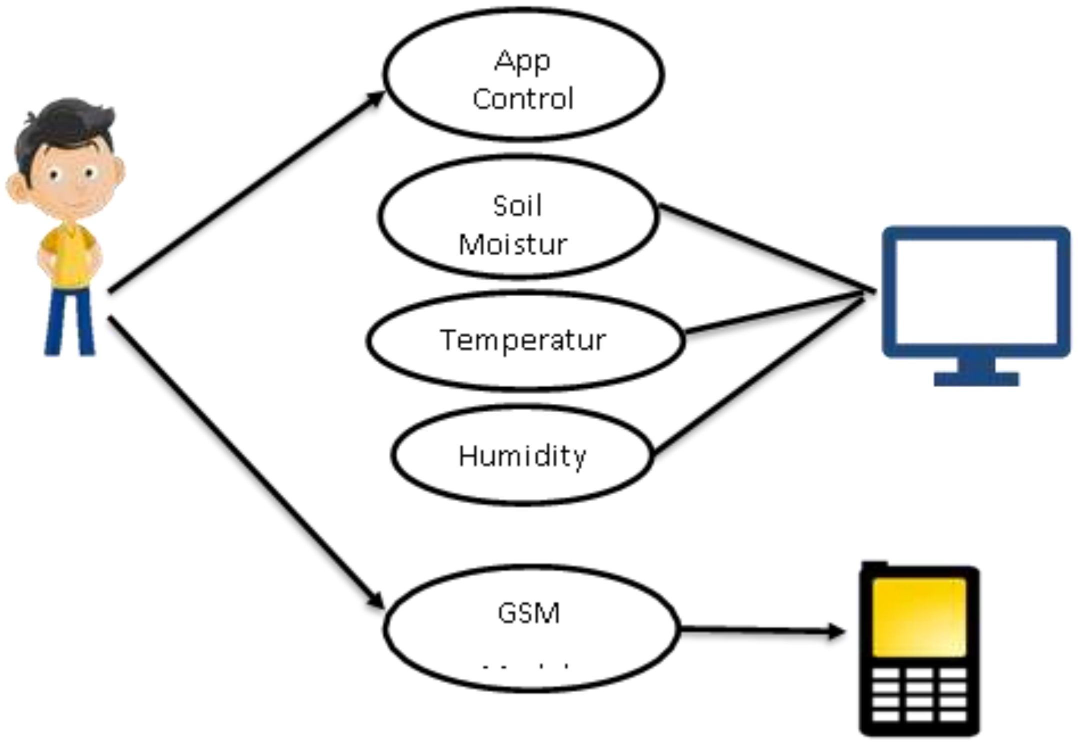

FIG.4 User case diagram

3. RESULTS AND DISCUSSIONS

The proposed IoT-based smart agriculture system includes a GSM module, control unit, NodeMCU8266, soil moisture sensor, humidity sensor, and temperature sensor. The system aims to provide assistance to farmers in getting live data for efficient environment monitoring which will enable them to increase their overall yield and quality of products. The system consists of a DHT11 sensor, moisture sensor. When the IoT-based agriculture monitoring system starts, it checks the soil moisture, temperature, and humidity. Rain alarm and soil moisture detector circuit can also be helpful in building Smart Agriculture Monitoring System. The set up uses the temperature sensor, moisture sensor and humidity sensor which measure the approximate temperature, moisture and humidity in plants. The researchers propose an IoT-based smart water quality monitoring system that uses sensors to monitor common water-quality parameters such as pH level and turbidity. The data is transferred to a cloud server using a SIM900 GPRS/GSM shield. In conclusion, the proposed IoT-based smart agriculture system aims to provide farmers with live data on temperature, soil moisture content among other factors for efficient environment monitoring. The system consists of various sensors that measure different parameters such as temperature and humidity. The data collected is then transferred to a cloud server for analysis.

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