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Crop Disease Detection using Machine Learning

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***Abstract*— Agriculture is the primary source of food for the world's population, despite the rapid increase in population. Early detection of plant diseases in the field would be beneficial to improve crop production efficiency. Technology has become increasingly important in agriculture in recent years, as it is used to improve efficiency, reduce costs, and increase yields. The emergence of accurate techniques in the field of leaf-based image classification has shown impressive results. Our proposed work includes various phases of implementation of image classification, namely dataset creation, feature extraction, training the classifier, and classification. The work also included hardware design and implementation, as well as software programming for the microcontroller unit of the detector. The system utilized the microcontroller to receive and send data from the various sensors to an online database.**

Keywords— Node MCU, Arduino, Humidity Sensor, Moisture Sensor, CNN

I. Introduction

Agriculture is considered an important pillar of the world's economy and also satisfies one of the basic needs of human being i.e., food. In most of the countries it is considered the major source of employment. Many countries like India still use the traditional way of farming, farmers are reluctant to use advanced technologies while farming because of either the lack of knowledge, heavy cost or because they are unaware about the advantages of these technologies. Lack of knowledge of soil types, yields, crops, weather, and improper use of pesticides, problems in irrigation, erroneous harvesting and lack of information about market trend led to the loss of farmers or adds to additional cost. Lack of knowledge in each stage of agriculture leads to new problems or increases the old problems and add the cost to farming.
Growth in the population day by day also increases the pressure on the agriculture sector. Overall losses in the agriculture processes starting from crop selection to selling of products are very high. Technologies like blockchain, IoT, machine learning, deep learning, cloud computing, edge computing can be used to get information and process it. Applications of computer vision, machine learning, IoT will help to raise the production, improves the quality, and ultimately increase the profitability of the farmers and associated domains. The Precision learning in the field of agriculture is very important to improve the overall yield of harvesting.

II. Discussion on Existing Systems

The existing method for plant disease detection is simply naked eye observation by experts through which identification and detection of plant diseases is done. For doing so, a large team of experts as well as continuous monitoring of plant is required, which costs very high when we do with large farms. The existing method for plant disease detection is simply naked eye observation by experts through which identification and detection of plant diseases is done. For doing so, a large team of experts as well as continuous monitoring of plant is required, which costs very high when we do with large farms.

Patil et al. proposed various methods for plant disease detection, and deep learning as preferred method because

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of its spectacular accomplishment [1]. Manjunath et al. proposed a method that involves dividing collected paddy images into different color bands, which classifies the picture as heathy or sick [2]. Elbasi et al. discussed the current state of machine learning and IoT in agriculture, highlighting key challenges and opportunities [3]. Devaraj et al. through their article proposed to develop a software system to find and classify disease [4]. Yang illustrated how airborne and satellite imagery and variable rate technology have been used for detecting and mapping cotton root rot, a destructive soilborne fungal disease, in cotton fields and how site-specific fungicide application has been implemented using prescription maps derived from the imagery for effective control of the disease [5]. Development of eAGROBOT, real time testing results obtained from cotton and groundnut plantations and future focus has been detailed by Pilli et al. [6].

Orchi et al. presented a contemporary overview of research undertaken over the past decade in the field of disease identification of different crops using machine learning, deep learning, image processing techniques, the Internet of Things, and hyperspectral image analysis [7]. Ouhami recognized the importance of using data from different types of sensors and machine learning approaches to build models for detection, prediction, analysis, assessment, etc [8]. Fang and Ramasamy reviewed the direct and indirect disease identification methods currently used in agriculture [9]. Kulkarni proposed a deep learning-based model which is trained using public dataset containing images of healthy and diseased crop leaves [10]. Badage proposed a system that intimates the agriculturist about the crop diseases to take further actions [11].

Plant disease identification by visual way is more laborious task and at the same time, less accurate and can be done only in limited areas. Whereas if automatic detection technique is used it will take less efforts, less time and become more accurate. In plants, some general diseases seen are brown and yellow spots, early and late scorch, and others are fungal, viral and bacterial diseases. Image processing is used for measuring affected area of disease and to determine the difference in the color of the affected area.

III. System Description

The system could be mainly divided into four subsystems based on the functionality. They are mainly the sub systems for retrieving sensor data, transferring data to database, disease detection and displaying predicted output in the webpage.

Figure 1 is the basic block diagram of disease detection system, figure 2 is the circuit diagram for interfacing 2 sensors with Node MCU. The circuits consist of mainly DHT 11 temperature and Humidity sensor, FC-28 Soil Moisture sensor and Node MCU. Figure 3 shows the Visual Studio Integrated Development Environment (IDE) and Figure 4 shows the online SQL database where sensor data are stored and later used for future purposes.

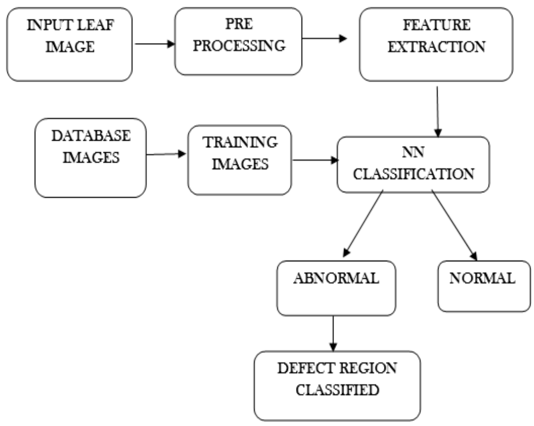

Fig. 1. Block diagram of the Disease detection

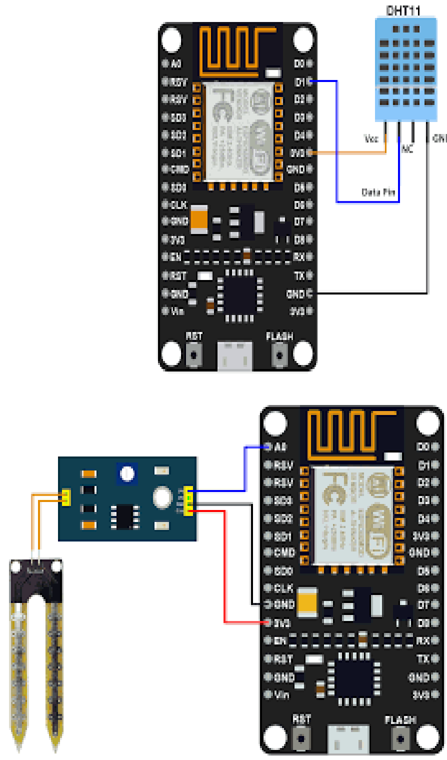

Fig. 2. Circuit diagram for interfacing both DHT 11 Temperature & Humidity sensor and FC-28 Soil Moisture Sensor

A. Sensors

It consists of both DHT 11 Temperature & Humidity sensor and FC-28 Soil Moisture sensor. Both of these sensors measure temperature, humidity and moisture content. The figure 2 shows the interfacing of these 2 sensors with Node MCU and table 1 and table 2 shows the specification of the sensors used.

TABLE I. SPECIFICATION OF DHT - 11

Parameter	*Ideal range*
Operating Voltage	3.5 – 5.5V
Accuracy	±1C to ±1%
Operating Current	0.3 mA
Signal Output	Serial Data

TABLE II. SPECIFICATION OF FC - 28

Parameter	*Ideal range*
Operating Voltage	3.3 – 5V
Accuracy	±1%
Operating Current	15 mA
Signal Output	0 – 5V

B. Data Transmission

Wireless protocols suit best for IoT based system. It also aids in reducing the space occupied by the system. ESP8266 Node MCU has been chosen to transmit data since it’s a cost-effective platform that could transmit data wirelessly. The real time data gathered from the sensors could be transferred seamlessly to the database.

C. Disease Detection

Disease detection in plant leaves is a technology-driven approach to identify and diagnose diseases affecting plants. It utilizes computer vision and machine learning techniques to analyze images of plant leaves and determine if they are healthy or infected with specific diseases. By capturing leaf images using cameras or smartphones and processing them through trained algorithms, this system enables farmers and agricultural experts to promptly detect diseases, take appropriate actions, and protect crops from potential losses.

The system's effectiveness relies on the quality of the dataset used for training the machine learning model and continuous improvement to stay up-to-date with new plant diseases and emerging techniques. Ultimately, disease detection in plant leaves contributes to sustainable agriculture by ensuring early disease management and maximizing crop productivity.

D. Display

Real-time data of the sensors are passed to an online database by Node MCU. Also, a webpage is created to create a profile for the user where the user can choose the input leaf image that is to be detected. The webpage also displays the predicted output which is obtained from the trained model. The model is trained by CNN algorithm.

IV. DEVELOPMENT OF SOFTWARE

A. Arduino Code

There is only a single Arduino sketch that is used. The code is used to retrieve the sensor data from the sensor to the Node MCU. The same code is used to connect to a Wi-Fi network and access the online database. Then, the data is transferred to the online database through js on format. The data from the sensors are transferred every 5 minutes. The Sketch's many steps are:

1. Set up the Arduino IDE and NodeMCU.
2. The moisture sensors' analog output port is set up on the analog pin of the Node MCU.
3. The sensor's output ports are set up on NodeMCU.
4. Configure Wi-Fi and XAMPP with the required security keys.
5. Data from the two sensors are transferred every 5 minutes.
6. Through Node MCU, the sensor's data is sent to XAMPP online database

B. Visual Studio Code

A Python code was created for image classification, feature extraction and disease detection. The machine learning model is trained using CNN algorithm. A well-trained model is at the core of this disease detection system.

The training process involves feeding the preprocessed data into the machine learning model and iteratively adjusting the model's parameters to minimize the classification error. Once the machine learning model is trained and validated, it is deployed in a real-time disease detection system. Farmers or agricultural technicians can use this system by capturing images of plant leaves using smartphones or specialized cameras.

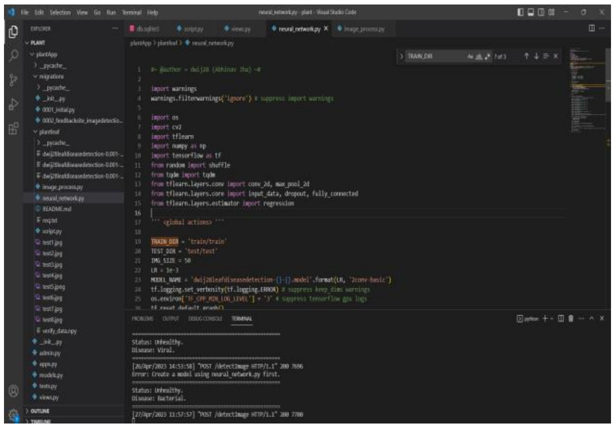

Fig. 3. Visual Studio IDE

These images are sent to the detection system, where they undergo the same preprocessing steps used during training. After preprocessing, the extracted features from the input leaf image are passed through the trained machine learning model. The model predicts whether the leaf is healthy or infected with a specific disease. The predicted output is then displayed in the created webpage and this result is stored in a database that is created inside the visual studio. Every output that is displayed in the webpage is stored in the database.

C. XAMPP online database

XAMPP was used for creating and running the online database. The sensor data is transferred to the online SQL database where it is stored and can be used for future purposes. It was user friendly and allows the transferring of data without much configuration.

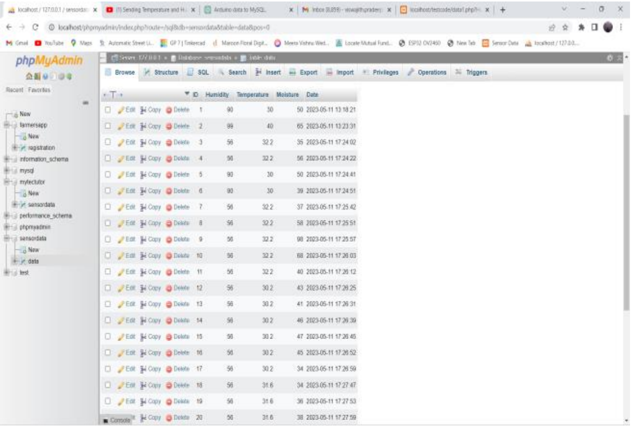

Fig. 4. Online SQL Database

V. RESULT

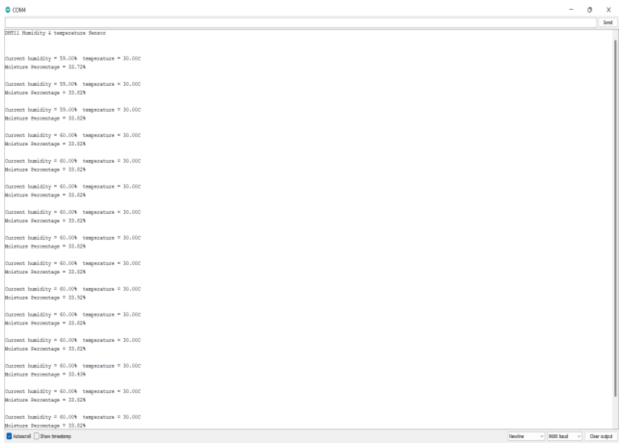

Fig. 5. Sensor Output

A machine learning model was developed successfully to predict the output of the diseased input leaf image. The model was trained by Convolutional Neural Network (CNN) algorithm. The various features of the resulting model are listed below

1. Accuracy: Our trained model achieved an accuracy of 70% on the test set. The accuracy was measured using appropriate evaluation metrics such as precision, recall and F1 score.
2. Speed and Efficiency: The model's efficiency in processing images allowed for quick identification of crop diseases, enabling timely interventions and to prevent further spread and mitigate crop losses.
3. Disease Classification: Our system successfully classified multiple crop diseases with high accuracy.
4. Generalisation: Our model exhibited strong generalising capabilities when tested on unseen or real world images not present in training dataset.

The results obtained from our crop disease detection system demonstrate its effectiveness in accurately identifying and classifying crop diseases using machine learning and image processing techniques.

Fig. 6. Webpage

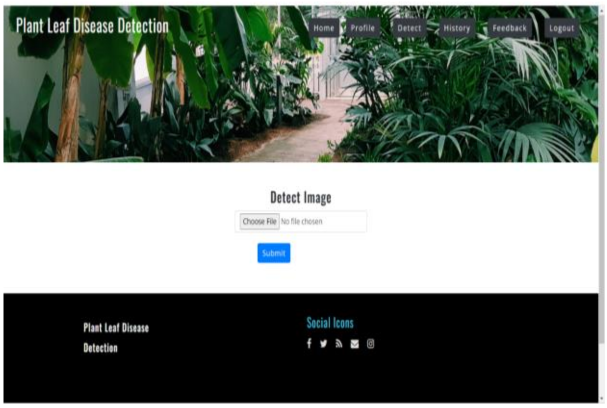

Fig. 7. User Logged in Page

VI. CONCLUSION

This paper shows that the plant disease recognition model based on deep learning has the characteristics of unsupervised, high accuracy, good universality, and high training efficiency. However, there are many challenges in accuracy practicability of plant disease detection in the complex environment. The model proposed not only guarantees the robustness of the convolutional neural network, but also reduces the number and quality requirements of the convolutional neural network on the data set and obtains better results.

Therefore, the model could help agricultural production personnel to prevent and cure the plant disease quickly.

The model which overcomes the problem of environment complexity can get an accurate identification result in practical application. Furthermore, this study enriches the existing theory and helps to improve the accuracy. This model not only adapts to complex environments, but also increases the accuracy of identification. Therefore, the model applies information technology to agricultural production and is favorable to sustainable development of smart agriculture.

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