IoT-Based Smart Farming System

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Abstract—The practice of agriculture dates back to 1200 BC during the Neolithic age, which marked the beginning of civilization. Since then, farming has continued to evolve and remain a vital aspect of society, particularly in India, where agriculture plays a significant role in the economy. Indian farming practices heavily rely on factors such as rainfall, soil quality, moisture levels, and environmental conditions. To improve productivity and yield, farmers in India have started adopting state-of-the-art technologies. One such technology is the Internet of Things (IoT) system, which has shown success in various fields. It is now time for Indian farmers to embrace Smart Agricultural systems to increase crop yields. By collecting data from sensors, selectors, and modern digital devices, farmers can monitor their agricultural fields' conditions. Smart Agriculture systems can analyze rainfall data, switch on pump motors, and monitor soil moisture levels using sensors that are connected to an Arduino-UNO module. With the help of networking technology, the Smart Agriculture system can be accessed and operated from anywhere, enabling farmers to monitor their fields remotely. By adopting these advanced technologies, Indian farmers can improve their productivity and achieve higher crop yields. This will not only benefit the farmers but also contribute to the country's economy as a whole.
Keywords: IoT, Sensors, Submersible Motor, Microcontroller, Effects to Consider Before Developing Your Smart Farming Solution.

I. INTRODUCTION

The utilization of smart farming techniques such as Precision Agriculture, efficient water management, and monitoring of soil moisture and humidity levels can greatly enhance the deteriorating standards of the agricultural sector. Precision Agriculture techniques prevent wasteful and unnecessary use of fertilizers and pesticides, enabling farmers to optimize the utilization of their land's unique features.

At a time when India's water tables are rapidly declining due to unprecedented demand from the agricultural and industrial sectors, Precision Farming can be a game-changer. However, many farmers still resist adopting modern practices, and delayed implementation can impede progress and hinder GDP growth in India.

During the Covid-19 pandemic, many migrants returned to their hometowns in India and chose farming as their career. These settlers can now explore Smart Agriculture systems, which take less time to adopt than traditional farming practices, enabling them to quickly reap the benefits of modern farming technologies. By embracing these innovations, farmers can increase their crop yields and enhance the overall productivity of the agricultural sector in India.

II. PROPOSED SMART FARMING SYSTEM METHODOLOGY

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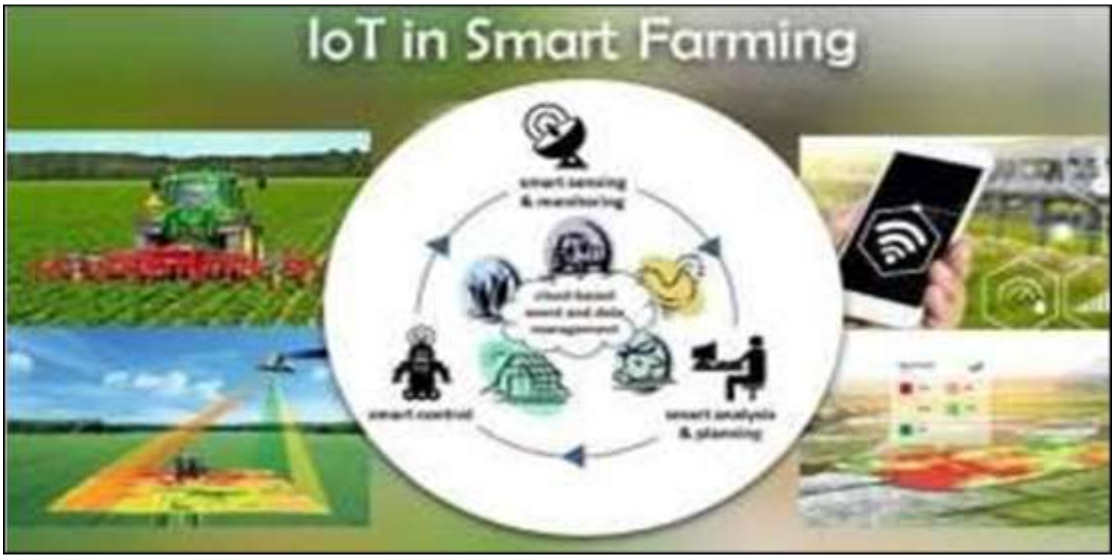
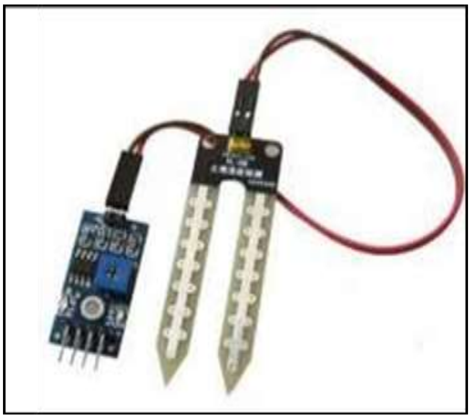


The proposed device utilizes a nodemcu microcontroller equipped with a Wi-Fi module (ESP8266) and a smartphone as the user interface. The system includes a soil moisture sensor, a humidity and temperature sensor (DHT11), a rain sensor, and a submersible motor that drives a water pump to irrigate the crops. The nodemcu uses the data from these sensors to determine the moisture content in the soil, the humidity and temperature of the environment, and the rainfall. Based on this data, the nodemcu decides whether or not to water the crops. The device uses tentative statements in the nodemcu programming to control the DC motor that drives the water pump. The humidity and temperature sensor provides the necessary data to determine whether the crops are suitable for growth, as some crops require specific rainfall conditions and temperature ranges.
The raindrop sensor measures the depth of the rainfall, and if it is sufficient, the crops are not irrigated. If there is not enough rainfall, the nodemcu turns the DC motor on to pump water to the crops. The data from the sensors is sent to the Blynk cloud through the Wi-Fi module on the nodemcu. The user can access this data through the Blynk app on their smartphone, which displays the humidity, temperature, and soil moisture levels and provides notifications for rainfall and the status of the DC motor. The farmer can control various buttons and switches through the app, which sends commands to the nodemcu to control the DC motor. The data is sent back to the Blynk cloud through Wi-Fi. This system provides a smart and efficient way to irrigate crops, utilizing modern technology to improve yields and productivity.

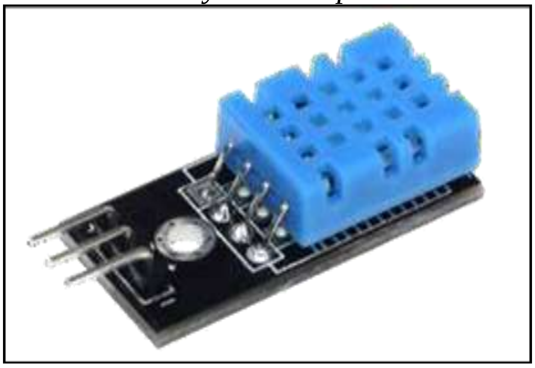
I. SENSOR:

A. *Soil Moisture Sensor*



A soil humidity detector is a detector that senses the moisture content of the soil. The sensor has both analogue and virtual affairs. The virtual affair is constant, and the analogue output threshold may be colourful. It works on the principle of open and short circuits. The output is excessive or low indicated through the LED. When the soil is dry, the current will not pass through it and so it'll act as an open circuit. For this reason, the affair is stated to be maximum. When the soil is wet, the current will pass from one terminal to the other and the circuit is said to be short, and the affair will be zero. The sensor is platinum carpeted to make the performance high. The range of sensing is also high. It is anti-rust and so the sensor has a long life which will afford the farmer at a minimum cost.

B. *Humidity and Temperature Sensor (DHT11)*

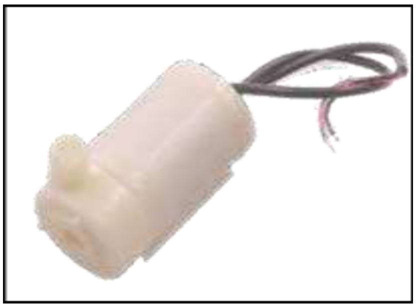


The humidity and temperature sensor (DHT11) illustrated in the figure is composed of a thermistor, a humidity sensing element, and an IC. The thermistor calculates the temperature of its surrounding environment by changing its resistance based on temperature variations. The moisture-sensing component contains a moisture-holding substrate located between two electrodes. The change in moisture content produces a change in resistance between the electrodes. The IC measures and interprets this resistance variation to provide the humidity value to the nodemcu. The sensor can operate within a voltage range of 3.3V to 5V, and has a temperature range of 0 - 50°C and humidity range of 20 - 90% RH. This detector is very useful for monitoring the temperature and humidity levels in smart agriculture systems.

C. *Raindrop Sensor*

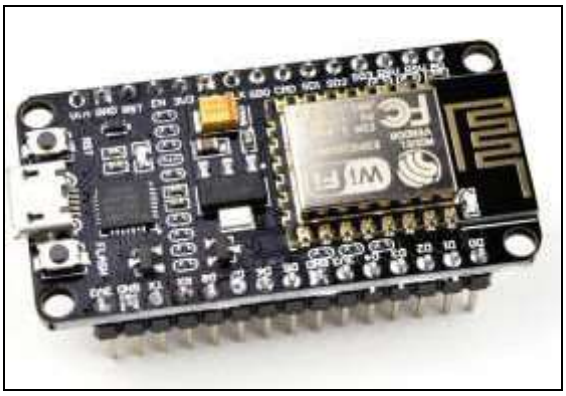
The raindrop sensor, as depicted in the diagram, works by connecting the nickel lines in parallel when drops fall on them, reducing the resistance and voltage drop across the lines. This is possible because water is a good conductor of electricity. When the voltage drop falls below a certain threshold, it indicates that it is raining. The sensor includes a rain board, control board, power indicator LED, and potentiometer for adjustable sensitivity. It operates at 5V and can detect resistance within the range of 100kohm to 2mohm.

II. SUBMERSIBLE MOTOR



The motor in the given figure is a DC motor that converts electrical energy into mechanical energy. It works on the principle of the Lorentz force. The direction of rotation of the motor depends on the polarity of the voltage applied to its terminals. The submersible motor can rotate in both clockwise and counterclockwise directions. The DC motor has a voltage range of 3-9V and has a speed of 3000 RPM.

III. MICROCONTROLLER



The Nodemcu is an open-source IoT platform that uses firmware running on the ESP8266 Wi-Fi module. Programming can be done using the C/C++ language or Lua script in the Arduino IDE. It has sixteen GPIO pins that can be utilized to manage different peripheral units such as sensors, LEDs, switches, and more. These pins can also function as PWM pins. Additionally, the Nodemcu has two UART interfaces and uses the XTOS operating system. It can store up to 4M bytes of data, and its operating voltage is 5V. The Nodemcu utilizes an L106 32-bit processor that runs at a speed of 80-160MHz.

Blynk is another open-source platform designed for IoT, allowing for the remote control of hardware, displaying sensor data, storing data, and visualizing it. The platform comprises a server, an app, and libraries. Whenever data is sent from the Blynk app, it travels to the Blynk Cloud before finding its way to the device. The connection between the app and the device can be through Wi-Fi, Bluetooth, GSM, Ethernet, or other means. The status of hardware pins can be manipulated through the use of widgets present in the Blynk app. An authentication token is generated for each design, serving as a unique identifier connecting the hardware and phone.

Data from the humidity and temperature sensor and raindrop sensor are sent to digital pins on the Nodemcu, while data from the soil moisture sensor is sent to the analog pin. The DC motor is connected to the Nodemcu via a robot, which is connected to two digital pins on the Nodemcu. The serial monitor can display sensor data if serial functions are written in the Lua script and if periodic communication exists between the Nodemcu and the device. The Wi-Fi network name and password, along with the authentication token, are written in the Lua script to connect the hardware to the

Blynk app. After dumping the code into the hardware, the status of crops and soil, along with the DC motor status, can be seen on the phone when connected to Wi-Fi.

IV. EFFECTS TO CONSIDER BEFORE DEVELOPING YOUR SMART FARMING SOLUTION

The potential applications of IoT in agriculture are vast, offering a multitude of benefits to enhance farm productivity and profitability. However, developing IoT applications for agriculture is a complex process and comes with several challenges that need to be addressed. It is important to be aware of these challenges before investing in smart farming.

A. *The Hardware*

To develop an IoT solution for agriculture, it is important to carefully select the sensors for your device, or even design custom sensors if needed. The choice of sensors will depend on the specific data you want to collect and the overall purpose of your solution. However, the quality of the sensors is crucial to the success of your product, as it will determine the accuracy and reliability of the collected data

B. *The Brain*

Data analytics is a crucial component of any successful smart agriculture solution. Simply collecting data is not enough; it must be analyzed and interpreted to be of any value. To achieve this, it is essential to have robust data analytics capabilities and employ predictive algorithms and machine learning techniques to extract meaningful insights from the collected data.

C. *The Maintenance*

Maintenance of hardware is a crucial challenge in IoT products for agriculture, as the sensors are often deployed in the field and are susceptible to damage. Thus, it is important to ensure that the hardware is durable and easy to maintain. Otherwise, frequent replacement of sensors may become necessary, leading to increased costs and reduced efficiency.

D. *The Mobility*

Smart farming operations need to be designed and adapted for use in the field. It is crucial that a farm owner or manager can access the information collected on-site or remotely, using a smartphone or desktop computer. Additionally, each connected device must be self-sufficient and have sufficient wireless range to communicate with other devices and transmit data to the central server. This is important to ensure that the data is accurate, up-to-date and can be analyzed in real-time, enabling farmers to make quick and informed decisions.

E. *The Infrastructure*

To guarantee the performance of your smart agriculture solution and its ability to handle large amounts of data, you need a robust internal architecture. In addition, your internal systems must be secure to prevent any potential security breaches, data theft, or unauthorized access to autonomous tractors.

F. *Connectivity*

Transmitting data between multiple agricultural installations remains a challenge for the implementation of smart farming. The connection between these facilities must be reliable enough to withstand harsh weather conditions and ensure uninterrupted operations. Currently, IoT devices use different connection protocols, but efforts to develop unified standards in this area are underway. The emergence of 5G and technologies such as satellite-based internet may help find a solution to this problem.

G. *Data Collection Frequency*

The optimal frequency of data collection can be a challenge in the agricultural industry due to the diverse types of data involved. Field, livestock, and environmental sensors, as well as machinery and equipment data, and even historical data can be subject to limitations and regulations. The secure and timely delivery and sharing of this data is currently one of the challenges in smart farming.

H. *Data Security in the Agriculture Industry*

Precision agriculture and the implementation of IoT technology involve working with large amounts of data, which increases the potential for security vulnerabilities that can be exploited by cyber attackers. Unfortunately, data security is still a relatively unknown concept in agriculture. For instance, many farms use drones that transmit data to the farm management system. This system connects to the internet but often lacks basic security protections such as strong passwords or remote access authentication. To address these security concerns, it is essential to implement best practices such as monitoring data traffic, using encryption to protect sensitive data, utilizing AI-based security tools to detect suspicious activity in real-time, and leveraging blockchain technology to ensure data integrity. To fully realize the benefits of IoT, farmers must become familiar with data security concepts, establish internal security policies, and adhere to them.

V. Conclusion

In this paper, we propose a technology that enables the analysis of systems used to evaluate soil quality and crop growth. By using these systems, farmers can address issues such as immigration, temperature fluctuations, and humidity imbalances. The sensors used to monitor agricultural parameters and microcontrollers can be easily integrated with each other and with the Internet of Things (IoT) to effectively manage crop growth conditions. This technology is capable of monitoring soil quality, temperature, humidity, and other important factors.

VI. References

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