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RESEARCH PAPER

A sensing approach for automated and real-time crop prediction in the scope of smart farming

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Internet of things (IoT) sensors have the ability to provide information about agricultural fields and subsequently take action based on user input, making smart agriculture an emerging concept. The development of a smart farm system using the advantages of cutting-edge technologies like Arduino, IoT, and wireless sensor networks is proposed in this paper. The goal of the study is to use rapidly developing technology, i.e., IoT and automated smart agriculture, to its advantage. The key to increasing the production of productive crops is to keep an eye on the environment. The main feature of this paper is the creation of a system that can use ESP8266 sensors to track temperature, humidity, moisture, and even the movement of animals that could damage crops in an agricultural field. If any discrepancy is detected, the system can send an short messaging service notification to the farmer's smartphone as well as a notification on the application that was created for the purpose. Through an android application, the system's duplex communication link, which is based on a cellular Internet interface, enables data examination and irrigation scheduling programming. The device has the potential to be helpful in water-scarce, remote places due to its low cost and energy independence.

Keywords: Blynk, predictive analysis, ThingSpeak

Introduction

The Indian economy is heavily reliant on the agricultural sector. Rural households rely on agriculture for over 70% of their income. With almost 60% of the population employed and a 17% gross domestic product contribution, agriculture is a significant component of the Indian economy. The previous few decades have seen a significant expansion in Indian agriculture.

In spite of the agricultural sector's modernization, we still need to develop better agricultural practices to increase crop yield. Crop productivity, soil nutrient content, smart irrigation systems, crop monitoring, and other issues are the main difficulties in agriculture. Improper irrigation management techniques lead to lower food production and less-than-ideal crop yields. Additionally, it is necessary to assist farmers in selecting the best crop to plant.

Using the IoT in agriculture is one strategy to solve these issues. IoT refers to the networking of sensors, network objects, and devices to automate routine processes and take appropriate action based on the environment. The objective of this effort is to examine agricultural improvements in order to automate irrigation and choose the best crop to be sown.

Objectives

The following are the primary objectives of this article:

1. To fully automate the irrigation system while increasing the effectiveness of the current system and minimizing human intervention.
2. To monitor the soil's temperature, moisture, and surrounding's temperature, humidity, and light of a

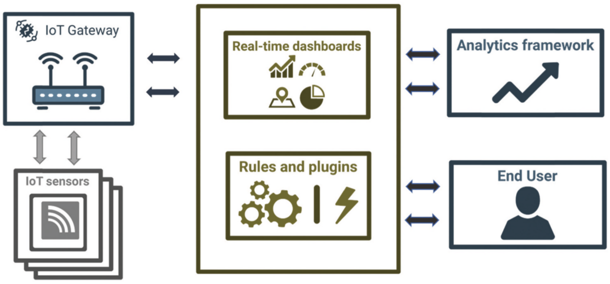


FIGURE 1 | Block diagram.

particular field and predict different types of crops which can be cultivated with the help of field data analysis and comparing/referring with government agriculture stats.

3. To automate required field appliances like water pumps, crop lights, etc. with the help of IoT as well as control them from manual switches with real-time feedback on the mobile app.
4. To protect field crops from animals with the help of radar formation.

Literature review

1. The papers (1, 2, 3) present a survey of recent studies on the Design and Development of Precision Agriculture System Using Wireless Sensor Network and a Survey on Current Challenges and Technological Solutions, as well as real-time irrigation control using remote sensing and control of an irrigation system using a distributed wireless sensor network.
2. In the paper (4), a technology-assisted wireless *in situ* sensor network was created for Southern Finland's river basins to monitor water and agriculture.
3. The focus of the papers (5, 6) is on how the IoT can be used in agriculture to implement smart farming and a cloud-based monitoring system for contemporary ecoagriculture.
4. The report (7) elaborates on opportunities, problems, and open research questions while addressing cybersecurity challenges in smart farming.
5. All of the earlier discussed factors were taken into account, and several technologies, particularly wireless sensor applications and wireless sensor network infrastructure, were emphasized in the papers (2, 8), and (9) (**Figure 1**).

Flow diagram

In **Figure 2**, sensors collect data on parameters like soil temperature, soil moisture, the surrounding temperature, humidity, and light in the field and are sent to the controller, i.e., the NodeMCU ESP8266. Furthermore, this data will be stored in the cloud and will be shared with the ThingSpeak server. Data will be analyzed on multiple parameters in ThingSpeak and real-time results will be visualized on the user end with the help of the data visualization app on their phone. Data will be stored and analyzed for 1–3 years, depending on the time period allowed, and suitable crops will be selected using live, government, and historical data, specifically soil w.r.t surroundings.

After the predicted crop is sown, the farmers receive all of this real-time data on their smartphone, allowing them to remotely monitor their field data. The microprocessor activates/deactivates the motor, lamps, and valves in accordance with sensor data. A farmer can also manually operate the motor and lighting using switches or through a phone app. On the farm, that plant receives a consistent and controlled amount of water (**Figure 2**).

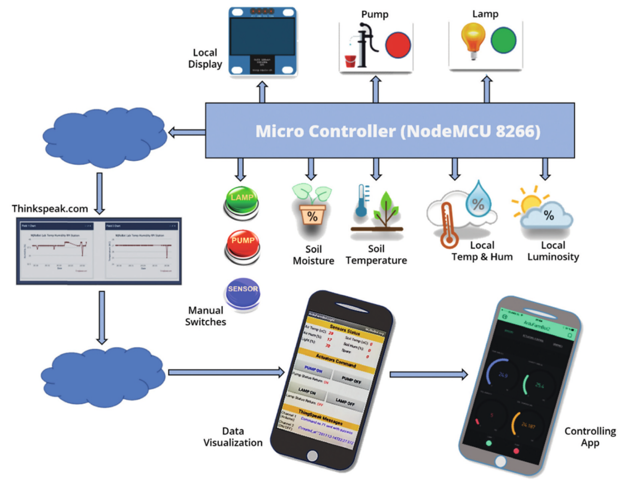


FIGURE 2 | Flow diagram.

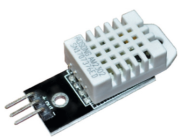
Hardware requirements

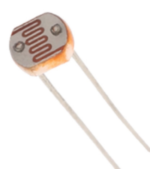
NodeMCU ESP8266: The development board NodeMCU and its open-source Lua-based firmware were created especially for IoT applications. Additionally included are ESP-12-based hardware and firmware that make use of the ESP8266 Wi-Fi SoC from Espressif Systems.

Soil moisture sensor: By measuring the earth's dielectric permittivity, which is a component of the water content, the soil moisture sensor employs capacitance to measure the amount of water present in the soil. Simply insert this powerful sensor into the soil, and the percentage of the soil's volumetric water content will be displayed.

Moisture in the soil: Capacitance is used by the sensor to determine the medium. Water content affects the soil's dielectric permittivity. The sensor determines the soil's water content by comparing the voltage and dielectric permittivity.

Soil temperature sensor: Maxim Integrated makes the DS18B20, a 1-wire programmable temperature sensor. In harsh settings like chemical solutions, mines, or soil, it is frequently employed to gauge temperature. The sensor's enclosure is strong and has the option to be waterproof, which makes installing it simple. With a respectable accuracy of 5°C, it can measure a wide range of temperatures, from −55°C to +125°C. It is a wonderful alternative for capturing temperature readings at several locations without using up a lot of digital pins on the microcontroller because each sensor has a unique address and utilizes only one MCU pin to relay data.





Surrounding temperature and humidity: The basic digital temperature and humidity sensor, DHT22, is quite affordable. It generates a digital signal on the data pin by employing a capacitive humidity sensor and a thermistor to measure the air's humidity. The Honeywell humidity sensor is used to determine whether something is damp. It communicates instrumentation quality relative to humidity execution detection with little effort and a patch- capable single inline package (SIP). Relative dampness is the amount of smoke that is currently being detected everywhere in relation to the total amount of smoke that may be detected everywhere at a given temperature.

Light (LDR): The terms photoresistor and cadmium sulfide (CdS) cell are also used to refer to light-dependent resistors, or LDRs. Another name for it is a photoconductor. It functions essentially as a photocell using the photoconductivity principle. The passive element essentially consists of a resistor, whose resistance value lowers as light intensity increases. This optoelectronic component is mostly employed in switching circuits that are actuated by light and dark, as well as light-varying sensor circuits.

Relay: A transfer is a switch that is operated by electricity. A switch can be accurately operated by a variety of moves using an electromagnet, but alternative working benchmarks are also utilized, such as solid-state moves. Moves are employed when a circuit must be controlled by a different low-control signal or when several circuits must be controlled by a single indication. The fundamental exchanges were utilized as enhancers in long-distance communication networks; they repeated the signal arriving from one circuit and re-transmitted it on a different circuit. In early personal computers and telephone exchanges, moves were typically utilized to carry out steady assignments.

OLED: A light-emitting diode (LED) with an organic compound film as the emissive electroluminescent layer generates light in response to an electric current and is referred to as an organic light-emitting diode (OLED or organic LED), also known as an organic electroluminescent (organic EL) diode.

Switches

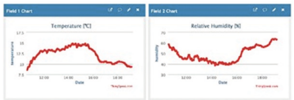
Lamps

Water pump

Software requirements

Arduino IDE: The cross-platform Arduino Integrated Development Environment program was created using C and C++ functions. It is used to create and upload programs to boards that are compatible with Arduino as well as other vendor development boards when third-party cores are used.

ThingsBoard: Using the ThingSpeakTM IoT analytics platform service, you can gather, visualize, and examine realtime data streams in the cloud. Data sent by your devices to ThingSpeak is instantly visualized by ThingSpeak. You can analyze data online as it comes in thanks to ThingSpeak's ability to run MATLAB§code. IoT solutions that require analytics are frequently prototyped and proof of concept using ThingSpeak.



MIT app inventor: A user-friendly, visual programming environment called MIT App Inventor makes it possible for anybody, including kids, to create fully working apps for smartphones and tablets. MIT App Inventor Beginners may launch their first straightforward app in about 30 min. Additionally, our technology is based on blocks. It creates complex, highly effective apps in a lot less time than traditional programming environments.

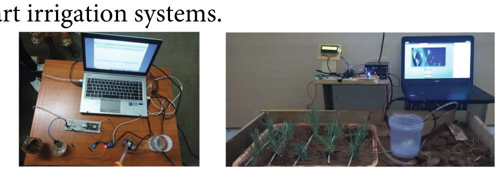
Blynk: Blynk is a platform that allows users to operate devices like Arduino, Raspberry Pi, and others remotely via iOS and Android apps. You may simply drag and drop widgets to create a graphic interface for your project on a digital dashboard. There is no board or shield that Blynk is bound to. Instead, it's your preferred supporting hardware. Blynk will get you online and prepared for the IoT regardless of how your Arduino or Raspberry Pi is connected to the Internet—through Wi-Fi, Ethernet, or this brand-new ESP8266 chip.

Working and results

The system's goal is to assist farmers in making wise selections while anticipating the crops. Along with the live data, historical temperature and humidity data from the government website is also gathered and saved to improve accuracy. The user can obtain a consolidated output and the general status of the field through this link, which enables them to make better decisions. It provides the average of all the readings for a single day. The project evaluates the field's temperature, light, and humidity using real-time data from a DHT-22 sensor and historical data from a government website, as well as the farmer's chosen kind of soil, in order to provide certain and precise crop predictions. It can be done with read-to-use platforms like ThingSpeak, supervised or unsupervised machinelearning techniques, or both. The most accurate result, which will then be presented to the end user through the app, is determined by comparing the accuracy results obtained by ThingSpeak. The method not only suggests the best crop but also the fertilizer for that crop. The reports are available for download in text, Excel, or comma-separated values (CSV) formats for additional analysis.

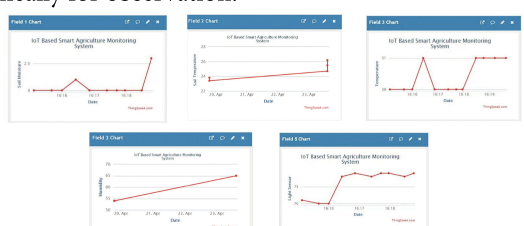
After the predicted crop is planted, the sensor node, which consists of a temperature and soil moisture sensor installed on the field, transmits real-time data to the microcontroller. Most of the time, a moisture/temperature range is prespecified in the datasheet of the module with respect to the surrounding data range, and whenever the actual values depart from this range, the microcontroller quickly turns on the water pump or bulb, which is connected to the output pins. A farmer can also manually use switches or a phone app to regulate lights and motors.

In order to ensure that the pipes are watering the fields uniformly and that no section becomes clogged or is left too dry, the microcontroller is also equipped with a solenoid valve. Through the ThingSpeak and Blynk apps, the end user may keep an eye on the complete system. Farmers can easily monitor and irrigate their farms from a distance thanks to smart irrigation systems.

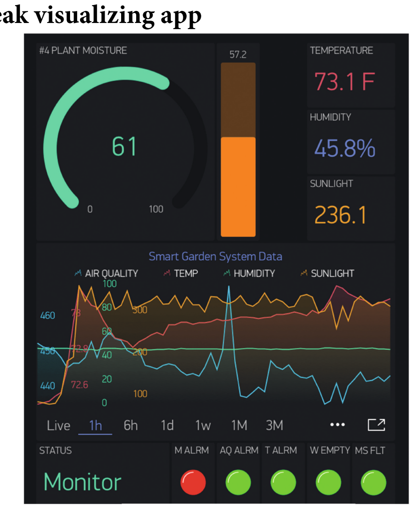


Results

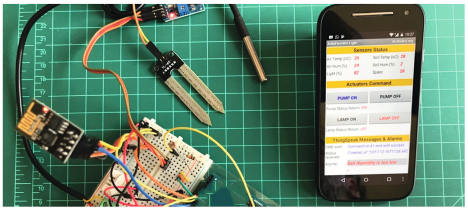
Here, using ThingSpeak, the sensor outputs are displayed graphically for observation.



ThingSpeak visualizing app



Controlling app:



Conclusion

Using current, official, and historical data improves the accuracy of the outcome. Additionally, comparing several IoT-based analytical methods improves the system's accuracy. As a result, the technology will be used to lessen the challenges faced by the farmers and to improve both the quantity and quality of their jobs.

Farmers and distant farm owners instantly and remotely receive the visualized data. Consequently, consumers can use a mobile app to modify numerous parameters from a distance.

Classifying the soil and its surroundings with a data mining algorithm aids in determining the overall health of the soil and the nutrient content of the soil. Prediction also aids in determining how much he can yield in a given soil and environment. This can help the farmer to yield a variety of crops seasonally. Also, platforms like Farmers may aggregate, monitor, and analyze real-time data streams acquired in the cloud using the IoT analytics platform service offered by ThingSpeak.

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