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 [ijirset@gmail.com](mailto:ijirset@gmail.com)

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# Tomato Leaf Disease Detection Using CNN and Monitoring Temperature and Moisture

Mrs. K. Shalini<sup>1</sup>, V. Manasa<sup>2</sup>, T. Shishir<sup>3</sup>, S. Rajeev<sup>4</sup>, A. Ranjith<sup>5</sup>

Associate Professor, Dept. of Electronics and Communication Engineering, TKR College of Engineering and Technology, Telangana, India <sup>1</sup>

B. Tech students, Dept of Electronics and Communication Engineering, TKR College of Engineering and Technology, , Telangana, India <sup>2,3,4,5</sup>

**ABSTRACT:** Tomato is the most popular crop in the world. After China, India is ranked second in the production of the Tomato. Tomato helps to prevent Blood Cancer, maintains healthy Blood pressure and reduce blood glucose in people with diabetes, but the quality and quantity of Tomato goes down due to various kinds of diseases. This incurs a great loss to the farmers and cause low agricultural productivity. To reduce the loss, we need to have a complete supervision over the growth of the crop. There are various diseases that infect the Tomato like Early Blight, Late Blight, Bacterial spot, Tomato Mosaic Virus, Septoria leaf spot and etc. So, it is necessary to solve the problems of farmers, by detecting the diseases of the Tomato plant at beginning stage we can reduce the wastage produced due to diseases in tomato. So, to detect this Deep learning – Convolution Neutral Networks (CNN) is used by which we can predict the disease in early stage and by taking necessary steps, the production can be increased. We also included Internet of Things (IoT) sensors to collect environmental information surrounding the tomato plant, such as temperature, humidity, and moisture content. We can diagnose tomato plant health more quickly and accurately by integrating image processing with environmental data.

**KEY WORDS:** CNN, IOT, Image processing, Disease detection.

## I. INTRODUCTION

Identifying plant diseases is key to avoiding losses in yield and quantity of agricultural products. Studying plant diseases means studying patterns that can be observed with the naked eye in plants. Monitoring health and detecting diseases in crops is essential for sustainable agriculture. Monitoring plant diseases manually is time-consuming and difficult. It requires a huge amount of labour, expertise in plant diseases and also requires excessive processing time. Therefore, image processing and machine learning techniques are used to detect plant diseases. Disease detection includes steps such as image acquisition, image preprocessing, image segmentation, feature extraction, and feature-based classification.

Today's agriculture industry is more data-driven, precise and intelligent than ever. The rapid emergence of Internet of Things (IoT)-based technologies has reshaped almost every industry, including “smart agriculture,” which has shifted the industry from a statistical approach to one. quantitative. Such revolutionary changes will disrupt existing agricultural methods and create new opportunities in the face of a series of challenges.

The goal of this project is to create an effective and trustworthy method for the early detection of diseases in tomato plants. To safeguard the tomato farming industry and ensure its sustainability, it has become imperative to develop swift and accurate disease detection mechanisms. We want to give farmers and agricultural specialists a useful tool to quickly detect and treat tomato plant problems. In disease recognition in such plants, the current system relies on visual observation which is a time-consuming process. This approach has the potential to transform agricultural methods, reduce crop losses, and promote the sustainable tomato production. This approach has the potential to transform agricultural methods, reduce crop losses, and promote the sustainable tomato production

## II. METHODOLOGY

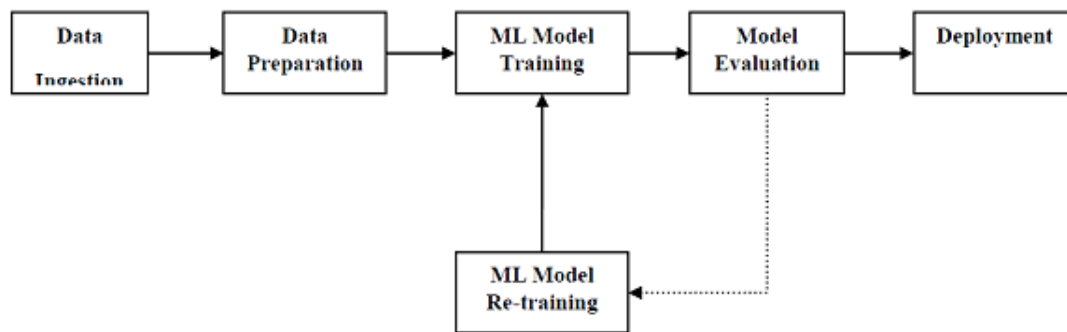


Figure 1:Block Diagram

### 1. Data Collection and Preprocessing:

**Data Acquisition:** Start by compiling an extensive dataset of tomato plant photos, comprising both healthy and variously ill plants. You can go through publicly accessible databases or think about gathering your own photographs.

**Data Preprocessing:** To improve model generalization, clean and prepare the dataset by scaling photos to a constant resolution, standardizing pixel values, and adding techniques like rotation, flipping, and brightness changes.

### 2. Modeling and Architecture:

**Convolutional Neural Network (CNN):** Select a CNN architecture that is appropriate for image classification jobs. VGG, Inception, and custom-made architectures are popular options.

**Transfer Learning:** Think about modifying pre-trained CNN models for your particular task. The amount of training time and data needed can be greatly decreased in this way.

### 3. Model Development:

**Split Dataset:** To appropriately assess the model's performance, divide the dataset into training, validation, and test sets.

**Loss Function and Optimization:** For the model's training, choose a suitable loss function (such as categorical cross-entropy) and optimization technique (such as Adam).

**Training Parameters:** Configure hyperparameters like learning rate, batch size, and training epoch count. To avoid overfitting, keep an eye on the model's performance on the validation set.

### 4. Assessment and Validation:

Use metrics like accuracy, precision, recall, and F1-score to assess the model's performance. These metrics shed light on the model's ability to identify various tomato plant diseases.

**Confusion Matrix:** To see where the model performs best and where it might misclassify diseases, visualize the model's predictions using a confusion matrix.

### 5. Model Optimization:

**Hyperparameter-Tuning:** Based on validation outcomes, fine-tune hyper-parameters to achieve the best possible model performance.

**Data Augmentation:** Experiment with various data augmentation strategies to improve the adaptability of the model.

### 6. Implementation:

**Integration:** To make the trained model accessible to farmers and agricultural specialists, integrate it into a user-friendly interface, such as a mobile app or web application.

**Real-time Detection:** Include real-time disease detection features, allowing users to capture images of tomato plants and receive disease details in real time.

### III.HARDWARE ARCHITECTURE

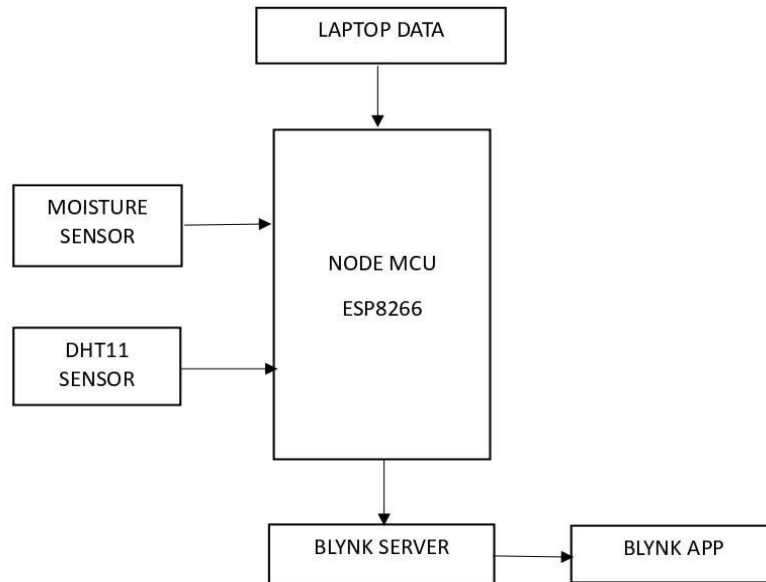


Figure 2 : Hardware diagram

**1. Node MCU:** Node MCU is an opensource firmware and development kit that helps you to develop a prototype of your IOT product with just a few lines of Lua script. Espressif Systems designed the microcontroller ESP8266. The Node MCU module comes with an integrated USB connector, various pinouts and it is equipped with a Wi-Fi module.

**2. Temperature and Humidity sensor (DHT11):** The temperature and humidity sensor function of the DHT11 Temperature and Humidity Sensor is combined with a calibrated digital signal output. An 8-bit microprocessor with great performance is built inside it. Its technique guarantees exceptional long-term stability and high dependability. It performs well and has outstanding quality, quick response, and anti-interference capabilities.

**3.Soil moisture sensor:** Soil moisture sensors come in a variety of forms, such as resistive, capacitive, and frequency domain sensors. Whereas capacitive sensors employ changes in capacitance, resistive sensors use changes in electrical resistance to monitor soil moisture.

**4.Blynk App:** With the help of the many widgets the Blynk app offer, we can use this app to create incredible interfaces for your projects.

**5.Blynk Server:** Blynk server is in charge of managing all correspondence between hardware and smartphones. You can host your personal Blynk server locally or utilize our Blynk Cloud.

#### IV.SYSTEM ARCHITECTURE

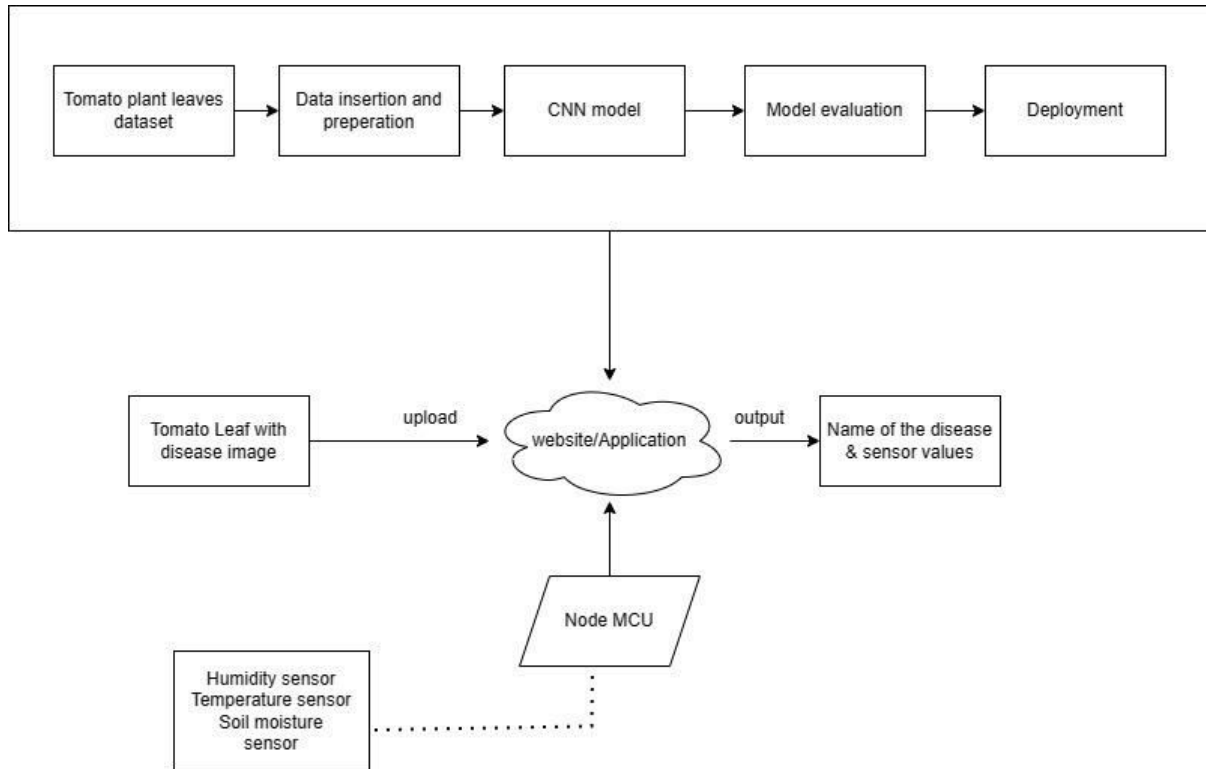


Figure 3: System architecture

#### V. WORKING

Combined with DHT11 and soil moisture sensors, the CNN-based leaf disease detection system offers a complete solution for tracking plant health and identifying diseases. The system uses uploaded images to classify plant leaves as healthy or diseased using convolutional neural networks (CNNs), and real-time sensor data from the DHT11 temperature and humidity sensor and soil moisture sensor offers insights into environmental factors critical to plant growth. Users may see and analyze sensor data with ease using the Blynk app, which provides a straightforward interface for tracking temperature, humidity, and soil moisture levels in real time. Furthermore, the Gradio library is utilized by the system to generate an intuitive online interface for inputting leaf photos and obtaining disease classification outcomes.

The technology gives consumers the ability to make knowledgeable decisions about plant care and disease management by fusing image classification with CNNs, sensor data acquiring, and an intuitive user interface. This ultimately encourages healthier plant development and higher agricultural yields.

#### VI.RESULT

Figure 4.1 depicts the first look of our front end. We have a text message called “click below to choose picture for testing” so that a user can understand to click the below button. It has a button called “Get Photo” which can be used to browse the images on the system’s hard disk. When we select the image and submit then it displays the status of leaf i.e. Healthy or Unhealthy, if it is unhealthy then it displays the particular disease name along with the treatment needed to cure the disease.

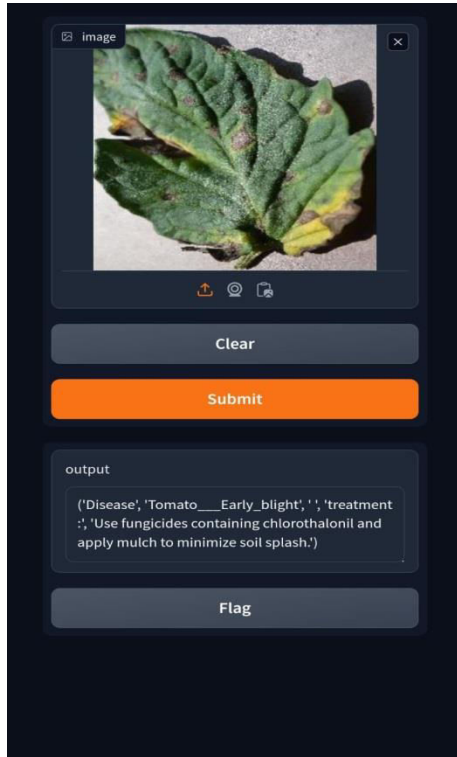


Figure 4.1: Uploading leaf image

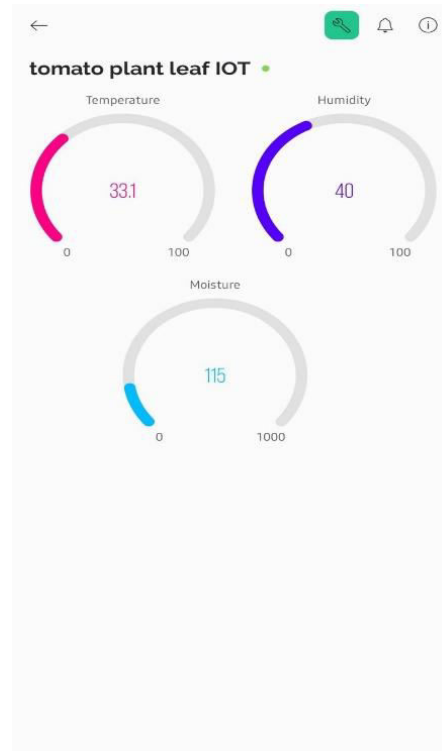


Figure 4.2 Sensor values

## VII. ADVANTAGES

1. High accuracy: Based on visual symptoms, CNN models are able to accurately detect and classify leaf diseases thanks to their great efficiency in image classification tasks.
2. Automation: The system can automate the process of monitoring plant health data, minimizing the need for manual intervention. Examples of these sensors include the soil moisture sensor and the DHT11 (for temperature and humidity).
3. Early Detection: Early detection of leaf diseases and plant health issues allows for timely intervention, preventing the spread of diseases and minimizing crop losses.
4. Real-time Monitoring: By allowing farmers to make educated judgments and adjust their agricultural methods accordingly, the system offers real-time monitoring of environmental parameters including temperature, humidity, and soil moisture.

## VIII. APPLICATIONS

- Precision agriculture
- Greenhouse management
- Urban farming
- Research and education
- Smart farming solutions



## IX.CONCLUSION

The integration of CNN model for tomato leaf disease detection, alongside real-time monitoring of environmental factors using IoT sensors such as temperature, humidity, and soil moisture, through NodeMCU, presents an efficient solution for precision agriculture, enabling timely intervention and optimizing crop health and yield.

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