DESIGN AND DEVELOPMENT OF AGRICULTURE MONITORING SYSTEM USING IOT

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Abstract: In our rapidly evolving technological landscape, it becomes imperative to extend progress into the realm of agriculture. Countless research endeavors have been dedicated to enhancing crop cultivation practices, yielding widespread adoption. To effectively bolster crop productivity, vigilant monitoring of the field's environmental conditions is indispensable. Key parameters, including soil characteristics, weather patterns, moisture levels, temperature, and water management, must be meticulously observed to optimize yield. The Internet of Things (IoT) has found a pivotal role in various real-time applications, breathing new life into traditional farming methods. The amalgamation of IoT and sensor networks in agriculture presents a transformative paradigm shift. Online crop monitoring through IoT empowers farmers with constant connectivity to their fields, offering real-time insights and control regardless of their location. A diverse array of sensors is deployed to monitor and gather data on field conditions. This comprehensive dataset is efficiently relayed to farmers through IOT technology, facilitating informed decision-making and precise resource management in agriculture.

Key words : IOT, agriculture, Sensors, Arduino

I. INTRODUCTION

Fundamental pillars of human survival hinges on agriculture, primary source of sustenance. Unfortunately, the majority of farmers in our country still rely on traditional farming methods, which entail laborious manual data analysis pertaining to soil and crop conditions. This cumbersome process can be transcended through the adoption of modern farming techniques. Given that the agricultural sector significantly contributes to a nation's economic growth, the imperative arises to introduce automation into agriculture, a move that can markedly boost crop yields and foster economic development. The integration of automation in agriculture facilitates precise crop monitoring, all without the need for constant human intervention in the fields. The Internet of Things (IoT) emerges as a pivotal technology, connecting objects embedded with sensors, s/w, and electronic components, such as microcontrollers, which cannot directly access the internet. Efficient crop productivity is intricately tied to an effective irrigation system. To achieve this, sensors are strategically deployed in the fields to gauge the soil's water requirements and administer irrigation automatically. Through IOT technology, farmers gain access to real-time information about their fields, ensuring optimal crop management. In the context of Indian agriculture, which is predominantly dependent on monsoons, irrigation plays a crucial role. This paper delves into the development of smart agriculture, exploring the configuration of wireless sensor networks for assessing temperature, humidity, and water level adjustments. It also examines the deployment of sensor nodes essential for optimizing the farming, monitoring manage-ment devices to collect and analyze data from these nodes, and the storage of such data on management servers with built-in emergency alert systems. While monitoring environmental factors is a step toward increasing crop yields, it is not the sole solution, as numerous other factors can significantly reduce productivity. To surmount these challenges, the implementation of automation in agriculture is essential. Although it has been explored at the research level, it has yet to be widely disseminated to farmers as a practical solution for harnessing their resources effectively. This paper seeks to bridge that gap by addressing the development of smart agriculture practices.

II. LITERATURE REVIEW

An integrated system harnessing an array of sensors for real-time environmental monitoring, encompassing parameters such as water levels, humidity, and temperature, is at the core of this solution. This sophisticated system combines the processing power of an IC-S8817BS with a wireless transceiver module utilizing the Zigbee protocol. Its primary function is to relay the precise field conditions directly to the farmer through text messages from mobile and email alerts, keeping them informed and in control. Notably, the system also boasts mechanisms to address sensor node failures while ensuring optimal energy efficiency. It's worth noting that although Zigbee technology offers numerous advantages, such as low power consumption and reliability, it does come with some limitations, notably in terms of communication range, which requires careful consideration in its implementation. [1].

An innovative approach to intelligent greenhouse monitoring, utilizing the power of Zigbee technology, has been proposed. This cutting-edge system seamlessly integrates data capture, processing, transmission, and reception functions. The core objective of this research endeavor is to establish an efficient greenhouse environment management system, capable of optimizing agricultural areas, reducing costs, and conserving energy resources. The implementation of IoT technology in this context adopts a robust B-S structure, with the cc2530 serving as the processing chip for wireless sensor nodes and coordinators. The system's gateway operates on the Linux operating system and is bolstered by a Cortex A8 processor at its core. This comprehensive design not only achieves remote monitoring and control of green-house conditions but also replaces traditional techno-logies with wireless alternatives, ultimately curtailing labor costs and enhancing overall efficiency [3].

An innovative approach has been devised to assess the effectiveness of wireless sensor networks in the realm of automated irrigation, with real-time data seamlessly transmitted to a web-server via wire-less communi-cation channels. The deployed sensors play a pivotal role in monitoring critical parameters such as temperature, humidity, and soil moisture levels, all of which are vital for effective crop management. The irrigation process is intelligently automated, triggered when the sensor readings fall below predefined threshold values. This system ensures that the farmer is consistently kept informed about the precise conditions in the field. Furthermore, it is worth noting that this technology extends its applications to greenhouse environments, where not only irrigation but also light intensity control can be automated, ushering in a new era of efficient resource management. However, it is important to acknowledge that the prediction of crop water requirements in this setup still presents challenges and may not yet be as precise as desired [6].

In a separate study, researchers have put forth an innovative approach employing wireless sensor networks to continuously monitor soil characteristics and environmental conditions. Many sensor- nodes are strategically positioned across the agricultural landscape, forming a comprehensive grid. These nodes enable the remote control of crucial parameters, either through a remote device/ internet services, seamlessly integrating sensors, Wi-Fi connectivity, and cameras with a microcontroller. This concept has transcended the realm of theoretical research, culminating in the creation of a tangible product designed to benefit farmers. In a parallel endeavor, another group of researchers has pioneered a solution where a microcontroller serves as the information hub, transmitting vital data over the internet through an IoT network facilitated by a Wi-Fi module, such as the ESP8266. This innovative setup has revolutionized automated irrigation systems, enabling precise control of water pumps based on real-time information fed to the controller, a significant leap forward in efficient resource management.

III. PROPOSED SYSTEM

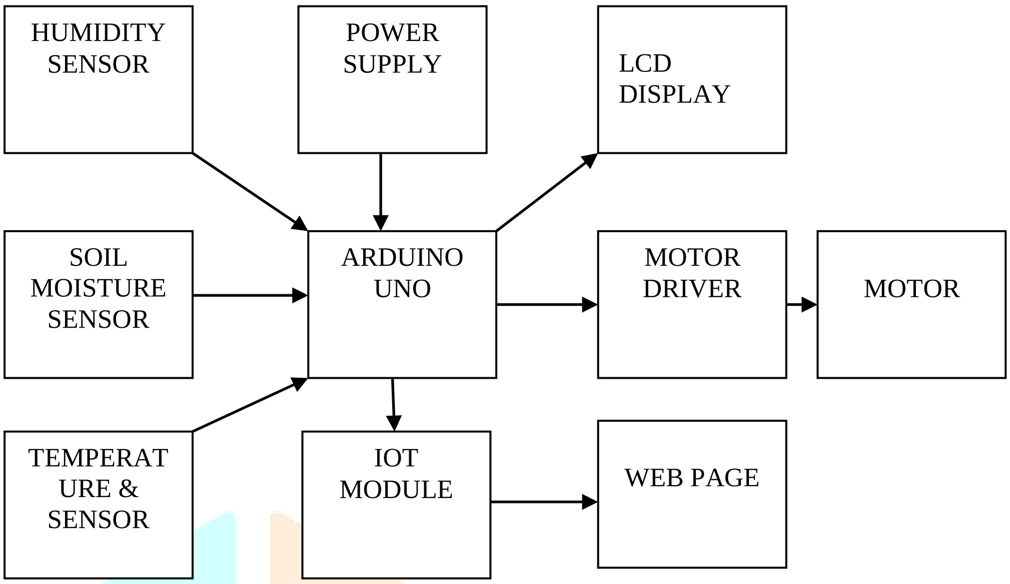

Fig – 1 : Block diagram of Monitoring system

In the agricultural field section, a variety of sensors, including tempe-rature sensors, moisture-sensors, ultrasonic sensors, and humidity sensors, are strategically positioned. These sensors collect critical data, which is then seamlessly integrated with an Arduino UNO for processing. The valuable information gathered from these sensors can be readily visualized on an LCD display, providing users with real-time insights into the field's conditions.

Received data in the control section, the is meticulously cross-referenced with predefined thre-shold values. If the moisture level registers as insufficient, the Arduino promptly triggers a water pump, ensuring the plants receive the necessary hydration. Once the system detects an optimal soil moisture level, it automatically halts the water pump operation and promptly notifies the user via the IoT module, keeping them updated on the water pump's status and soil moisture levels. This intelligent system also factors in the potential threat of pest infestations and offers a solution through precise pesticide application. The proposed irrigation system combines efficient water management and targeted pesticide spraying for optimal crop care.

Parameters such as moisture content, temperature, and humidity are continuously monitored by a network of sensors, facilitating informed decision-making. The precise delivery of water- pesticides is orchestrated by a spray-motor and a motorized pump, enhancing the efficiency of agricultural processes. Furthermore, the inclusion of an ultrasonic sensor enables remote plant growth monitoring, allowing users to observe the status of their crops at any time and from anywhere via a dedicated web interface supported by the IoT technology.

In the current system, the integration of Thingspeak, an iOS-compatible platform, offers advanced control over the Arduino-based hardware. This empowers users to closely monitor plant growth via the ultrasonic sensor and receive real-time updates on the dedicated webpage through the IoT module. Additionally, the system ensures timely and automatic watering through predefined time delays, optimizing resource utilization in the agricultural field.

Hardware

The ATmega328 is a versatile single-chip microcontroller developed by Atmel as part of their megaAVR family. AVR is 8-bit RISC-based microcontroller boasts an array of features, including 32 kB ISP flash memory with read-while-write capabilities, EEPROM-1kb, SRAM-2kb, general-purpose I/O lines-23, generalpurpose working registers-32, flexibletimer-counters with compare modes-3, support for internal and external interrupts, a serial programmable USART, a byteoriented- 2-wire serial- interface, SPI serial port, and a 6-channel 10-bit A/D converter (8 channels in TQFP and QFN/MLF packages). It also includes a programmable watchdog timer with an internal oscillator and supports five software-selectable power-saving modes. Operating in the voltage range of 1.8 to 5.5 volts, this microcontroller achieves impressive throughput approaching 1 million instructions per second (MIPS) per megahertz.
In the context of the project at hand, we are utilizing an Arduino UNO, which is a microcontroller board based on the ATmega328P. The ATmega328P comes equipped with 32 kB of flash memory for storing your code. The Arduino UNO board offers a set of digital input- output-14 pins, analog-inputs-6, a 16 MHz quartz crystal, USB connectivity, an ICSP (In-Circuit Serial Programming) circuit, and a reset button for user-friendly development. With the Arduino software, programming this versatile microcontroller is made accessible and convenient for a wide range of applications.

YL-69: Soil moisture sensor

A soil-moisture-sensor, also known as a hygrometer, is a crucial tool employed to assess soil humidity levels. Comprising two key components, this sensor consists of an electronic board and a probe equipped with two sensing pads, specifically designed to gauge water content. The sensor is equipped with several features, including a built-in potentiometer for adjusting sensitivity in relation to its digital output, an indicator LED for power, and a digital output LED. The voltage output by the sensor varies in response to the soil's moisture content. Essentially, the soil moisture sensor serves the purpose of quantifying the water content within the soil. When the sensor registers a soil moisture reading surpassing a predefined threshold value, it outputs a low-level signal (0V), whereas if the moisture reading falls below the threshold, it outputs a high-level signal (5V). This digital output, conveyed via the digital pin, directly informs users about the current soil moisture level, allowing them to assess whether it meets the desired threshold.

DHT11:Temperature and Humidity sensor

The DHT11 stands as a fundamental, highly affordable digital sensor designed to detect temperature and humidity. Its functionality relies on a capacitive- humidity- sensor paired with a thermi-stor to accurately gauge the conditions of the surrounding air, transmitting the data as a digital signal via its dedicated data pin. Notably, it doesn't require any analog input pins to operate effectively. The DHT11 sensor plays a pivotal role in measuring both temperature and humidity with precision. Furthermore, sensor supports signal transmission over a distance of up to 20- meters, making it a versatile choice for various applications.

Ultrasonic Sensor

The sensing –probe- element comprises a unique wire-cable designed for precise surface-level detection in a wide range of fluids, encompassing water, salt water, and various types of oils. This sensor-element is engineered with electrical insulation and isolation, ensuring that it remains impervious to corrosion, even after prolonged exposure to the liquid it is immersed in. It offers a robust and enduring solution for fluid level monitoring.

IoT Module:

The Internet of Things (IoT) represents a transformative paradigm where various entities, whether objects-animals- individuals, are equipped with distinctive identifiers and empowered to seamlessly exchange data across networks. This interconnected ecosystem operates independently of direct human-human or human-computer interactions, giving rise to a network of unprecedented scale and potential. IoT has its roots in the convergence of wireless technologies, specifically Micro-Electro-Mechanical Systems (MEMS), and the vast landscape of the Internet. In some contexts, this groundbreaking concept is also termed the "Internet of Everything." Within the Internet of Things, a "thing" can take on numerous forms, encompassing a person equipped with a heart monitor, a farm animal with a biochip- transponder, or even a vehicle equipped with built-in sensors that can alert the driver when tire- pressure falls below safe levels. This interconnected web is redefining the way we perceive and interact with the world around us.

IV.RESULT AND DISCUSSION

Following the signal conditioning phase, the humidity and soil temperature data is seamlessly transmitted through the Wi-Fi module integrated into the proposed system. This data is then efficiently received by the user's device via an open-source IoT server, ensuring real-time access. These readings, encompassing sensor data for soil and crop temperature as well as humidity, are displayed over time. Whenever the signal diverges from the predetermined system reference values, corresponding alerts are communicated to the field section, prompting user intervention. In instances where soil moisture levels dip below the recommended range, the system promptly transmits a notification to the user through the Wi-Fi module and IoT server, enabling the user to issue corrective commands through the same communication channel. The system's output also furnishes users with essential data on plant height, which is calibrated according to the system's specifications. Key components of the system include Humidity, Temperature, and Moisture sensors linked to an LCD module, an Arduino UNO, an Ultrasonic sensor for plant growth monitoring, and an IoT module for data transmission. Furthermore, motor-driven pumps and pest sprayers have been integrated for irrigation and pest control, with a versatile stepper motor facilitating both forward and reverse operations.

V. CONCLUSION AND FUTURE SCOPE

This system proves invaluable for monitoring vital agricultural parameters such as temperature-humidity-moisture levels- leaf growth, and the precise dispensing of water and pesticides through a motorized pump via an IoT module. It significantly reduces the need for manual labor and human intervention. This setup is built upon Arduino UNO, incorporating Temperature as well as Humidity sensors, soil-moisture sensors, ultrasonic sensors, and an IoT module. Moreover, a user-friendly Thing-Speak platform can be developed to facilitate system control via mobile devices, leading to reduced damage from predators and enhanced productivity. The inclusion of an ultrasonic sensor allows for real-time plant health monitoring, enabling users to observe their crops remotely on the web. Looking ahead, the integration of new hardware, like corn-tending robots, demonstrates the fusion of data-collecting software with robotics for tasks such as fertilizing corn, applying seed cover crops, and collecting data to optimize yields while minimizing waste. IoT sensors with the capacity to provide precise information about crop yields- pest infe-station, and soil nutrition will continue to play a pivotal role in modern agricultural production.

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