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Improvements in Plant Health Monitoring through Internet of Things (IoT)

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Abstract—

The ultimate aim of this concept is to reduce labour demands on farmers, allowing them to save money for increased stockpiling. Farmers typically see a decline in income due to bad harvests. Among the many significant reasons that contribute to this are the lack of nutrients, the moisture of the soil, the variations in temperature, and so on. As a result, the prevalence of diseases in the crop reduces both its quality and its yield. New, state-of-the-art IoT gadgets can effortlessly monitor agricultural regions and report on their current state. In this article, we'll go over the steps required to construct a smart agriculture system utilizing state-of-the-art technologies like Node MCU, the Internet of Things, Android, Wireless Sensor Networks, Keeping a close eye on weather trends and the early detection of plant diseases is essential for increasing agricultural output. The proposed system can monitor temperature, humidity, and moisture using sensors using NodeMCU, and it can send SMS alerts and a notification on the application created for the same on the farmer's smart phone over Wi-Fi/3G/4G. The technology uses cellular networks and the Internet protocol to facilitate a two-way communication connection. Farmers may be able to detect plant diseases early using this reliable, non-destructive method. Three different types of tomato plants were used to develop an Internet of Things (IoT) based approach to plant disease diagnosis (two infected and one healthy).

Keywords— Internet of Things (IoT); Smart Farming; Machine Learning; Soil Moisture sensor; Temperature and Humidity sensor;

I. INTRODUCTION

Farming is the process of cultivating land for food production and animal husbandry is the study of producing food and other goods from animals. Farming isn't just about making money; it's fundamental to human society, and its ultimate aim isn't only to sustain but to elevate the lives of the people it serves. The success of the agriculture sector is crucial to the well-being of any society. With a shrinking agricultural labour base over the past few decades, more farmers are turning to internet connectivity technologies to automate previously labor-intensive tasks.

The Internet of Things (IoT) is a system that links common household items to one another and to remote servers. IoT solutions are being created to assist farmers in increasing yields while keeping costs down and safeguarding the environment, with the ultimate goal of reducing the demand-supply gap. Guaranteeing the optimal use of resources to maximize crop yield while reducing overhead costs through the use of IoT technology. Connected sensors in the IoT can reveal useful data about farms. Farmers can use this technology to monitor their crops without having to personally visit the fields.

Their research [1] examined the use of cloud computing as the backbone for various distinct types of IoT sensor monitoring networks in agriculture. The information gleaned from this survey will be used to better understand the wide range of technology now in use, with the ultimate goal of advancing the cause of sustainable and intelligent agriculture. You can use technology to monitor and control factors like humidity and temperature, as well as to search for and locate unseen animals. The amount of water in the soil may be determined thanks to the soil moisture sensor. Infrared (PIR) sensors detect animals and indicate them as a high-frequency signal. Composting can go more quickly if a pH sensor and a water stream sensor are used. After compiling this data, the water pump's power supply will activate automatically to provide the ideal amount of water for the field. With the provided microcontroller address, the field's current status can be viewed online. They developed a mobile app for farmers and VA staff as part of the effort. The farmer and VA officer can both use the app to gain insight about the land's condition [2]. The information gathered from the article's review [3] could help in the early detection of agricultural diseases. Agricultural output is diminished by plant diseases, which are caused by both biotic and a biotic factors. It is possible to diagnose the state of a plant's health by analyzing diagnostic information included in images of the plant. Increased agricultural yields are a direct result of early disease identification. A number of techniques for extracting features, segmenting photos, and classifying them are explored in length in [3], many of which have been used by agricultural researchers. Multiple strategies for plant survival in the face of advances in digital image processing are discussed.

There are a wide variety of image processing techniques that can be used to identify plant leaf diseases, including image acquisition, image pre-processing, image segmentation, feature extraction, and image classification. When noise is present in a picture, it can be removed using a variety of filtering methods, greatly simplifying the process of diagnosing a condition. The analysis of plant disease symptoms using digital and mobile phone images has proven difficult. Classifying plant diseases using machine learning algorithms has been increasingly popular recently, and early results are encouraging for some diseases and crops. Thanks to recent advancements in deep Convolutional Neural Network (CNN) based architectures, classification accuracy has improved significantly. In this work, we provide an IoT-based system for monitoring farmland, and we utilize a VGG16 pre-trained deep learning model to classify images of tomato crops into one of three categories based on the presence or absence of two disease classes and a healthy class. This protocol enables a wide range of sensors to send data over the internet. Growers can use their smart phones to keep tabs on their crops without leaving the house. This technology presents a clever solution to the problem of how to increase crop yields by detecting diseases early on, by monitoring a wide range of parameters that affect farming. Sensors for soil moisture, humidity, and temperature are all part of the Internet of Things setup (DHT11). It is necessary for the NodeMCU to communicate with the sensors (ESP8266).

The following is a flow diagram of our planned IoT system:

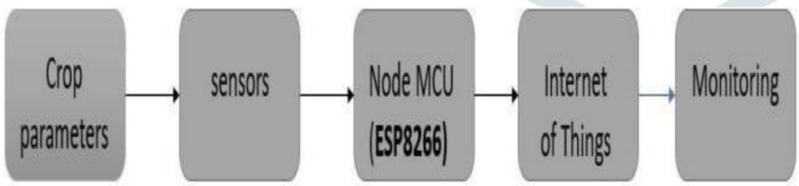

Fig. 1. Flow Diagram of IoT System

II. EXISTING SYSTEM :

This paper aims to build a sophisticated system for keeping tabs on farmland and identifying plant illnesses. The following results are desired in order to accomplish the set goals:
The purpose of this exercise is to learn to recognize the many plant diseases that can affect a crop at any given time. To monitor conditions like moisture, temperature, humidity, and dew point in the soil. Give farmers instant updates and notifications via a mobile app. To facilitate farming by allowing farmers to run their businesses from the convenience of their own homes.

III. PROPOSED SYSTEM

As part of the Internet of Things (IoT)-based Smart Agriculture System, a mobile application is made available to farmers. Soil moisture, temperature, and humidity are just a few of the many parameters that may be measured by our Internet of Things-based hardware solution. The software download features an agriculture-specific app for Android devices. We developed an Android app that communicates with the hardware system over the Internet of Things and notifies the farmer of any changes in the field's environment, such as temperature or humidity.

3.1 IOT SYSTEM :

We use an Internet of Things (IoT)-based system to keep tabs on things like temperature and humidity (using a sensor called DHT11), soil moisture, and more (soil moisture sensor). The following image is a schematic of the IoT system.

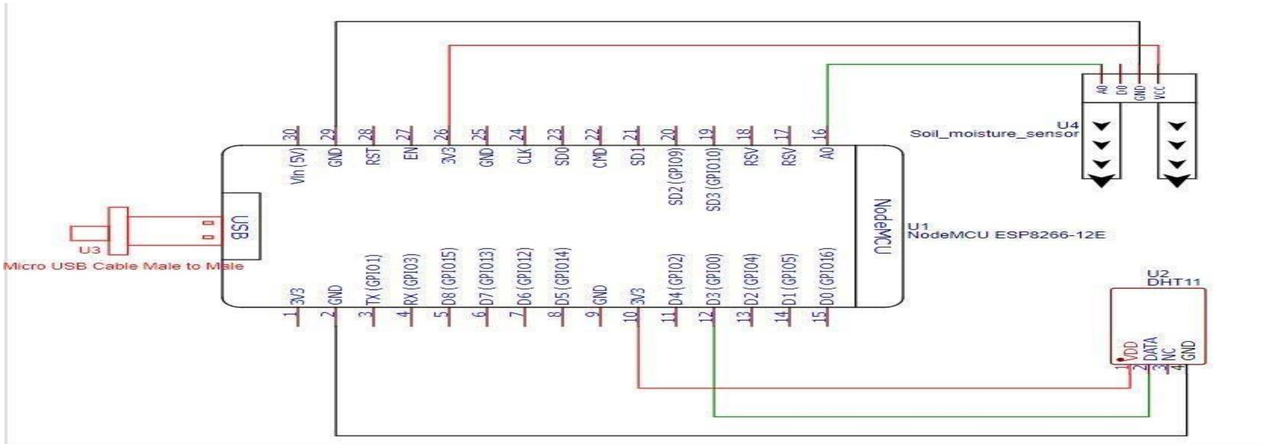

Fig. 3.1 Circuit Diagram of the IoT System

3.2 TEMPERATURE AND HUMIDITY SENSOR (DHT11) :

Inexpensive and easy to use, the DHT11 is a digital temperature and humidity sensor. It takes readings from a thermistor and capacitive humidity sensor in the air and sends them as a digital signal over the data pin. Though the interface is straightforward, it does necessitate planning ahead to collect data.To find dew point, dew point=(C-(100-H)/5), Where, C=temperature value in degree Celsius,H=Humidity value.

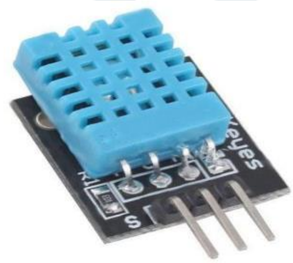

Fig. 3.2 Temperature and Humidity Sensor

3.3 SOIL MOISTURE SENSOR

A soil moisture sensor is a tool for measuring the soil's hydration levels in terms of volume. The sensor can determine the volumetric water content of soil without extracting any moisture by using other soil as a reference. Environment-related parameters such as soil type, temperature, and conductivity can all influence results and necessitate calibration. To measure water volume indirectly without drying the sample, neutrons can use features such as electrical resistance or conductance, dielectric constant, and neutron-neutron interaction. Because of potential influences from things like soil type, temperature, and conductivity, it needs to be calibrated.

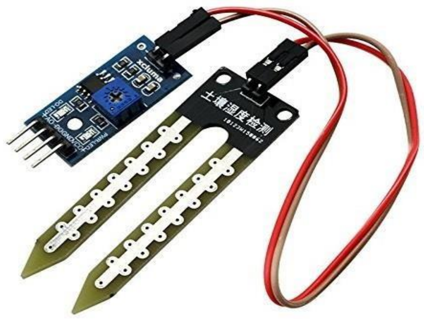

Fig. 3.3 Soil Moisture Sensor

3.4 NodeMCU :

The NodeMCU firmware is free and available to anyone. Prototyping board layouts and firmware can be downloaded for free [10]. The firmware is based on the eLua project, and it was developed using the Espressif Non-OS SDK for ESP8266. It depends on several free software packages, such as Lua-cjson and SPIFFS. Due to constraints on availability, users must pick the components that are most relevant to their project and build a firmware that is specifically designed for their needs. Prototype hardware typically takes the form of a dual in-line package (DIP) consisting of a USB controller and a smaller surface-mounted board housing the microcontroller unit (MCU) and antenna.

Fig. 3.4 Node MCU

The ESP-12 module of the ESP8266, a Wi-Fi system-on-a-chip (SoC) with a Tensilica Xtensa LX106 core, served as the starting point for the design. These sensors monitor environmental conditions in the farms, transmitting data about things like temperature, humidity, and moisture content to a central processing unit called a Node MCU (ESP8266). For Internet of Things (IoT) projects, Node MCU provides a development board with open-source firmware written in Lua. Hardware is based on Espress if Systems' ESP-12 module, while the ESP8266 Wi-Fi System-on-Chip (SoC) provides the brains. The data collected by the sensors is stored in the Node MCU, which is linked to the Thing Speak IoT analytics platform service. The smart farming system's hardware consists of the following:

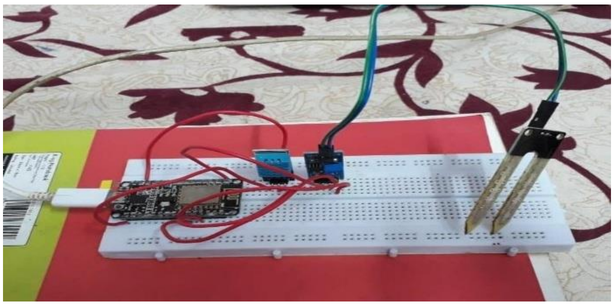

Fig. 3.4.1 Hardware System

IV. RESULTS & DISCUSSION

The mobile application calculates and displays several metrics such as temperature, humidity, and moisture level. The following figures explain how to measure temperature, humidity, and soil moisture in this study. The graphs were examined using Thing Speak, an IoT analytics tool that allowsusers to gather, visualize, and analyze live data streams in the cloud. The experimental analysis' dew point was estimated to be for disease identification, three groups were used: healthy,bacterial spot, and early blight.The second important aspect of our study is determining ifthe crop is infected or healthy, as depicted in the diagram.

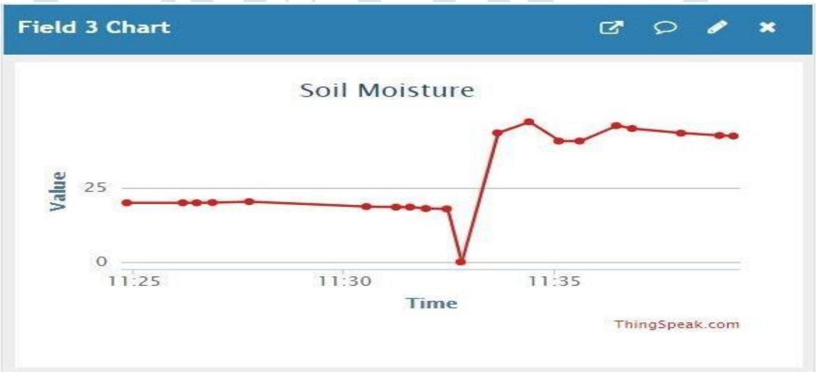

Fig 4.1 shows the readings of the Humiditysensor.
the humidity was estimated to be 77 percentages

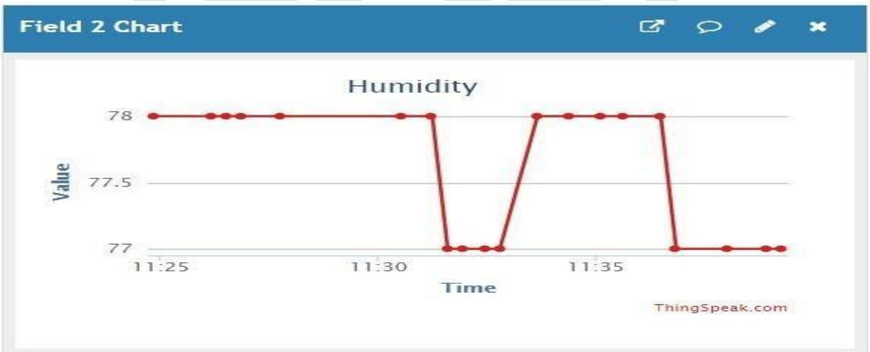

Fig. 4.2 shows the readings of the Temperature sensor.
the value of temperature was estimated as 30 Degree Celsius.

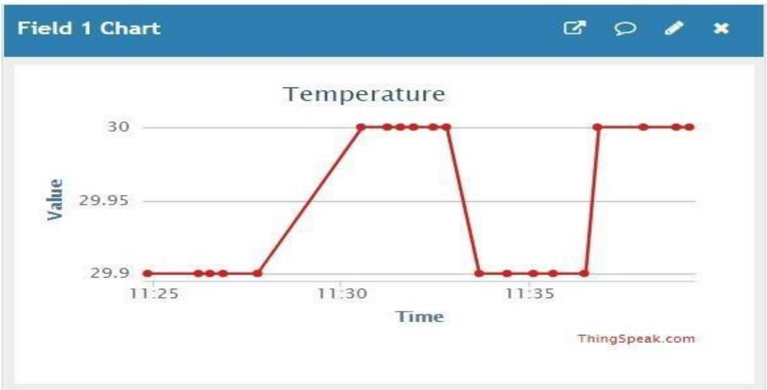

Fig. 4.3 shows the readings of the Soil Moisture Sensor.
the soil moisture reading was estimated to be 42.33 percentage.

V. CONCLUSION

This paper explores IoT-based Smart Farming technology, as well as Machine Learning-based plant disease detection. This technology decreases farmers and growers physical labor, increasing output in every way conceivable. Wireless sensors, cloud computing, communication technologies and various machine learning algorithms are all discussed.

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