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Smart Farming System Using IoT For Efficient Crop Growth

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***Abstract*—Technology is crucial for Indian agriculture, which employs half of the population and impacts the country's economy. However, natural factors hinder operations, and there have been slow technological advances. By embracing effective technology, farmers can boost yield and make informed decisions on which crops to sow. It's time to leverage technology to improve the agriculture sector in India.**

***Index Terms*—Raspberry Pi 4, PH sensor, Soil moisture sensor, Rain sensor, Light sensor, Temperature and humidity sensor, 16*2 Lcd, Jumper wires.**

I. Introduction

Crop growth and yield have significant impacts on agriculture and farmers. Automated recognition of agricultural diseases is necessary for accurate identification[1]. This chapter provides an overview of my recommended research technique, including its history, problem description, objectives, and scope. Illiteracy among farmers is a major cause of rising microbial infection rates. Farming has become more industrialized and technology-driven, with smart agricultural devices allowing for greater control over the process of producing crops and rearing animals. Smart farming, based on IoT, reduces waste and increases output by monitoring factors such as fertilizer usage and vehicle trips, enabling effective resource management. IoT-based smart farming solutions use sensors to monitor crop fields and automate irrigation systems, streamlining the process.

II. Literature Survey

Agriculture is the oldest profession and foundation of civilization. Plants are living beings susceptible to various illnesses caused by microorganisms. Plant diseases can cause significant damage to crops and even pose a threat to human life. The Irish Famine in 1840 is an example, where millions died of starvation due to the late blight of potato disease decimating the potato crop. Plants are essential to our survival. This study assesses the land available for bioenergy projects in 2050 without compromising food security. It considers factors such as food waste, low-productivity land, urban agriculture, and insect protein use. The methodology is based on population food needs, agricultural productivity changes, and available surplus land for biofuel production. The research defines three scenarios: optimistic, ideal, and pessimistic. Social segmentation differences were not considered by the authors.[1] Industry 4.0 emerged from evolving technologies and changing expectations. Monitoring water quality is vital to prevent waste and ensure a healthy environment. IoT technology enables real-time water quality monitoring and control using sensors measuring parameters for residential water use. The system should support independent operation.[2] Precision agriculture (PA) and smart farming (SF) are gaining attention from both the agriculture sector and research community. These technologies utilize IoT devices to improve farmers' use of inputs (such as pesticides and fertilizers), but they also introduce new security risks. To increase awareness and enable further research in this area, a security survey is necessary. This paper lists the security features of SF and PA, outlines the types of cyberattacks that can compromise these features, and provides a taxonomy.[3] The term "Internet of Things" (IoT) is applied specifically to the power industry as "UPIoT." This integration of communication and power networks provides complete system status perception and business penetration across all power production, transmission, and consumption links. Edge computing satisfies the demands of real-time perception, quick response, and privacy protection in UPIoT. However, there has been no comprehensive study on the use of edge computing in UPIoT. This paper presents the history, architecture, and construction challenges of UPIoT, followed by a detailed analysis of its functionalities.[4] Effective water management is crucial in nations where water is scarce, especially for agriculture. Research on reducing irrigation water usage has grown due to potential impacts of global warming on water supply for food production. However, smaller farms often cannot afford typical commercial irrigation sensors. Manufacturers have developed inexpensive sensors that can be linked to nodes to create affordable farmland monitoring and irrigation management systems. WSN and IoT technology have facilitated these developments.[5] Countries are utilizing various technologies to improve agriculture efficiency and sustainability. SMART irrigation, which employs IoT and sensing technologies, can promote water efficiency and contribute to SDGs, including Goal 6 and Target 6.4.[6] India's population is over 1.2 billion and growing rapidly. This will lead to a food shortage in 25-30 years, making agricultural growth necessary. Farmers are struggling due to lack of rainfall and water scarcity. An autonomous irrigation system is being developed to monitor soil macronutrient levels (N, P, K) and save time, money, and electricity. Soil samples are tested using a color chart to measure nutrient levels.[7] Precision fertilizer application boosts crop yield while reducing over-fertilization's negative effects. Smart fertilizer management uses data, sensors, and smart instruments for accurate fertilization. Advance prediction technologies enable precise N fertilization, and damage caused by nutritional deficiencies can be diagnosed using RGB pictures. Nutrient biomarkers can predict the status of a single nutrient with high accuracy.[8] It's fascinating to think about how agriculture played such a crucial role in human evolution and the development of our society. Thanks to digital technology, we can design more efficient systems for agriculture and increase output. Precision agriculture is a prime example of this, and there have been many recent efforts to improve farming using technology. One such project is an IoT-based system that farmers can use to monitor microclimates in their fields. It's exciting to see how technology is helping to revolutionize the agriculture industry and make it even more productive.[9] Digital twins are a new era in smart greenhouse horticulture. They are a digital representation of a real-world object that duplicates its behavior and states across time in a virtual environment. Research shows that they can increase production and sustainability while addressing the lack of green workers in greenhouse horticulture. A systematic literature assessment on Digital Twin applications in greenhouse horticulture identified 8 papers that explicitly address Digital Twins, as well as 115 studies that implicitly apply the Digital Twin idea to IoT-based systems. The findings suggest that the concept of the Digital Twin is in a pivotal phase.[10] The paper presents a method for creating orthonormal coordinate bases to optimize class separability indexes using redundant dictionaries of biorthogonal bases, which is useful for multiclassification issues with embedded classes. The approach trains wavelet networks with sine and cosine wavelet packets as basis functions and maximizes the Cross Entropy function between two complimentary classes. The packet structure of the approach allows for an adaptable number of bases once the tree depth is chosen.[11] Smart farming uses technology to increase output and reduce environmental impact. Farm management information systems (FMISs) automate agricultural operations. Many FMISs now use IoT technologies to improve business goals, but they require specific functional and quality requirements. Developing an IoT-based FMIS requires designing the necessary components to meet these requirements.[12] This research proposes an IoT-enabled smart drip irrigation system that accurately meets increasing watering demands. Web/Android apps monitor and regulate drip irrigation systems, reducing human intervention and water waste. The system automatically waters plants based on predetermined conditions, promoting efficient water use.[13] Our study focuses on implementing a smart agriculture system that allows farmers to access field data easily via Wireless Sensor Networks (WSN) from a web or mobile application. Real-time WSN data for temperature and soil moisture is shown via the app, and crop schedules can be visualized. The program also allows real-time tracking of crop transplant and harvest times for each month, with an automated technique used to minimize water usage.[14] Surface irrigation is common in agriculture due to its simplicity, but it often leads to improper irrigation application. A study was conducted using an IoT-based system to develop and test an automatic check for a closed-end level basin layout in loamy soil.[15] Our quick-deploy crop health monitoring system uses IoT and drone technology to collect data from agricultural fields and take necessary measures. We focus on clustering IoT devices and localizing them for data harvesting, taking into account UAV paths, sensor heterogeneity, weather conditions, and IoT device communication costs. Localization is achieved with smaller UAVs carrying arrays of antennas and receivers.[16] The use of IoT and UAVs in agriculture has led to a shift towards precision farming. In this study, we provide an overview of recent research on IoT and UAV technology in agriculture, covering fundamental technology such as intelligent sensors, sensor types, networks, and protocols, as well as IoT applications and smart agricultural solutions.[17]

III. Methodology

A. SYSTEM BLOCK DIAGRAM

The block diagram of proposed Smart Farming System using IoT is shown in fig:1:

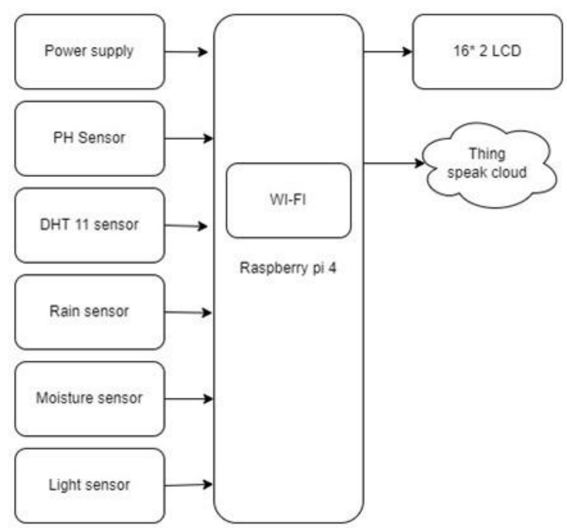

Fig. 1. Block of Proposed Smart Farming System

B. Hardware

a) **Raspberry Pi 4:**

The below Fig:2 shows that the structure of Raspberry Pi is a small computer that performs the functions of a microcomputer and a network. The Internet of Things relies heavily on these components. With Internet access, automation systems can be connected to remote control devices. Raspberry Pi is available in different versions. Pi2 model B is used here.

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It has a 900 MHz and quad-core ARM Cortex-A53 CPU and 1 GB of RAM. The device has 40 GPIO pins, full HDMI port, 4 USB ports, Ethernet port, 3.5mm audio jack, Video Camera Interface (CSI), Display Interface (DSI) and Micro SD card slot.

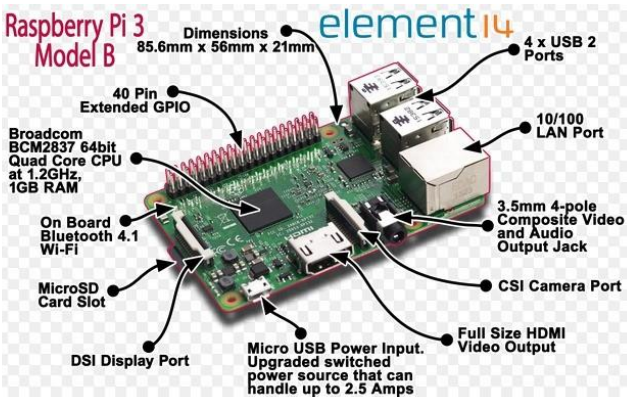

Fig. 2. Raspberry Pi 4

b) **DHT 11 Sensor:**

The below Fig:3 shows that DHT 11 is a basic, inexpensive digital temperature and humidity sensor. Because it outputs a digital value, it can be connected directly to the data pin instead of the ADC. Includes a powerful sensor to detect humidity. The only limitation of this sensor is that it only provides new data every 2 seconds.

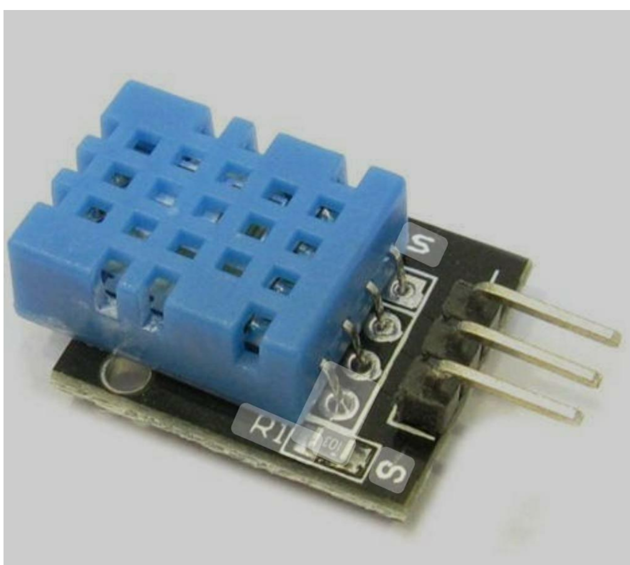

Fig. 3. DHT 11 Sensor

c) **Light Sensor:**

The below Fig:4 Light sensors help farmers monitor ambient light levels to ensure that plants receive adequate light for growth. By using this information, farmers can optimize their plant growth and maximize crop production.

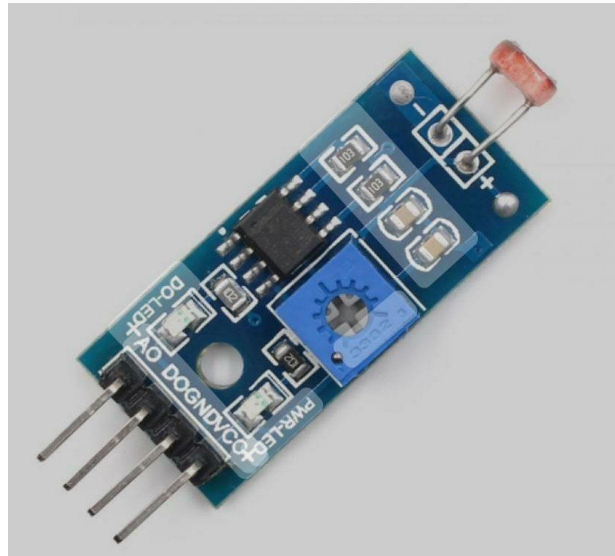

Fig. 4. Light Sensor

d) **Rain Sensor:**

The below Fig:5 Rain sensors help farmers adjust irrigation schedules based on real-time rainfall data. By temporarily turning off irrigation during heavy rainfall, farmers can prevent waterlogging and root rot, which can be harmful to crop health. This is a great example of how technology is being used in agriculture to promote sustainable practices.

Fig. 5. Rain Sensor

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e) **PH Sensor:**

The below Fig:6 PH sensors help farmers ensure that their soil is in the ideal PH range for the crops they are growing. By monitoring soil PH levels, farmers can promote healthy plant growth and maximize crop yields.

Fig. 6. PH Sensor

f) **Soil Moisture Sensor:**

The below Fig:7 Soil Moisture Sensor measures the amount of water in the soil. It uses the electrical resistivity properties of the soil. The The relationship between the measured property and soil moisture is calibrated and varies depending on such environmental factors such as temperature, soil type or electrical conductivity. Here it is used to sense the moisture in the field and transfer it to the raspberry pi to see the water pump on / off Map control.

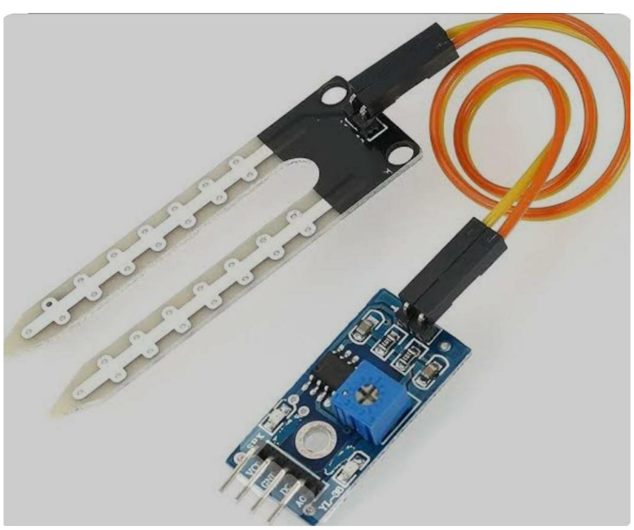

Fig. 7. Soil Moisture Sensor

C. Software

a) **Python:** Python is a popular programming language that was created by Guido van Rossum and first released in 1991. It is an interpreted, high-level language that is designed for a wide variety of applications. One of the key features of Python is its focus on code readability and its use of concise syntax, which allows programmers to express complex ideas with relatively few lines of code. Python is well-suited for both small and large-scale projects and is used by developers all over the world.

IV. Results and Discussions

The Raspberry Pi 4 can be connected to sensors and LED displays, and programmed using Python IDLE. The output can be viewed on Real VNC Viewer, and the LCD display can show data such as temperature, moisture, pH sensor, and resistance values in shows in below fig:8.

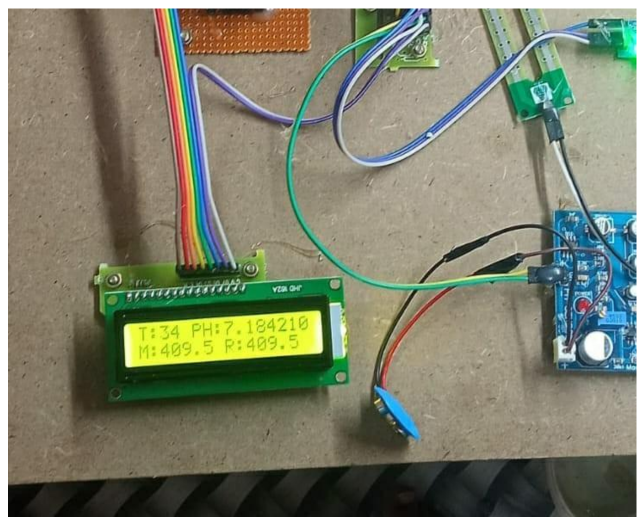

Fig. 8. 16*2 lcd

Using Python to develop the agricrop code to discover optimal crops for the season is a great way to maximize yields and profitability for farmers. The VNC viewer provides a user-friendly interface for analyzing the output data. Overall, this technology is a promising innovation for the agriculture industry as shown in below in fig:9.

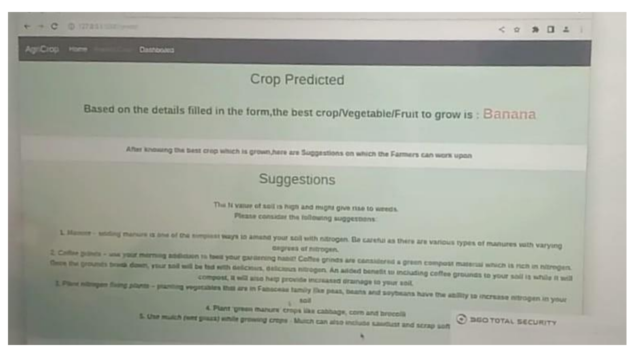

Fig. 9. Agricrop

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V. Conclusion

Smart farming and crop recommendation using Raspberry Pi offer numerous benefits, including cost-effectiveness, real-time monitoring, and automation of farm operations. Despite some limitations such as processing power constraints and dependence on internet connectivity, Raspberry Pi-based solutions have significant potential to enhance productivity, sustainability, and profitability in agriculture. However, careful consideration of security, scalability, and technical support is essential for successful implementation.

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