Smart Agriculture System

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Abstract- Since Internet of Things (IoT) sensors have the potential to gather data about agricultural regions and act accordingly based on human input, the concept of intelligent agriculture is still in its infancy. This article proposes constructing an innovative farm system using IOT, wireless sensor networks, Arduino, and other cutting-edge technology. The article aims to use automation and cutting-edge technology like IOT and intelligent agriculture. Keeping an eye on the environment is one of the key strategies to boost the yield of profitable crops. This study details the construction of a system that monitors temperature, wetness, humidity, and even the movement of animals that might damage crops in agricultural areas using sensors based on an Arduino board. The system warns farmers via SMS and an application designed for the same purpose that runs on their smartphone and connects to Wi-Fi, 4G, or 3G networks if there is any disagreement. The system features a duplex communication link based on a cellular Internet interface, and it can be set for data inspection and irrigation scheduling through an Android application. The technology might be helpful in isolated and water-limited areas because of its low cost and energy independence.

Key Words -IOT WSN Smart Agriculture Gateway Sensors.

1. INTRODUCTION

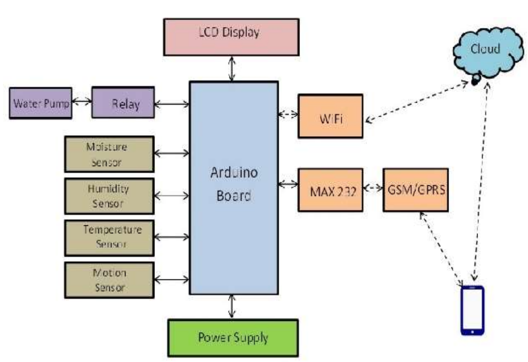
The primary industry in India is agriculture. 58% of Indians who live in rural regions depend on agriculture, according to the India Brand Equity Foundation (IBEF). According to the second recommended estimate from the Central Statistics Office, agriculture's share in India's GDP is expected to be around 8%, a substantial contribution. In such a scenario, agriculture would use much water, particularly freshwater resources. Current market surveys estimate that agriculture uses 85% of the freshwater resources available worldwide, and this percentage will continue to be dominant due to population growth and rising food demand. However, with the introduction of intelligent agriculture systems like the one proposed in this paper, there is hope for significant water conservation in the future. Planning and plans to employ scientific and technological developments to use water intelligently are required(Patil & Kale, 2017). Water savings in various crops may be achieved by numerous techniques, ranging from simple to very sophisticated technical ones. One of the current systems uses thermal imaging to track the plants' water state and irrigation timing. By sensing the water level in the soil and using actuators to manage irrigation as required rather than predefining an irrigation plan, irrigation systems may also be made more intelligently and save water. To irrigate bedding plants (such as Vinca rosea, impatiens, petunia, and salvia), an irrigation controller is used to open a solenoid valve when the volumetric water content of the substrate falls below a setpoint. The developing worldwide water crisis: Apart from resolving conflicts and shortages among water users, the human and animal populations are also contributing to the contamination of freshwater supplies, with pollution levels rising alarmingly. If this keeps up, food production will be limited, impacting human productivity and, ultimately, the ecology in the future(Naresh & Munaswamy, 2019). The population explosion, which has occurred at a rate higher than the rate of food supply, is the leading and most significant cause of this issue. This population rise will strongly impact its expansion on the global map, particularly in nations with limited water resources. Given the anticipated population expansion, there must be a minimum 50% increase in food production. Around the world, 85% of freshwater is used for agriculture. This causes water supply issues and necessitates genuine efforts to use water sustainably. Due to various factors, only a fraction of this additional demand may be met by the practical development of irrigated agriculture; the remainder must be met by raising the productivity of rain-fed agriculture. Suppose unprecedented levels of international cooperation and coordinated planning are not implemented. In that case, many severe water-related issues will arise over the next fifty years, endangering the health of many terrestrial ecosystems and severely affecting human well-being, especially in the world's poorest nations. This study discusses a clever and intelligent agricultural system that can assist farmers in making sensible use of water levels and address other discrepancies, such as animals entering fields without authorization(Blancaflor et al., 2022). A microprocessor and several sensors, including but not limited to motion, temperature, humidity, and wetness, make up the system. The sensors, microcontroller, and internet are all connected to the system via wired and wireless connections. Additionally, the system includes an Android application that lets the user input data that will be used to regulate the watering. This study proposes a Smart Agriculture System that will leverage IOT, WSN, and cloud computing concepts to assist farmers in scheduling irrigation on their farms through an agriculture profile that they can modify to suit their needs. An automated irrigation system is created based on user input to maximize crop water usage. The system includes a dispersed wireless network for temperature, moisture, and soil sensors in the plant roots(*Smart et al. Using IoT | Proceedings of the Third International Conference on Advanced Informatics for Computing Research*, n.d.). Furthermore, a gateway device manages sensor data, initiates actuators, and sends information to an online application. An algorithm was created to regulate the amount of water used using temperature and soil moisture threshold values encoded into a microcontroller-based gateway. For crops to develop correctly, fertilization and watering schedules must be followed precisely. The following are some of the many variables that influence how much water crops need under different climate conditions:

- Temperature
- Humidity
- Sunshine
- Wind speed
- Passive infrared sensor
- Seed monitoring
- pesticide.

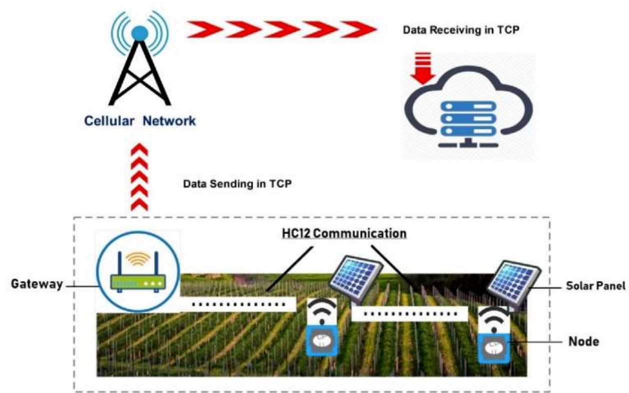
Several sensible judgments for boosting crop productivity may be made using the meteorological data from online repositories and the field's gathered and felt climatic data. Crops require a lot of water in hot, dry, sunny, and windy; in contrast, crops require less water in cold, humid, gloomy environments with minimal wind. A system with six components—monitoring, management, planning, information distribution, decision support, and control action—was abstracted in a previous research model. Data analysis uses the above research model to improve decision support(Srivastava & Sharma, 2019). An innovative GSM-based agricultural system was presented by (Bhavya et al., 2023) to automate agrarian duties. A clever irrigator that operates on a mechanical bridge slider configuration suggests automation. The smart irrigator gets a signal from the intelligent farm sensing system via a GSM module. The sensed data is sent to a central database, where all crop information is examined and sent to an irrigation system for automated operations. IOT-based smart agriculture(Bayih et al., 2022) provides services, including smart control and intelligent decision-making based on real-time data from fields and information on irrigation. Along with Wi-Fi, actuators, and other hardware components, interface sensors are used to execute actions that may be controlled by any smart device situated remotely. The system was built utilizing in-field sensors, which gather data from the farm and transmit it to the base station via GPS. There, the base station determines what has to be done to regulate irrigation based on a database that is part of the system. Researchers track soil-related variables like moisture and humidity since they are critical to any crop's flourishing ability. The system may be operated in two modes: auto and manual. The user may utilize an Android app or instructions in either auto or manual mode to handle the system's activities, or it can make choices on its own and manage the installed devices. The Internet of Things has shown to be a dependable and reasonably priced technology for putting intelligent systems in place (Jaliyagoda et al., 2023). Real-time environmental factor measurement and online services enable advanced rural connection in innovative village systems. IOT is used in nearly every stage of the process, including growing, harvesting, packing, and shipping, according to the study suggested by (Rajpoot & Singh, 2022). Farmers and all other stakeholders will benefit from real-time data given by sensors and RFID tags in all the crop above cultivation phases, enabling a comprehensive picture of the product from production to sales. The automated agricultural system described in [7] uses actuators to operate the motor and light sensors to determine the moisture values from the moisture sensor. It also uses light sensors to determine whether to switch on or off the lights in the greenhouse. An automated method undoubtedly aids farmers in raising agricultural yields. Paper [8] creates a human-centric agriculture model for an IOT context. It globally integrates IOT and cloud computing to eliminate insufficiency and poor management, which are the leading causes of issues in agriculture.

Fig1. Hardware block diagram

2. Proposed system



The creation of an Internet of Things system with sensors and a microcontroller for intelligent agriculture is demonstrated. The implementation's goal is to show off the microcontroller's clever and intelligent skills so that judgments about plant watering may be made. At the same time, the field's environmental conditions are being continuously monitored. The setup is depicted in Fig. 1. Additionally, it seeks to upload a predetermined watering plan into an application created specifically for farmers, according to their convenience. An automated irrigation system driven by solar energy is being implemented. It comprises a wirelessly dispersed network of soil moisture and temperature sensors placed in the root zones of plants. These sensors track the parameters continually and transmit the data to the Arduino board for additional processing, which acts as an IOT gateway. A WiFi module has been installed on this gateway to provide wireless access, and it will update the data in the cloud. With the attached module, the IOT gateway is also capable of GSM. The general packet radio service (GPRS) protocol, a packet-oriented mobile data service utilized in 2G and 4G cellular worldwide systems for mobile communications, is employed in this receiver unit's duplex communication link based on a cellular Internet interface (GSM). The user may continually monitor the parameters from



the comfort of their home or while on the go, thanks to the data being uploaded to the cloud. With the usage of the intelligent agricultural application, farmers may provide user input to the system, which can then adjust accordingly. As indicated in Fig. 2, the farmer may choose a profile for irrigation based on the crop and the season and schedule and plan the water resource consumption wisely. One of the leading indicators that water is needed for crops is the volumetric water content of the soil. Without this technique, the farmer would have to physically examine each crop by looking at the dirt in the fields, which is laborious, time-consuming, and stressful. The intelligent system can handle this; it will notify the user if the water content drops below the level that the farmer has specified. Animal intrusion into fields, particularly that of cows, monkeys, dogs, and other species, is a frequent problem and one of the things that might upset or disrupt output. This means that one person must constantly monitor the fields, which is inaccurate and wastes one person's productivity. This may be avoided with the help of this device, which features a motion sensor to identify any animals in the fields and alert the farmer when one is seen. The farmer may first be able to configure the distance range for which he needs to identify animals in the program.

3. SYSTEM DESIGN

As seen in Fig. 3, the system architecture comprises an Arduino Uno R3 microcontroller board, motion, humidity, moisture sensors (LM 35), an ESP8266 Wi-Fi module, and a GSM module. The program is an Android application that allows you to build up a profile for irrigation that is predetermined depending on the seasons or a daily or weekly basis. Additionally, the software is set up to notify the farmer anytime the physical parameters it detects fall below a particular threshold value. The Arduino Uno will then receive a control signal from the farmer, turning the irrigation on or off [9].

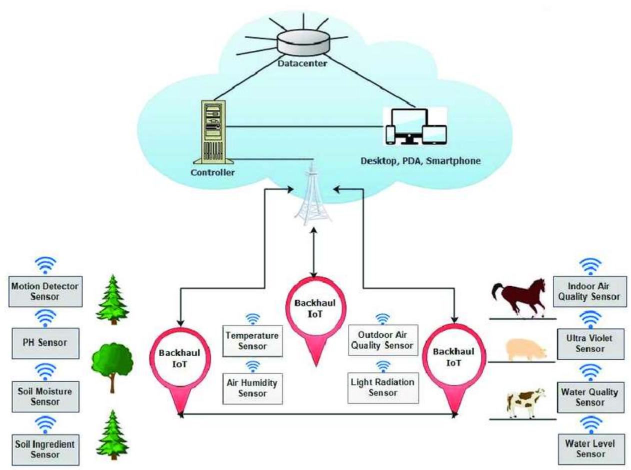


Fig3. IOT implementation

The Arduino Uno board serves as the IoT gateway and oversees all operations. All of the physical characteristics are sensed by sensors, which then translate analog values into digital values. Temperature and humidity are measured on the field using sensors that monitor these variables. Capacitive soil moisture sensors are used to gauge the soil's moisture content. Wind speed also impacts crop productivity. The method that we have built measures this as well. An RTC module is also integrated to record sensor data in real-time. The IOT gateway receives this data after that. The Wi-Fi gateway then uses the IOT module to send the data to the cloud. Our system's cloud will house a database, a web server, and decision logic. The information obtained from the IOT gateway will be preserved in the database. Next, the decision logic determines if the farmer's action to water the plants is necessary. For instance, a temperature threshold in the designed system is maintained at 25 ◦C. The database will initiate a decision logic action once the temperature exceeds the threshold, and the built Smart Farming Android application will receive a notice. Additionally, an SMS will be sent to the farmer's registered mobile phone notifying him. A signal will be transmitted to the cloud and from there to the gateway, which will then send a signal to activate the relay and turn on the water pump, depending on the farmer's decision to turn on or off the irrigation.

4. IMPLEMENTATION

An IOT-based innovative agricultural system creates irrigation recommendations using real-time data. Using his login credentials, which include his username and password, the farmer first accesses the system using an Android application. After that, he is free to choose the crop for that season. The system is put into use in three stages.

• Sensing

• Processing

• Information distribution.

During the sensing phase, physical characteristics such as temperature, wetness, humidity, and motion are sensed. All these sensors are attached to the Arduino Uno R3 microcontroller board. Because it can send data to the cloud, this board serves as the created system's Internet of Things gateway. The Wi-Fi ESP8266 module is being used for this broadcast.

The cloud is where the processing phase happens. It consists of a web server, a database that stores the felt data, and a decision engine that makes judgments based on the sensed data. During the information dissemination phase, the decision logic's output will first be provided to the Android application and subsequently to the IOT gateway. The end-to-end algorithm of the intelligent farming system is assumed below.

Start

◦ continuously obtain sensor data

◦ A/D conversion of the sensed data on the Arduino Board

◦ Direct the data to the cloud over the IOT Gateway

◦ If the statistics are above the threshold

- Direct an announcement to the Smart Farming Application
- If the consumer chooses to Turn ON
  - Direct a control signal to the server, i.e. cloud
  - Control signal is then directed to the IOT gateway
  - The IOT gateway activates the relay, and the water pump is turned ON
- Else, if the user chooses to Turn OFF
  - Direct a control signal to the server, i.e., cloud
  - Control signal is then directed to the IOT gateway
  - The IOT gateway activates the communication, and the water pump is turned OFF
- Endif

◦ Else

- Endure examination for the threshold condition

◦ Endif

End

The Smart Farming Application is developed on Android. It delivers the subsequent features.

1. Choice to turn ON/OFF the water pump

2. Choosing an irrigation profile allows the farmer to choose when to start and stop watering on a given day. This enables the farmer to devote his attention to other worthwhile endeavors. Using the application profile, the farmer can also stick to the same routine for a week or a month.

3. Submission to the farmer to custom a specific pesticide for their crop

4. Inform the farmer of the invasion of the field by animals.

5. Conclusion

Farmers can benefit significantly from IOT-based innovative agricultural systems since excessive or insufficient irrigation harms farming. The environmental characteristics of that specific place may be used to determine threshold values for climatic factors like humidity, temperature, and wetness. Additionally, the system detects animal incursions, the leading cause of crop decline. This system creates irrigation schedules based on data from the meteorological repository and perceived real-time data from the field. This technology may advise farmers on the necessity of irrigation or not. It is necessary to have constant internet access. This may be fixed by utilizing a GSM module instead of a mobile app to expand the system so that the farmer receives suggestions via SMS straight on his phone.

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