Advance Agriculture Monitoring System

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Abstract: The Indian agricultural sector makes up approximately eighteen percent of the gross domestic product (GDP) and accounts for around forty percent of the total rural Net Domestic Product (NDP). Despite its significant contribution to the country's economy, the Indian agricultural system faces several challenges. One of the primary issues is its partial reliance on traditional practices. By making the agricultural system smart, the farmers in due course of time would be able to have a higher yield, effective management. Also, the chances of human errors would also reduce tremendously like disproportionate supply of water to the crops and imbalanced use of fertilisers and pesticides.In this paper our main focus is to smartly increase the yield and productivity of the crops by taking into account the different agricultural parameters like soil moisture content, soil temperature etc. This is where the Internet of Things (IOT), machine learning, and cloud computing and artificial intelligence comes into play. Also, the data collected is stored in the cloud for reference. Moreover, this paper will also enable the farmers to get the timely information regarding the moisture content level of the soil through a mobile application. The main objective of our work is to help the farmers through a smart agricultural system that focuses mainly on irrigation with the help of IOT, which will optimise the water usage in the crop plants.

Keywords: Internet of Things, Machine learning, Smart monitoring.

1. Introduction

In today's technological era, so many farm hands lack essential knowledge on agriculture, leading to capriciousness in their practices. Maximum farming and related activities extremely rely on predictions and forecasts. When these forecasts fail, farmers often face considerable losses, and some are driven to desperate measures such as suicide. Understanding the importance of factors like soil quality, air quality, irrigation, and crop growth parameters such as humidity, temperature, and moisture is crucial. The concept of the Internet of Things (IoT) was introduced in 2009, with the aim of connecting all devices and gadgets to the internet. IoT is continually evolving, and it has significantly improved various aspects of our lives, including business, healthcare, and society. IoT-based products have made our lives more convenient. The forecast suggests that by 2020, there will be an estimated 50 billion devices linked to the internet, representing a market value of $14 trillion. The Internet of Things (IoT) is a swiftly advancing domain that carries significant implications for technical, social, and economic progress. In the realm of computer technology, five prominent topics have emerged in the modern world: IoT, Big Data, Cloud Computing, Data Mining, and Cyber Security. Among these, IoT is particularly focused on devices. The progression of IoT is steered by the merging of diverse technologies, encompassing real-time analytics, machine learning, commodity sensors, embedded systems, and more, which collectively contribute to the materialisation of the Internet of Things. IoT devices are increasingly designed for a wide range of applications, including consumer, commercial, industrial, and infrastructural uses. In recent years, a significant trend has emerged in the development of IoT devices, resulting in explosive growth in the number of interconnected and internet-controlled devices. While the specifics of IoT applications can vary widely, there are fundamental characteristics shared by most IoT devices.

2. Related Works

Numerous research teams worldwide are dedicated to the advancement of intelligent agriculture monitoring systems. Izzatdinet al., in 2008, introduced a system called "Remote Monitoring in Agricultural Greenhouse Using Wireless Sensors and Short Message Service (SMS)," where data was transmitted through SMS. In contrast, our proposed system transmits the data to a mobile application.

In 2010, J. Hwanget al. presented a paper introducing an Arduino-based remote irrigation system designed for agricultural plantations situated in remote areas. This system was developed to supply water to the plantation when the soil humidity fell below a predetermined threshold. However, the initial system lacked the capability to monitor soil moisture levels. To address this limitation, our proposed system has been enhanced with an additional feature: it now provides real-time soil moisture and temperature values, which are accessible to the farmer through a mobile application.

In 2011, M. Dursun and S. Ozden introduced "A wireless application of drip irrigation automation supported by soil moisture sensors." Their paper described irrigation based on soil moisture measurements. In addition to this, our proposed system incorporates the display of temperature and humidity values.

The paper titled "Automatic Irrigation System on Sensing Soil Moisture Content," authored by C. Arun and K. L. Sudha in 2012, aims to establish an automatic irrigation system that activates and deactivates the pumping motor based on soil moisture levels. However, the paper focuses solely on soil moisture values. In contrast, our proposed paper expands upon this existing system by introducing temperature and humidity values as additional parameters.

In 2013, S. R. Kumbhar and A. P. Ghautule developed the "Microcontroller based Controlled Irrigation System for Plantation." Their paper employed an older-generation microcontroller with limited memory to control the system. In contrast, our proposed system utilises the Arduino Yun board, which is more user-friendly and facilitates easy program uploading.

In 2014, L. Shabadi created a system called "Irrigation Control System Using Android and GSM for Efficient Water and Power Management." This system utilised GSM for control, which could potentially incur higher costs. To address this issue, our proposed system incorporates the Arduino Yun board, which comes equipped with a built-in Wi-Fi module, offering a cost-effective alternative.

In 2015, A. Nayyar and V. Puri unveiled an IoT-based smart stick tailored for real-time monitoring of diverse agricultural parameters. This innovative agricultural IoT stick empowers farmers to promptly acquire up-to-the-minute data on temperature and soil moisture. The fundamental idea behind this device is a "plug and measure" concept, enabling farmers to swiftly implement a smart monitoring system by situating the stick in their fields and receiving real-time data on their smart devices like tablets and smartphones. The data collected by the embedded sensors can be effortlessly analysed and processed by agricultural experts, even in remote areas, thanks to the utilisation of cloud computing technologies.

In 2016, A. C. Pusatkar and V. S. Gulhane directed their attention toward the application of Wireless Sensor Networks (WSN) for real-time agricultural field monitoring. The paper underscores the problem of stagnant agricultural yields and introduces the monitoring of additional parameters. In addition to the traditional factors like humidity, temperature, and soil moisture, this paper emphasises the monitoring of water levels, flood conditions, wind direction, wind speed, and weather. Conventional agricultural papers often depend on wired communication, which poses numerous challenges. Consequently, the paper advocates for the adoption of wireless networks.

The authors also propose an alert system to notify farmers, and the model incorporates various technologies like Global System for Mobile (GSM), ZigBee, General Packet Radio Service (GPRS), and Global Positioning System (GPS) to ensure secure data transmission. The model also suggests an automated irrigation system, powered by embedded systems, to reduce the energy and financial burden on farmers. This paper aims to optimise water usage, thereby increasing farm yields and promoting efficient water management and sustainability in the proposed irrigation system.

In 2017, L. C. Gavade and A. D. Bhoi proposed a model aimed at detecting soil humidity, temperature, sunlight, as well as the contents of N, P, and K using sensors deployed in agricultural fields. By assessing these parameters, farmers can enhance soil productivity by identifying nutrient deficiencies. India's average agricultural productivity falls below the global average, and this paper offers a strategy to achieve an "evergreen revolution" in agriculture, with the aim of boosting yields.

Fertilisers are essential for achieving robust crop yields, yet an improper balance of P, K, and N can result in reduced productivity. Traditional methods rely on manual soil sampling, but this paper introduces a chemical analysis approach that incorporates three techniques: optical methods, conductivity measurement, and electrochemical methods. These techniques are valuable for the measurement of primary nutrients in the soil.

3. Problem Definition

Leveraging technology in farming and cultivation necessitates a comprehensive understanding of deep learning in agricultural practices and science. Constructing a system that optimises the cultivation process, thereby enhancing the efficiency and sustainability of agriculture, demands careful consideration and in-depth exploration of various factors. The goal is to develop a precise agricultural system that can benefit numerous farmers and be adapted to diverse contexts.

We should be ready to address inquiries such as: Is it viable to create a framework capable of accommodating a wide range of scenarios within an agricultural context? How does automation function within agriculture, and at which stages of the cultivation process is it applied? What is the overall cost and benefit of employing cultivation processes, and how can cost reduction be achieved through automation? What are the fundamental components required for designing smart farming techniques, and which element within this process tends to incur the highest expenses, and how can these expenses be minimised? To what extent and by what means can cost reduction be accomplished? Do geographical factors like temperature, soil mineral content, moisture levels, location, and seasonal variations have a substantial impact on the cultivation rate? What parameters are taken into consideration during the cultivation process?

These questions may remain unanswered even by experts, as horticultural science encompasses a multidisciplinary field where all the aspects listed must be meticulously considered when making decisions. Additionally, agricultural research is closely tied to specific geographical regions, as the climate and soil characteristics can vary significantly from one location to another.

4. Proposed Design Hardware & Software Selection

As previously mentioned, the primary objective of this paper is to develop a highly efficient IoT-based smart agricultural system. This system is designed to detect and monitor soil moisture levels, ambient temperature, and humidity using handheld devices.

4.1 Devices Required

The system comprises a NodeMCU that incorporates a soil moisture sensor for measuring soil moisture content, a DHT11 sensor for monitoring temperature and humidity, and an automatic water irrigation system. To execute this setup, we have utilised the Arduino platform to program the hardware components assembled on a PCB.

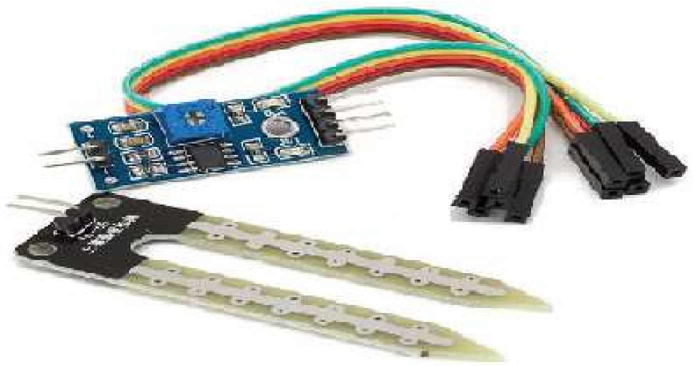

Figure 4.1 Soil Moisture Sensor Module (Source: Soil Moisture Sensor, 2021)

The soil moisture sensor module is a user-friendly sensor that supports both analog and digital readings. It allows for the measurement of moisture or water content in the soil simply by inserting it into the ground. When the soil's moisture level is low, the sensor produces a digital output of 0V, and it generates a 5V output when the moisture level in the soil is high.

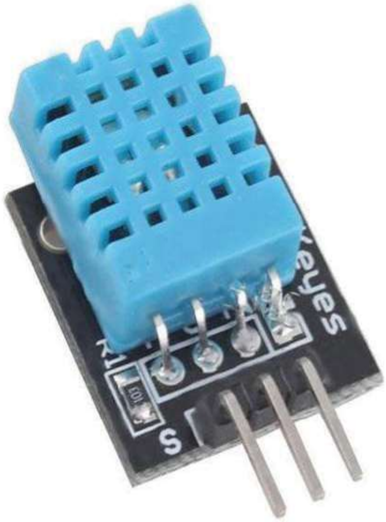

Figure 4.2 *DHT11 Sensor Module* (Source: DHT11, 2018)

The DHT11 is a sensor module that is capable of providing calibrated digital outputs for both humidity and temperature. It can be easily connected to various microcontrollers, such as Raspberry Pi, Arduino, and more, delivering instantaneous results. Despite being a cost-effective sensor for humidity and temperature, the DHT11 offers high reliability and long-term stability.

5. Flowchart and Working Principle

Once the data from various sensors, including humidity, temperature, and soil moisture, is collected, it is transmitted to the Blynk cloud via the internet and then to the user's Blynk mobile application. If the soil's moisture level falls below a predefined threshold, the user's app will receive an alert message, and the motor will be automatically activated using a relay.

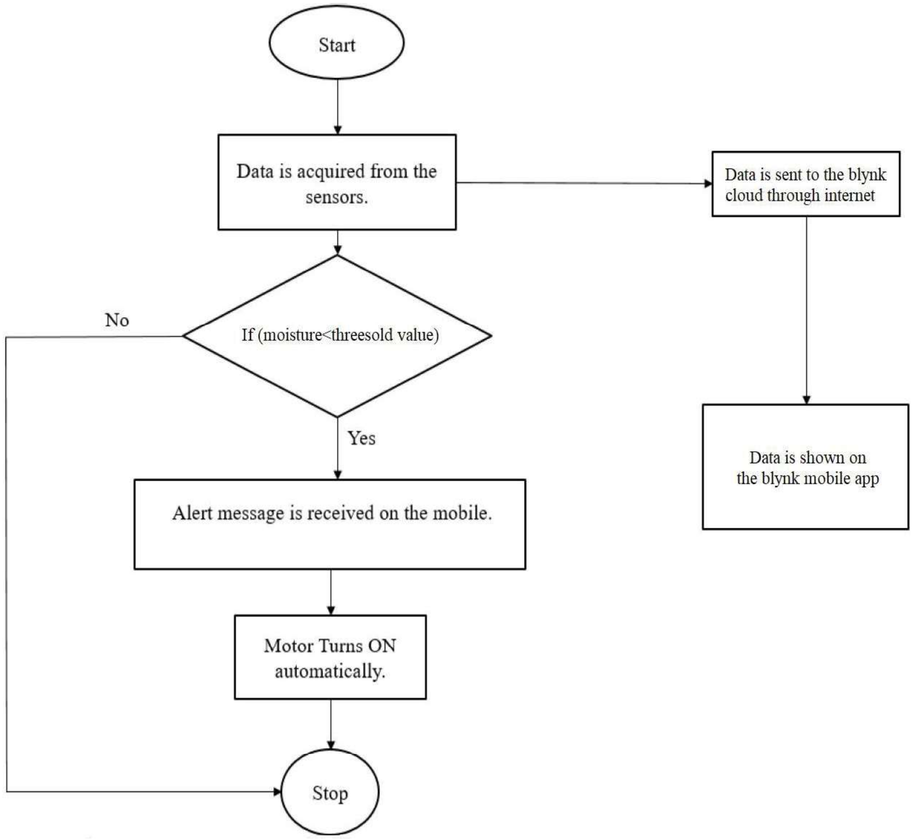

Figure 5.1 shows the flowchart of the proposed design

6. Conclusion

Our paper delves into the integration of smart technology, specifically the Internet of Things (IoT), in the agricultural sector. We are aware that farmers invest a significant amount of effort and time into periodically watering their fields. Often, an inappropriate amount of water is supplied to the soil, resulting in oxygen deficiency and hindering the proper growth of plants. The smart irrigation technique highlighted in our paper ensures that the soil receives regular and proportional watering through the various mechanisms discussed earlier. Additionally, it simplifies the work of farmers by enabling them to monitor soil moisture content and temperature through a mobile-controlled application. The data stored in the cloud facilitates agriculturalists in devising strategies to enhance yield. Our paper introduces a cost-effective, economically viable, and sustainable model. We place a strong emphasis on the integration of IoT in agriculture, and the concepts outlined in this report aim to significantly enhance traditional farming practices, ultimately leading to increased yield and productivity.