Automation irrigation system using arduino for smart crop field productivity

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ABSTRACT

Agriculture is essential to the prosperity of agricultural countries like India. Thus, the suggested strategy is to use automation and internet of thing (IoT) technology to make agriculture smart. Applications enabled by the IoTs include irrigation decision assistance, crop growth monitoring and selection, and more. an Arduino-powered technology that boosts agricultural productivity. This study's main goal is to find the least quantity of water necessary to grow crops. Most farmers squander a lot of time on the fields rather than concentrating on the water that plants have access to at the right moment. The suggested system determines the required amount of water based on the data obtained from the sensors. Two sensors provide data on the soil's temperature, humidity, amount of sunlight each day, and soil temperature to the base station. The suggested systems must determine the amount of water required for irrigation based on these criteria. The system's main benefit is the use of precision agriculture (PA) in conjunction with cloud computing, which will maximise the use of water fertilisers while maximising crop yields and also assist in determining field weather conditions.

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1. INTRODUCTION

Agriculture is the main source of income for most people in India, including 70% of farmers. The bulk of irrigation techniques, including as drip, terraced, and ditch irrigation systems, are manually selected by farmers in India. The system in the plant's root zone consists of a dispersed wireless network of soil-moisture and temperature sensors. A gateway device also analyses sensor data, activates actuators, and delivers information to a web application. An algorithm was developed for a microcontroller-based gateway that controls the amount of water by establishing temperature and soil moisture threshold values. The electricity for the system came from solar panels, and it included a duplex communication connection based on a cellular-internet interface that enabled data examination and irrigation scheduling to be configured through a web page. When compared to conventional agricultural irrigation practises, the automated system achieved water savings of up to 90% throughout its 136-day test period on a field of sage crops. In the last 18 months, three different locations have successfully employed replicas of the automated system [1].

The internet of objects is a growing method for tying things together and collecting data (IoT). Frameworks for the internet of things (IoTs) are utilised for data and information management and communication. The system allows users to register their sensors, generate data streams, and analyse data. There are several ways to utilise IoT in agriculture. Smart surroundings, intelligent water, intelligent metres, security and emergency response, industrial control, intelligent agriculture, home automation, and e-health are a few examples of IoT applications. The "Internet of Things" is built on a device that can process and relay data collected by sensors to the user [2]. Wireless sensor networks (WSNs) are used in the development of decision support systems (DSS) to tackle a variety of real-world issues. Precision agriculture is one of the sectors that needs DSS the most nowadays (PA). In summary, this study suggests WSN as a novel and effective method for selecting options and maximising agricultural resources. Precision agricultural systems based on the IoT are described in detail, with a focus on the hardware and network architecture as well as software process control. The system collects, analyses, and tracks data from the sensors in a feedback loop before turning on the control devices depending on a predetermined threshold value [3].

IoT sensors may offer information about agricultural areas and then act on it depending on user input, making smart agriculture a unique idea. With the use of cutting-edge technology including WSNs, IoTs, and Arduino, this research seeks to create a smart agricultural system. The goal of the project is to make use of cutting-edge technology like IoT and smart agriculture with automation. To increase the output of fruitful crops, environmental monitoring is crucial. In order to measure temperature, humidity, wetness, and even the movement of animals that can harm crops in agricultural areas, the system in this study will employ sensors. In the case of any disagreement, the system will use Wi-Fi, 3G, or 4G to send the farmer's smart phone both an standard short messages standard (SMS) message and a notification on the specially built application. The system's duplex communication connection, which is built on a cellular-internet interface, allows for data inspection and irrigation schedule to be configured using an android app. The gadget may be beneficial in distant areas with little access to water because of its cheap cost and energy independence [4].

Agriculture, one of our enduring industries, has benefited significantly from cloud computing. The cost-effective use of cloud computing tools that can build an entire computing ecosystem, from sensors to tools that observe data from agricultural field images and human actors on the ground and precisely feed the data into repositories along with their location as GPS co-ordinates, can lead to the development of practical applications. Currently, sensors may be used to identify water sources in a study region. Farmers' issues have always halted our development. One approach to deal with these problems is to assist farmers using modern techniques. This study suggests a strategy for incorporating the benefits of significant new technological breakthroughs like the IoT and web services in order to provide an effective method for processing the large amounts of data produced by agricultural production. The strategy combines IoT and cloud computing to encourage the rapid modernization of agriculture, support the implementation of smart agricultural solutions, and assist in the effective resolution of farmer-related difficulties [5].

Agriculture, the most diverse economic sector, is crucial to a country's overall economic success. Certain agricultural tasks will become more proficient thanks to developments in agricultural technology. In this work, we propose a unique approach to smart farming that utilises wireless communication technology to connect a smart sensing system with a smart irrigation system. Our approach focuses on measuring the soil's physical characteristics, such as its pH, nutrient content, and moisture content, all of which are essential for farming. A smart irrigator placed on a portable overhead crane system sprays the crops with the necessary amount of green manure, compost, and water after evaluating the vital physical and chemical qualities of the soil. This work [6] illustrates the thorough modelling and control techniques of a smart irrigator and smart agricultural system.

A key management idea that permits precise soil parameter monitoring and control is precision farming. Farmers may use automation to apply the correct quantity of water and fertiliser to the right field at the right time. The design and development of an autonomous precision farming system (APFS) for agricultural automation are discussed in this study. It is a low-power, user-friendly device that aids farmers in determining the best times to water and fertilise their crops depending on soil and environmental conditions. Based on data from the field and preloaded programmes in the controller, the system can intelligently run pumps and valves. The autonomous precision farming system (APFS) monitors and maintains a number of agricultural characteristics, including soil moisture, pH level, air temperature, humidity, fertiliser concentration, among others, and also gives farmers feedback. Wireless data collection via wireless motes is one aspect of APFS. The user interface is responsive because to the graphical TFT touch screen. When dangerous circumstances or key field metrics are discovered, the gadget may be set up to alert farmers. The farmer's mobile phone may get these notifications through short message service text messaging (SMS) text messages that have been pre-programmed. The system also includes a feature that enables mobile phones and dual tone multi-frequency (DTMF) technology to remotely operate agricultural field equipment [7].

Farmers who must water crops at certain times and quantities might benefit from this tactic. In order to accurately determine when to turn on and off the motor, the automated irrigation system monitors changes in the ambient temperature and moisture sensors. In order to prevent human mistake, a machine checks the soil moisture level. A country is the agrarian India. The majority of people in India are employed in agriculture. Agriculture accounts for 16% of the total GDP and 10% of exports. In order to make the system power independent, this study offers a configuration where the farmer chooses the crop being farmed utilising a Renesas microcontroller, GPRS module, pulse width modulator (PWM), HTML page, and a solar module. The continuous detection of soil moisture content using moisture sensors is the key component of this system. The main CPU compares the detected data to previously saved standard data for the specific crop, and then just the necessary quantity of water is pumped using the system PWM. Using a solenoid, an electromechanical device, pumped water is directed to a specific area of the land. When the appropriate moisture content is attained, the sensor alerts the microcontroller to stop the motor. This saves water by only providing the quantity needed at any one moment. The project's goal is to use technology in agriculture to help farmers irrigate large areas of land while using less water [2], [8]–[14].

Since agriculture is the backbone of the Indian economy, it needs to be protected. Security is crucial not just in terms of resources but also in terms of agricultural goods, such as protection from insect or rodent assaults in fields or grain storage. These difficulties should also be taken into account. Today's security systems lack the intelligence to send out notifications immediately after finding a problem. Combining conventional methods with cutting-edge technology like WSNs and IoT might modernise agriculture. With this scenario in mind, we created, tested, and assessed a "internet of things"-based device that can analyse and communicate observed data to the user. This security tool, which can be operated and monitored remotely, may be used in agricultural fields, grain depots, and cold storage facilities. This research aims to provide approaches for solving issues including rodent identification, agricultural risks, and real-time warning based on information analysis and processing without human intervention. The gadget integrates the aforementioned electrical and sensor components using Python programmes. Based on test scenarios [15]–[19] that we tried, we were successful in 84.8 percent of them.

The Cluster of European Study Projects (CERP) research describes the IoT as a vital element of the future internet that makes it possible for "things" with identities to connect with one another. IoT will be used in a variety of areas, including smart cities, agriculture, energy, environmental protection, health, and home automation. However, if various IoT applications were created on different architectures, IoT co-building, convergence, and openness would be constrained. To reduce costs in the IoT industry, a top-down architectural approach to design unity is necessary. This study proposes a top-level generic IoT architecture that is especially well suited for the creation of smart cities, classifies IoT platforms, and categorises IoT platforms.

Devices may be remotely controlled through the internet owing to the IoT. It can operate sensors that are used in a variety of settings, like as water management systems, train networks, and dazzling highways. As a result, errors committed by individuals and by the system itself may be avoided. The sophisticated global system for mobile communication (GSM) (800-900MHz)-WSN (IEEE 802.15.4) based greenhouse monitoring and control utilising SMS terminal are presented in this study together with modelling and optimizations. Sensor stations and base station terminals in the proposed system carry out various conditioning tasks. The PIC18F4520 controller is used in the greenhouse to improve the climatic conditions. The sensor station has sensors that detect soil moisture, light, temperature, humidity, and other variables. The base station uses the GSM network to establish a connection with the user, while the sensor station and base station interact using ZigBee wireless modules. Field parameters may be collected using SMS by employing GSM terminal connection to the proposed system. The components of the greenhouse are all solar-powered. The wireless sensor stations in the greenhouse monitor many factors, including temperature, humidity, light, soil moisture, and others, using relative standards. It has been used to condition suggested greenhouse attributes to account for variations in sensor set points.

IoT is a recent area that has affected and enhanced other fields. It is currently evolving as a result of the incorporation of new sensors, sensor networks, and RF-based communications. Using an LM35 temperature sensor is a practical and cost-effective way to change the medium's temperature. The primary focus of this study is on the use of the LM35 temperature sensor for measuring soil temperatures. Before being used to detect the soil temperature of potted rice, the sensor was chosen, a correction coefficient was applied based on the theoretical relationship between the sensor output voltage and Celsius temperature, and the sensor was calibrated. The calibration findings reveal that there was a very substantial linear connection between the measured medium temperature and the sensor output voltage, and that although each sensor correction coefficient differs, they are all quite close to 1. A temperature sensor of the LM35DZ type was employed to gauge the soil temperature throughout the vital rice potted testing phase. The results of the research demonstrate that the features of soil temperatures lag and that changes in air temperature and soil temperature are practically identical. Whether or not the paper screen was in situ, the variance analysis revealed that there was no statistically significant change in soil temperature.

It is capable of displaying intelligent behaviour, precise sensing, and precise identification. Mobile and computer network-based technologies have changed when cloud computing and IoT were combined. Additional networks used nowadays include 3G, LTE, GSM, WLAN, WPAN, WiMax, RFID, Zigbee, NFC, and Bluetooth, which provide IoT development and remote system operation. Over the last 10 years, both climate change and rainfall have become more erratic. As a result, a large number of farmers in India have embraced climate-sensitive practises known as smart agriculture. "Smart agriculture" is a term for automated and guided IoT-based information technologies. IoT is extensively utilised and expanding quickly in all wireless situations. This study has examined and evaluated how IoT technology interacts with sensor technologies, wireless networks, and real agricultural system conditions. The remote monitoring system is a prospective treatment that combines internet and wireless communications (RMS). The main objective is to gather real-time data on the environment in which agriculture is generated in order to make agricultural amenities, such as SMS warnings and advice on weather patterns and crops, etc., widely available.

The advent of new technologies has made WSNs with low power and cost feasible. For sensing soil factors including temperature and humidity, this research offers a hierarchical WSN. We created sensor nodes that are totally buried and gather soil data. These nodes communicate with one of the several relay nodes above ground using their radios to deliver the measurements they have gathered. A base node that is linked to a workstation receives the data collected from the network's sensor nodes via relay nodes with long-distance communication capabilities. With a relatively low duty cycle and hence a long lifespan for soil monitoring applications, the proposed hierarchical WSN makes use of a probabilistic communication protocol.

In the modern scientific community, wireless sensing technologies are widely used. WSN is used to stay up with the quick advancement and expansion of technology. Power efficiency is a key concern in the investigation of WSNs. Utilizing ZigBee technology could be able to overcome this issue. The major goal of this research is to analyse how data is sent across a wireless medium using a wireless sensor network and monitoring system. Given that temperature, soil moisture, and air humidity are vital components that must be maintained in precision agricultures (PA) [20]–[25], this article shows how to design an automated irrigation system employing regulated parameters.

2. PROPOSED WORK

Connecting the Arduino Uno to computers, other Arduinos, or microcontrollers is possible. Digital pins 0 (RX) and 1 (TX) of the ATmega328 support UART TTL (5V) serial communication (TX). The pin Mode(), digital Write(), and digital Read() routines show how to utilise the Uno's 14 digital pins and 6 analogue pins as inputs or outputs in Figure 1. They need 5 volts to function. A 20-50k ohm internal pull-up resistor is included on each pin; it is by default disconnected but under ideal operating circumstances, it may provide or receive 20 mA. The flowchart for the recommended system is shown in Figure 2

Figure 1. Arduino

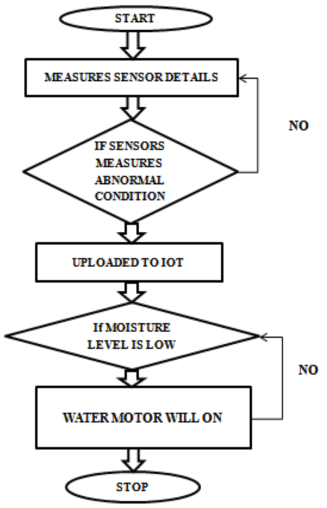

Figure 2. Flow chart of the proposed system

3. BLOCK DIAGRAM OF PROPOSED SYSTEM

The following describes the characteristics of the suggested systems: i) Microcontroller: ATmega328P from Microchip, ii) 5 volts is the operating voltage, iii) 7 to 20 volts of input voltage, iv) 14 Digital I/O Pins (of which 6 provide PWM output), v) Six analogue input pins, and vi) 20 mA is the DC current per I/O pin, and 3.3 V is the DC current. Pin: 50 Ma. Figure 3 shows the Uno's six analogue inputs, labelled A0 through A5, each of which offers 10 bits of resolution (i.e., 1024 distinct values). The proposed sytem are considered with a lot of sensor controlled by the arduino UNO.

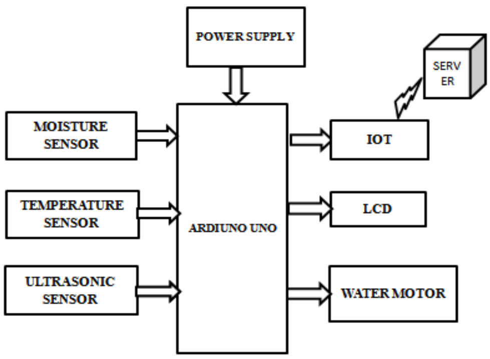

Figure 3. Block diagram of the proposed system

4. RESULTS AND DISCUSSION

The conventional method of monitoring the agricultural environment involves repeated inspections and physical measurement taking. By giving crops water at precise times and amounts, this technology aids farmers. Additionally, it checks the soil's moisture content and protects against human mistake. It could exhibit sharp intellect, accurate perception, and accurate identification. Plant leaf diseases are recognised using five key methods. Photos are recorded, upgraded, separated into problematic and advantageous areas, retrieved characteristics are extracted, and then the images are categorised using a digital camera or scanner. The plant leaf will next be examined for any diseases that could be there. Here, we outline a step-by-step process for gathering the characteristics of the negative image. On 4G mobile phones, real-time results and system status were captured. The system uses information from the temperature and humidity sensors to show the temperature and humidity of the agricultural area. An image recognition system may be used to remotely assess the health of a crop. Figure 4 demonstrates how two sensors in this situation regulate the watering system, simplifying any required troubleshooting. The temperature and soil moisture data from the previous month are taken into consideration when choosing the threshold voltages for the calibration of the sensors. Figure 4 shows the simulation's results.

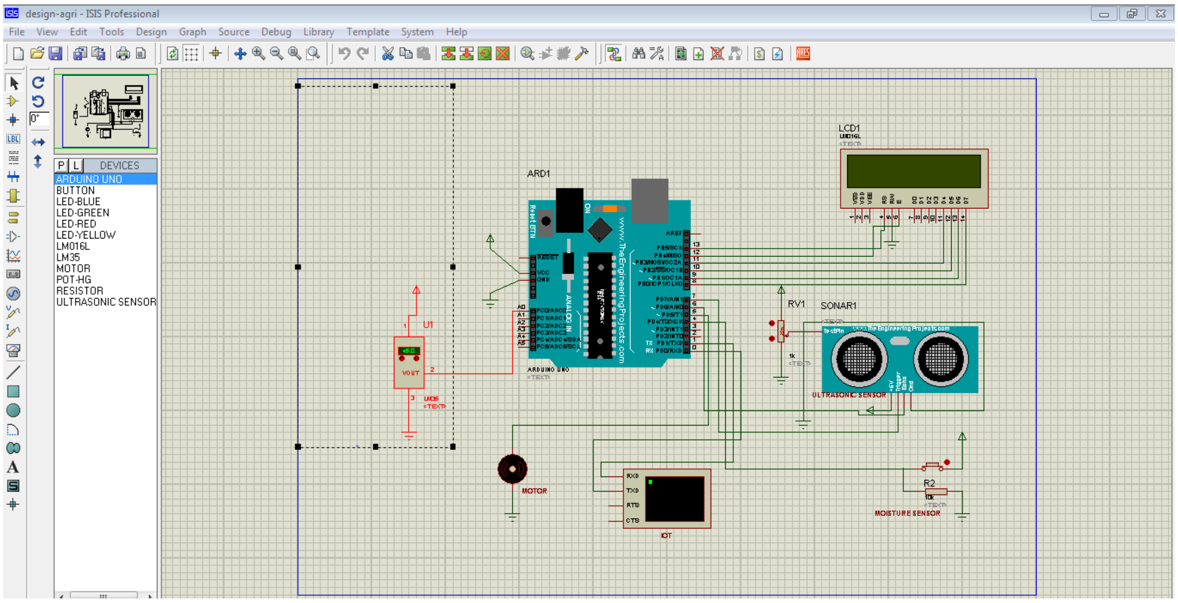

Figure 4. Simulation results

5. CONCLUSION

Low-complexity electronics are used to build an irrigation system for agriculture in Pennsylvania. The circuit successfully uses two sensors-temperature and soil moisture-to transmit calibrated data to the system. All three nodes have been successfully interfaced with the Raspberry Pi microcontroller and two sensors. According to all observations and actual testing, the proposed strategy provides a complete answer to the problems related to field operations and irrigation. By using such a system, it may be possible to significantly improve both the crop field and overall productivity. With this method, the irrigation system may be fully automated while simultaneously providing farmers with up-to-date information on the land and crops to aid in making informed choices. "A revolutionary kind of computing in which dynamically scaled and often virtualized resources are supplied as a service through the internet," according to Wikipedia, is cloud computing. Two sensors control the watering system, which makes troubleshooting easy in the unlikely event that it becomes required. The proposed correlated data-based technique requires less hardware than earlier suggested methods. Readings of soil moisture and temperature from prior months are used to define the threshold voltages for sensor calibration. The crop and plantation may alter the threshold levels. Machine learning will someday be used to manage data and simplify hardware.

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