Design of Intelligent Control and Monitoring System for Agriculture Based on Renewable Energy and IoT

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Abstract: As the population rises, agriculture is becoming a big growth field worldwide. Improving production and farm efficiency without constant manual supervision to satisfy the rising demand for food is a major challenge in agriculture. Climate change is also a significant issue for the agriculture industry, aside from the growing population. The research aims to provide the Internet of Things (IoT) with an intelligent agriculture system. Intelligent farming that provides high precision crop management, helpful data collection and automatic farming techniques can be used. This work provides an intelligent framework to track ground moisture and temperature in agriculture. Without human interference, appropriate action is taken after analyzing sensed data dependent on these principles. Temperature & relative humidity are assessed and processed for further data analyses in the Thing Speak Database.

Keywords: IoT, Food, Agriculture, Cloud server, Security.

1. Introduction

The Beecham study "Toward more Smart Agriculture: Farming Using the IoT Sight" suggests that our projected global population could grow by 70%, hitting a growth of 10 billion by 2050[1]. It is very important to increase farm productivity to ensure good yields and crop production. The biggest challenge in high-quality agriculture is volatile weather, such as rainfall, temperature, humidity etc. Humidity is also having a strong influence on crop turgor, a metric of plant cell water because it is a major environmental parameter in agriculture [2]. If the humidity level is low, sweating happens very easily in plants. Furthermore, plants can be drawn when the plant cells draw too much water due to the high transpiration rates. In comparison, the transpiration rate decreases when both air and temperature moisture are high, which decreases evaporative cooling [3]. A constant manual effort, which is very unreliable and not always practicable, was needed to track certain environmental situations and behavior accordingly [4].

In the implementation of the smart agricultural concept to simplify agriculture, IoT plays a major role. IoT is a contemporary computer and contact paradigm where the ordinary things are sensed by a sensor, a microcontroller and a transceiver [5]. Moreover, the contact with each other or recipient of sensed data becomes an important part of the Internet structure. At IoT, all items used in our daily lives are linked to a special identity, meaning that information can be transmitted across the network without any human participation. Every day IoT grows, and many more objects are related worldwide. IoT is ideal for many fields such as accurate farming, smart grid, environmental control, etc. [6].
highly mobile, interoperable and omnibus design of IoT technology is gaining prominence in the agricultural sector. Several environmental parameters that affect agriculture must be monitored at various sites in order to automate agricultural activities. Temperature, moisture and water levels are important environmental parameters [7]. Various types of sensors are installed to track certain agricultural and microcontroller environmental parameters. According to environmental factors, the microcontroller scans various actuators or agricultural machinery (pump, ventilator, etc.) without any human interference. These sensed data will, also, be preserved in the cloud [8].

The WLAN module is connected to a microcontroller that sends sensed cloud parameters. Mainly the GSM and/or CDMA/GPRS technology is used for the wireless environmental control system. However, they have some drawbacks, such as high networking costs, poor connection speeds, etc. [9]. The objects have a special id as part of the Internet. Version 6 of the Internet Protocol (IPv6), version 4 of the Internet Protocol (IPv4), usually acts as an object identifier. The remaining document is set accordingly: Section II - illustrates the study on smart agriculture. Section III - defines the proposed device architecture for IoT-based smart agriculture. Section IV - discusses the experimental setup for applying the method and findings, and Section V - finishes the article.

2. Related Work
In [10], a cost-effective agricultural product where water is scared was proposed. The machine consists of low-cost sensors and basic circuits that regulate water flow automatically. Moisture, humidity and LCDs are also sensed. This method offers water to plants dependent on soil humidity and crop water demand.

In [11], an indigenous low-cost irrigation programmer with multiple sensors for detecting humidity, wind and temperature is dependent on the microcontroller. Based on these values, this device produces sufficient actuators (relay, solenoid valves, motor). The data collected was sent to the user via GSM and saved in a memory card via an SMS module.

Smart IoT based and cloud computing agriculture is proposed in [12]. The agricultural knowledge cloud is built with various resources to accomplish dynamic resource allocation and load balancing. Wireless correspondence in the agricultural information cloud is managed by a broad quantity of data collected by RFID[13].

The deficit irrigation management scheme presented in [14] consists of the network of irrigation inspectors and land sensors in the field. Wireless connections connect irrigation controllers to the farmers’ machine. The device may be used where water access is limited; water quality is low or where lixiviation is prohibited. DSS is used to maximize irrigation and fertilizer management, depending on the chosen plant, water availability, and plant growth. The DSS can be run either on a user's computer or a web server, & can review the DSS if necessary to change the drainage strategies[15].

3. Proposed System
Our key goal is to create an intelligent IoT-based farming method, which monitors high-voltage electrical devices, including pumps, flaps etc. Based on ambient conditions such as soil humidity and temperature, without human intervention. For potential data analysis, these parameters are saved on the cloud. Agriculture is performed for a better-controlled climate in playhouses.
The device proposed is made up of multiple layers, as seen in Fig. 1. It is split into four subsystems: cloud layer, middleware, communication layer and sensor layer.

3.1. Sensor Layer
The Sensor Layer is our proposed system's first layer. It collects and tracks various environmental metrics. Various types of detector modules are used in farming for sensing or capturing parameters. Two types of sensors used to control soil humidity and temperature sensors to monitor the temperature level in playhouses were used in the study. In the soil, humidity sensors are used. The Arduino-based microcontroller binds these sensors. The microcontroller, which was connected to the field of agriculture with sensors, developed fundamental IoT objects.

3.2. Middleware design
The middleware design is our system's second layer. In order to automate the agricultural operation, the middleware is required, and it controls the actuators. The microcontroller must be planned. Sensor values are inserted in the microcontroller and function appropriately according to various field monitoring parameters' threshold values. This layer closely tracks soil temperature, and soil humidity levels since all parameters influence crop yield directly and obey decisions.

If the soil humidity is less than the threshold mark, a pump machine is turned on as the insufficient soil moisture content decreases the farm yields. The thresholding for moisture content is appropriate for various soil types. The proposed solution finds 15% of soil texture to be a cut-off. The pump is automatically shut off when the humidity level reaches the threshold and prevents unnecessary fuel use.

The microcontroller opens the flap of the playhouse when the temperature thresholds are higher than the threshold value. The device suggested considers a ceiling of 40°C temperature. Temperature changes result in a decline in plant life, which impacts the balance between plants and pests. It also improves the breathing rate of crops and lowers the fertilizers' effectiveness. The microcontroller sends sensed data from a portal to the ThingSpeak cloud in addition to manipulation of actuators.
3.3. Communication Layer
With the Bluetooth enabled Wi-Fi moduled, this layer of the microcontroller offers wireless connectivity to the gateway. Bluetooth offers short-range connectivity over wireless Internet, as the gateway can be far from the surveillance area. Instead of broad cabling, Ethernet-based connectivity is discouraged. With sensors installed over the monitored area, The microcontroller transmits the perceived soil wetness & temperature to the server via the portal. The IP protocol is operating on the backdoor. The ThingSpeak cloud HTTP request to the channel concerned is submitted by the microcontroller for sensory purposes.

3.4. Cloud & Application layer
The new technology of cloud computing is useful in the area of smart agriculture. The proposed model uses the cloud computing platform to record numerous agrarian field data. Different channels are generated in this layer, which corresponds to a ThingSpeak cloud parameter field where data are stored (temperature, soil moisture). Microcontroller regularly transfers sensed data via a communication protocol to the respective channel. These data are collected in terms of time (soil humidity value, temperature value), which can be used for future studies. The condition of farming fields (temperature, soil moisture) in the ThingSpeak web service can be tracked remotely in terms of a graph. Applications relevant to the cloud farming that farmers or researchers may use can be made.

4. Results and Discussion
Different equipment is used to produce the proposed device, as a microcontroller and numerous sensors are connected to the Arduino UNO board. As a sensor for soil humidity, LM35 was used. The Steeper generator is linked through a 6-pin relay to a high voltage control system with the Arduino UNO board. LM35 is a temperature unit integrated with the circuit and is attached to Arduino board analogue pin. The LM35 sensor's output is the celsius heat ratio & the estimated value is transferred to the Atmega hardware.

![Figure 2. Experimental setup](image)

Picture 2 demonstrates this work's experimental setup, which constitutes controller and sensor modules like humidity sensor, LM35 module and power supply circuit.

Figure 3 shows the level of field temperature, and figure 4 shows the level of soil moisture.
Figure 3. Field Temperature

Figure 3 shows the field temperature with the temperature and moisture statistics recorded in the agricultural field, plotted against temperature and date using the speak server.

Figure 4. Field Moisture level

Figure 4 shows the field humidity with moisture and temperature statistics recorded in the agricultural field, plotted against moisture and date using the speak server.

5. Conclusion

Based on the above system setup, soil humidity, temperature levels and values, based on the preset soil humidity and temperature values, The Controller Board regulates high-voltage equipment without human interference. This device ensures continuous field surveillance and activates the necessary events as needed in the absence of an individual in the agricultural sector. It lowers to a certain degree, human effort and agricultural costs. The soil humidity and temperature threshold value need to be updated and combined with manual middleware updates. At a certain time, the computer transfers ambient parameter values to the cloud in real-time from the field via Wi-Fi. This importance can be used for future research and monitored to promote crop growth by more parameters such as biotic factors like fungi, monera, etc.

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