Monitoring Plant Health and Detection of Plant Disease Using IoT and ML

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Abstract-- **Crop diseases represent a severe difficulty in agriculture, affecting each exceptional and amount of agriculture production. Hence, it's essential to increase the plantation and also to increase the production of crops. It is essential to increase crops yield and productiveness, keeping track of plant diseases until its harvesting is a major requirement. In this paper, an automatic disease detection machine has evolved the usage of the Internet of Things (IoT) and Machine Learning which monitor temperature, humidity, rainfall, and color via sensors on the usage of NodeMCU primarily based totally on variants in plant leaf health condition. By the usage of those parameter values presence of the plant, the disease is identified. Machine Learning algorithm-based image processing is used for detecting diseases in the early-stage and keeping tracking diseases in leaves this task can be attained by using an artificial Convolution Neural Network algorithm. In this article tomato crop diseases had been considered for the study. The gathered information stays uploaded to the internet server by way of an IoT platform for information processing. A Mobile Application is developed which facilitates to show the status of the parameters and ship SMS warnings and notifications.**

Keywords-- Machine Learning (ML), Internet of Things (IoT), Mobile Application, WebServer, Sensors, Image Processing, Convolution Neural Network, NodeMCU.

I. INTRODUCTION

India is the second largest producer of food through agriculture. Most of the people here depend on framing for their livelihood. In India agriculture is the primary economic activity. Plant health plays an important role in achieving high yields. Proper monitoring of plant health conditions at different stages of plant growth is essential to decrease infecting plant diseases. The presence of pests and diseases affects crop production evaluation and significantly reduces yields. Initially, plant health monitoring and disease analysis tasks are performed manually by experts. Manual prediction is time consuming and there can be many incorrect predictions can occurs. In addition, manual forecasting requires significant effort and time-intensive processing. Plant disease detection using image processing is an effective solution for early and accurate detection. Farmers regularly use a variety of disease control strategies to prevent plant disease.

Identifying plant diseases is essential for farmers and agricultural professionals. In most of the plants, diseases occurs in plant leaves. This proposed system tracks plant diseases especially in tomato leaves and finds solutions to reduce causes to improve plant health and overall productivity. This process can be achieved by considering image processing and convolution neural network concepts for detection and analysis of plant diseases. A training database set is created for diseased images. IoT sensors using NodeMCU can measure the distinction between normal and diseased plant leaves based on changes in values of parameters like temperature, humidity, colour, soil moisture and rainfall.

IoT sensors can provide data approximately agricultural regions and may be without problems monitored, making smart agriculture a unique concept. The appraisal of sensor networks and Internet of Things (IOT) has played vital role in agriculture sector and the disposal of sensor node in real time environment. These IOT sensors collects the fields data at any time and accumulated data is analysed in real time basis through IoT analytics platform. The cloud platform gives the actual time evaluation of records for the detection of adversaries in records. IOT allows devices across farm to measure all kinds of data remotely and provide this information to farmers or experts in real time, resulting in decreased human intervention and operating cost. Sensors connected to IOT can provide data on agricultural lands. Farmers or agricultural department members can use this technology to check the actual state of their crops without having to be present in the field. Smart farming primarily based totally on IOT technologies enhances crop production in farming industry.

II. CONTRIBUTIONS

The objective of this article is to focus on the concept of cloud computing to meet the needs of using the Internet of Things and smart sensors in combination with image processing to identify and detect crop diseases and to analyse real-time data acquired for Smart farming application.

The following are expected outcomes in order to meet the objectives:

1. To identify the plant disease specifically on the tomato leaves that impact plant at various stages of development.

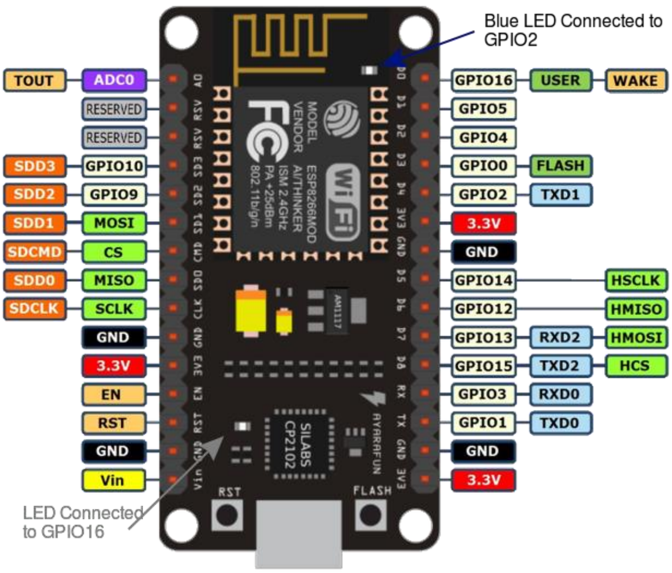
2. To keep track of variables such as soil moisture, temperature, humidity, and rainfall.

3. Modelling of Convolutional Neural Networks and Performance evaluation of the model.

4. SMS warnings or a notification through app on the application intended for the same on the smartphone.

III. PROPOSED SYSTEM

The proposed system is based on IoT system which monitors temperature humidity, soil moisture, rain and color sensors for collection data from plants based on variations that are caused by temperature , humidity and color factors on plant leaves. Due to environmetal factors plant undergoes changes which are captured by temperature, humidity and color sensors and that captured data is analyzed using NodeMCU. The data gathered from the above sensors are produced to NodeMCU from which the information is communicated to the local agriculture officer through SMS or app notifications who further communicates to farmers about live status of the crop. The WiFi shield (ESP8266) is used in this system to communicate the studied data from the host system to the cloud platform for further analysis. Cloud-based platform www.thingspeak.com collects data, which is then compared to the dataset in order to determine if the leaf in question is normal or diseased.



The Figure.1 shows schematic diagram of the proposed work.

B. Components

1. Temperature and humidity Sensor

DHT11 is used as temperature and humidity sensor which comes with integrated NTC that measures temperature and 8-bit microcontroller that produce output of temperature and humidity values as serial data. DHT11 is a low-cost, digital temperature and humidity sensor which makes use of capacitive humidity sensor and ambient air thermistor and further provides a digital signal as output for the input data. As it is commonly used sensor for temperature and humidity checking, its quite easy to use but collecting output data should be done in careful way as new data can be captured only after every 2 seconds, hence readings occured from sensor may be older than 2 seconds while using library. Although easy to use, collecting pieces of data requires careful planning.

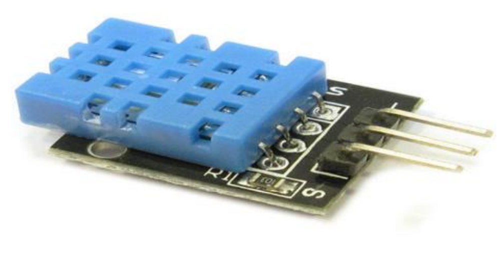


Figure.2 Temperature-humidity-sensor

2. Soil Moisture

The sensor contains a fork-shaped probe with two contact leads that penetrate the ground to measure the amount of water. Two current-carrying probes flow through the earth to obtain resistance and measure moisture. Moisture content present in earth's soil is measured my soil moisture sensor based on changes in electrical conductivity of earth. Exceed level of the tuning threshold makes comparator to activate the digital output. Two exposed conductors of probe which is in forkshape acts as variable resistor, where the resistance is measured between two electrodes of sensor. Depending on the water content of the soil resistance varies.

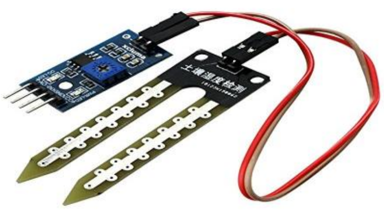


Figure.3 Soil Moisture

3. Rain sensor

Occurence of rain can be sensed by rain sensor which consists of rain detection plate with a comparator which controls intelligence. Rain sensor also detects short circuit caused by water fall on a pronted circuit board ribbon. It works on the principle of resistance. The sensor contains a sensor pad with a series of exposed copper tracks placed outdoors, on a roof, or where rain may affect it. Normally, this road is not connected, it leads to water. Rain sensor also consist of electronic module which connects the touchpad to the NodeMCU. Output voltage generated by this module i available in the analog output pins based on resistance. Rain sensor acts as a variable resistor that changes state. When the wet content is more in sensor resistance increases and also decreases when the sensor is dry. This sensor has two connected outputs which are part of comparator, one is analog output and other one is digital output. In the presence of raindrops, the resistance decreases because water is an electrical conductor, and in the presence of water, the nickel wires are connected in parallel, reducing the resistance and reducing the voltage drop across them.

Figure.4 Rain sensor

4. Color sensor

The TCS3200 is a color sensor module that can identify different colors with varying wavelength. It has a matrix of 8 8 photodiodes and has a red, blue, and green filter.This module is ideal for various color recognition projects, such as reading test strips and color matching. It can detect the light emitted by the photodiode and its output frequency. The module is powered by a 3.3V supply and features four white LEDs that are designed to light up when the module is turned on. A typical color sensor uses a high-intensity white LED to project a light onto an object.

To detect the color of reflected light, almost all color sensors consist of a grid of color-sensitive filters, also known as "Bayer filters", and an underlying set of photodiodes, such as those shown in the figure below. The sensor can also work in complete darkness to determine the color or brightness of an object. The TCS230 operates on a supply voltage of 2.7 to 5.5 volts and provides a TTL logic level output.

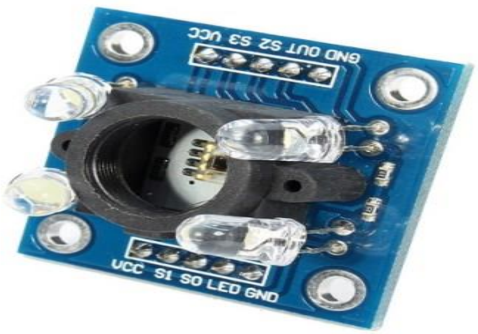


Figure.5 Color sensor

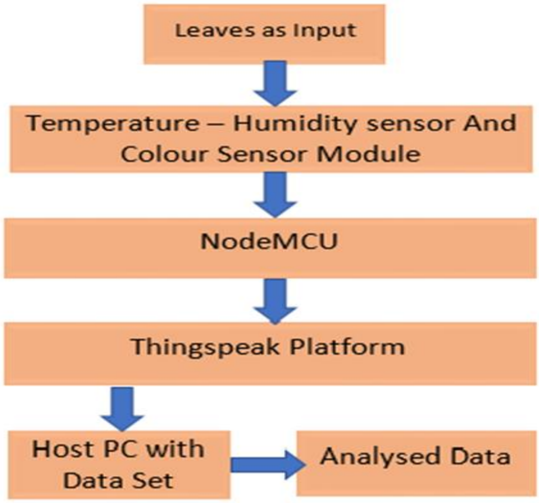
5. Node MCU

The ESP8266 WiFi module and hardware based on the ESP12 module are both included in the NodeMCU open-source platform. It creates its own scripts with the Lua programming language and the ESPlorer IDE. Its purpose is to make programming the ESP8266 as simple as possible without needing to understand the hardware or the language.

Figure.6 NodeMCU

6. Cloud platform

To communicate the read data to the cloud, we utilise the ThingSpeak cloud platform. ThingSpeak is a cloud-based IoT analytics platform that collects, visualises, and analyses real-time data streams. APIs for social networking sites and devices are available to make data access, retrieval, and logging easier. ThingSpeak is a data platform for the Internet of Things that is available to the public. The device or application may connect with ThingSpeak via the RESTful API and keep the data private or public. Use ThingSpeak to analyse and analyse your data as well. MathWorks and MATLAB numerical computing packages are both supported by ThingSpeak. Users of ThingSpeak may use MATLAB to analyse and display loaded data without having to acquire a MathWorks MATLAB licence. Temperature, humidity, and colour variations were shown using graphs. You can tell if the numbers are in the same range based on the plotted data. If this is the case, the sheet is either healthy or sick.



Flowchart

IV. PLANT DISEASE DETECTION

Discoloration of plant tissue is a common characteristic of plant diseases. It can be partially or fully suppressed by the breakdown of the green tissue's chlorophyll. The condition is then used to determine if a plant is healthy or sick.

Machine vision equipment is commonly used in agriculture to identify diseases in plants. By acquiring photos of the same plant, the machines can detect diseases in the plants. Conventional machine vision methods are often used to diagnose plant diseases. They use a light source and shooting angle to determine the ideal illumination source for each photo. Unfortunately, traditional image analysis techniques can be challenging to implement due to their complexity. For instance, distinguishing the differences between the regions of a plant's lesions can be challenging due to the varying sizes and shapes of the lesions. There is also some interference when photographing plant diseases in natural light. Existing classical approaches currently appear to be ineffective and difficult to obtain better detection results.

Traditional technologies for plant disease detection have some limitations. To address this, we used the dataset in our disease identification technique. The dataset contains approximately 10895 images and is divided into three categories: bacterial spot, healthy disease, and late blight. We use the pre-trained VGG16 model, which is an integrated neural network (CNN) model for training. We use this model to load our dataset, resize the image, and split it into test and training data. For each class, 10716 pictures are used for learning and 1079 pictures are used for tests. Then the model is configured to perform the training.

The model is trained to perform its intended function. It is saved in a directory where it has been trained. The program uses HTTP and the base64 format to communicate with the server. If the plant does not respond to the illness, the program will send a response with "healthy".

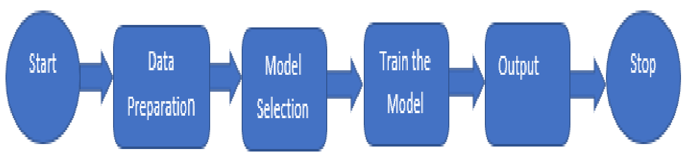


Fig. Flow Diagram of Machine Learning

CNN has advantages when it comes to extracting picture features. Like a biological neural network, it uses a weight-sharing network topology to minimize the complexity of its model and the number of weights.

V. RESULT

The mobile application calculates and displays several measurements such as temperature, humidity and humidity. The following figures explain how temperature, humidity and soil moisture were measured in this study. The graphs have been tested using ThingSpeak, an IoT analytics tool that allows users to collect, visualize, and analyze live data streams in the cloud. The dew point of the experimental analysis was estimated to be 25.4 degrees Celsius. The second important aspect of our study was to determine if the substrate was infected or healthy, as shown in the diagram.

1. Output of classifier showing Healthy leaf of Tomato

2. Output of classifier showing Disease-Early Blight

3. Output of classifier showing disease-Bacterial Spot

For disease identification, three groups are used: bacterial white spot disease and healthy late blight.

VI. CONCLUSION

This article talks about the various components of plant disease detection that are connected to the Internet of Things. One of these is the ability to detect diseases in tomatoes. A simple and effective method for detecting diseases in plants is to use wireless sensors to measure various parameters. The data collected by the system is then analyzed and sent to a web server. Wireless sensor networks are widely used for monitoring various aspects of a person's life. This paper presents an architecture that uses a simple neural network to classify different kinds of tomato leaf diseases.