CC-314 & CC-315 Mini Project-I

Semester-6

Plant Leaf Disease Detection Through CNN

submitted to

By

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DECLARATION

I hereby declare that the study entitled **“Plant Leaf Disease Detection Through CNN”** submitted to the Gujarat University, Navarangpura, Ahmedabad (Gujarat) in partial fulfilment of M.Sc. (Int) Artificial Intelligence & Machine Learning degree is the result of investigation done by myself. The material that has been obtained (and used) from other sources has been duly acknowledged in this study. It has not been previously submitted either in part or whole to this or any other university or institution for the award of any degree or diploma.

Place: Ahmedabad | Signature

Date: | Name of Student

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Abstract

This goal is to explore the application of Convolutional Neural Networks (CNNs) in the detection of plant leaf diseases. Plant diseases significantly impact agricultural productivity, leading to economic losses and food insecurity. Early detection and accurate diagnosis of these diseases are crucial for timely intervention and effective management. Traditional methods of disease detection are often labor-intensive and time-consuming. In recent years, deep learning techniques, particularly CNNs, have shown promising results in automating disease detection processes. This study provides a comprehensive overview of plant leaf diseases, discusses the fundamentals of CNNs, reviews relevant literature on the application of CNNs in plant disease detection, presents a methodology for implementing CNN-based disease detection models, analyzes the results obtained, and concludes with insights into the efficacy and potential challenges of CNN-based approaches in plant disease diagnosis.

Keywords:

- Plant leaf diseases
- Convolutional Neural Networks
- Deep Learning
- Disease detection
- Agriculture

Introduction

Plant diseases pose a significant threat to global food security by adversely affecting crop yield and quality. Timely and accurate detection of these diseases is essential for implementing appropriate management strategies to mitigate their impact. Traditional methods of disease detection, such as visual inspection by agricultural experts, are often subjective, labor-intensive, and time-consuming. With recent advancements in computer vision and deep learning, there has been growing interest in leveraging these technologies for automated disease detection in plants. Convolutional Neural Networks (CNNs) have emerged as powerful tools for image classification tasks, including the identification of plant diseases based on leaf images. This dissertation aims to investigate the effectiveness of CNNs in detecting plant leaf diseases and to provide insights into their potential applications and limitations in agricultural settings.

Basic terminology

Plant Leaf Diseases: Any deviation from the normal functioning or appearance of plant leaves caused by pathogenic microorganisms, environmental factors, or physiological disorders.

Convolutional Neural Networks (CNNs): Deep learning models specifically designed for processing and classifying visual data, such as images.

Deep Learning: A subset of machine learning techniques that involves training neural networks with multiple layers to learn hierarchical representations of data.

Image Classification: The process of categorizing images into predefined classes or categories based on their visual features.

Agriculture: The science and practice of cultivating crops and raising livestock for human consumption and other purposes.

Literature Review

Title: Plant disease detection using CNN

Authors: Shrestha, G., Das, M., & Dey, N. (2020, October).:

The study introduces a CNN-based method for detecting plant diseases, leveraging image processing techniques. It assesses the method's efficacy using a dataset comprising 12 cases of diseased plant leaves and 3 cases of healthy leaves. Through simulation and analysis, the study evaluates factors such as time complexity and the area of infected regions, providing valuable insights into the method's performance.

Title: Plant leaf disease detection using CNN algorithm.

Authors: DeepaLakshmi, P., Lavanya, K., & Srinivasu, P. N. (2021):

The paper addresses the importance of agriculture in India's economy and the need for improved food production methods. It introduces a CNN-based approach to identify diseased and healthy leaves with over 94.5% accuracy in an average processing time of 3.8 seconds, highlighting its potential for enhancing farming techniques.

Title: Review on convolutional neural network (CNN) applied to plant leaf disease classification.

Authors: J., Tan, L., & Jiang, H. (2021):

The paper discusses the urgency of accurate plant disease detection for food security and reviews recent advancements in using CNNs for this purpose. It outlines deep learning principles, addresses challenges, and suggests future directions for plant disease classification.

Methodology

This study employs a methodology for training and evaluating CNN-based models for the detection of plant leaf diseases. The methodology consists of the following steps:

Data Collection:

- The dataset is taken from Kaggle website.

- There are 87K RGB images of healthy and diseased crop leaves across **38 classes**. Split into 80/20 training and validation sets, preserving directory structure. An additional directory with 33 test images created for prediction.

- Train images :70295
- Test images: 33
- Validation :17572

Dataset-link: https://www.kaggle.com/datasets/vipoooool/new-plant-diseases-dataset

Data Preprocessing:

```
training_set = tf.keras.utils.image_dataset_from_dir
    'train', #directory name
    labels="inferred",
    label_mode="categorical",
    class_names=None,
    color_mode="rgb",
    batch_size=32,
    image_size=(128, 128),
    shuffle=True,
    seed=None,
    validation_split=None,
    subset=None,
    interpolation="bilinear",
    follow_links=False,
    crop_to_aspect_ratio=False
)
```

Data preprocessing for a CNN involves preparing image data for training. This includes resizing images, normalizing pixel values, augmenting data for diversity, and converting images to arrays or tensors. The goal is to optimize input data for effective learning by the CNN model.

Here,

- It includes Standardize image sizes, normalize pixel values, and apply augmentation techniques to enhance dataset variability and quality.

- It loads images from the 'train' directory.
- Images are labeled using inferred labels.
- Labels are encoded in categorical format.
- Images are resized to 128x128 pixels.
- Data is shuffled, and a batch size of 32 is used for training.

Feature Extraction:

```
cnn.add(tf.keras.layers.Conv2D(filters=32,kernel_size=3,padding='same',activation='relu',input_shape=[128,128,3]))
cnn.add(tf.keras.layers.Conv2D(filters=32,kernel_size=3,activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2,strides=2))
```

```
WARNING:tensorflow:From C:\Users\Mit Thaker\anaconda3\lib\site-packages\keras\src\layers\pooling\max_pooling2d.py:161: The name tf.nn.max_pool is deprecated. Please use tf.nn.max_pool2d instead.
```

```
cnn.add(tf.keras.layers.Conv2D(filters=64,kernel_size=3,padding='same',activation='relu'))
cnn.add(tf.keras.layers.Conv2D(filters=64,kernel_size=3,activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2,strides=2))
```

```
cnn.add(tf.keras.layers.Conv2D(filters=128,kernel_size=3,padding='same',activation='relu'))
cnn.add(tf.keras.layers.Conv2D(filters=128,kernel_size=3,activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2,strides=2))
```

```
cnn.add(tf.keras.layers.Conv2D(filters=256,kernel_size=3,padding='same',activation='relu'))
cnn.add(tf.keras.layers.Conv2D(filters=256,kernel_size=3,activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2,strides=2))
```

```
cnn.add(tf.keras.layers.Conv2D(filters=512,kernel_size=3,padding='same',activation='relu'))
cnn.add(tf.keras.layers.Conv2D(filters=512,kernel_size=3,activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2,strides=2))
```

Feature extraction in a CNN means automatically identifying important patterns in data, like edges or textures in images, using convolutional layers. These features are then used for predictions or classifications, enhancing the model's understanding of the data.

Here,

- Feature extraction is done through convolutional layers (Conv2D) and max-pooling layers (MaxPool2D).

- Convolutional layers apply filters to input images, extracting features like edges and textures.

- Activation functions (ReLU) introduce non-linearity. Max-pooling layers down-sample feature maps, retaining essential information.

- Together, these layers capture and refine features from the input images, enabling the network to learn meaningful representations for classification.

Classification CNN Algorithm working:

- Input pre-processed leaf images into the CNN architecture. Forward propagating the images through the convolutional layers to extract hierarchical features. Flatten the feature maps and pass them through fully connected layers for classification. Calculate the loss between predicted and true labels and backpropagate gradients to update model parameters. Iterating through multiple (10) epochs of training, adjusting model weights to minimize classification error.

Deployment:

- Deploying the trained model which detects the disease by using steamlit.

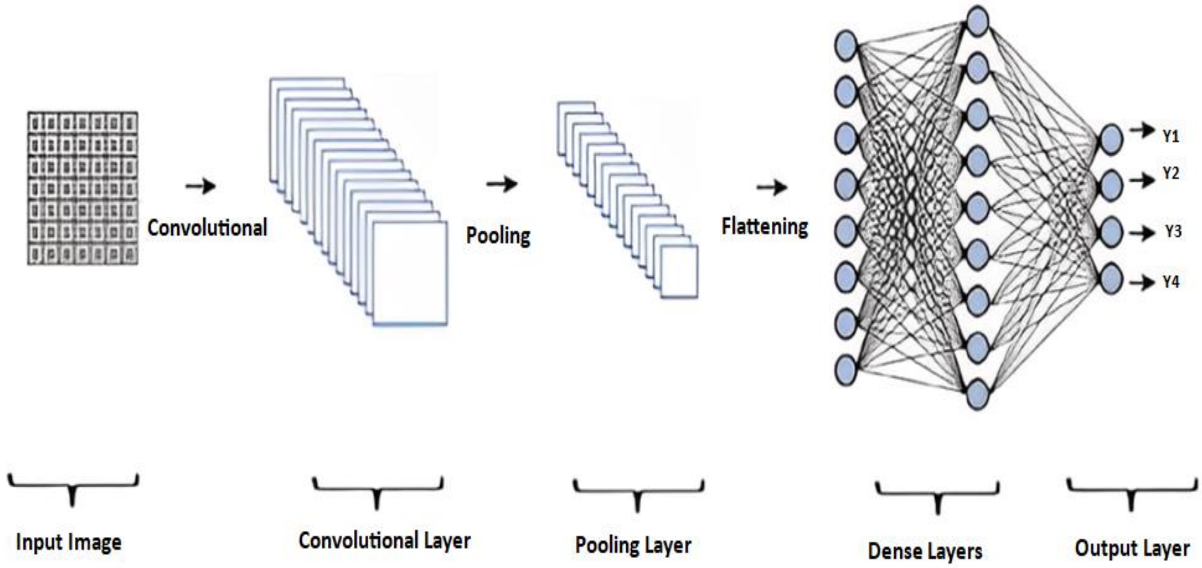
Convolutional Neural Network:

- Convolutional Neural Networks are specialized artificial neural networks designed for processing visual data.

- They use layers that analyze small regions of an image, learn features, and gradually combine them to recognize complex patterns.

- CNNs excel in tasks like image recognition, object detection, and classification due to their ability to automatically extract relevant features from raw data.

Convolutional Neural Network Architecture:

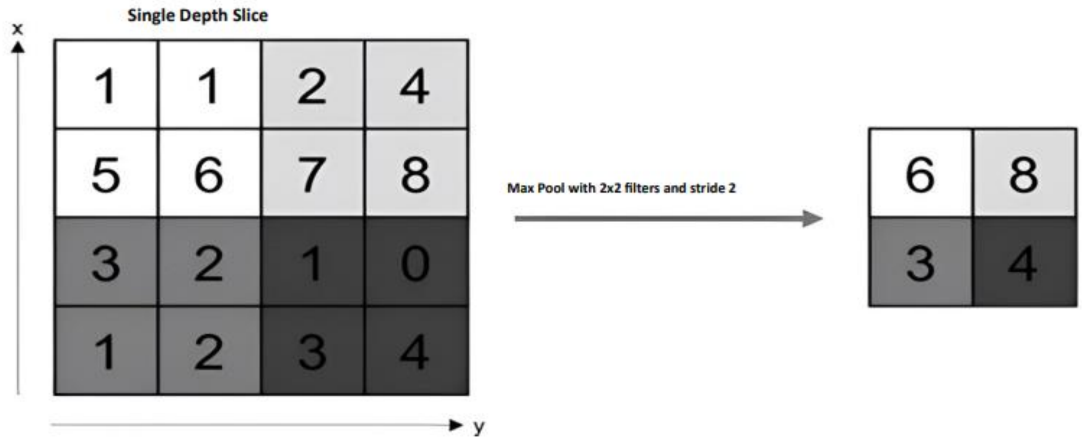


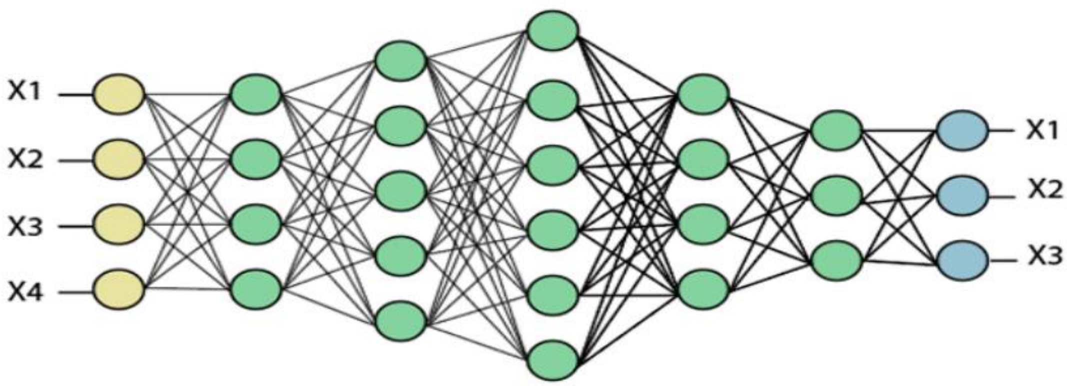
- **Convolutional layer:** Produces an activation map by scanning the pictures several pixels at a time using a filter.

- **Pooling Layer:** Reduces the amount of data created by the convolutional layer so that it is stored more efficiently.

- **Dense layers:** They are fully connected layers where each neuron is connected to every neuron in the preceding layer.

Fully Connected Layer ‘s





1) **Fully connected input layer** – The preceding layers output is "flattened" and turned into a single vector which is used as an input for the next stage.

2) **The first fully connected layer –** Adds weights to the inputs from the feature analysis to anticipate the proper label.

3) **Fully connected output layer** – Offers the probability for each label in the end.

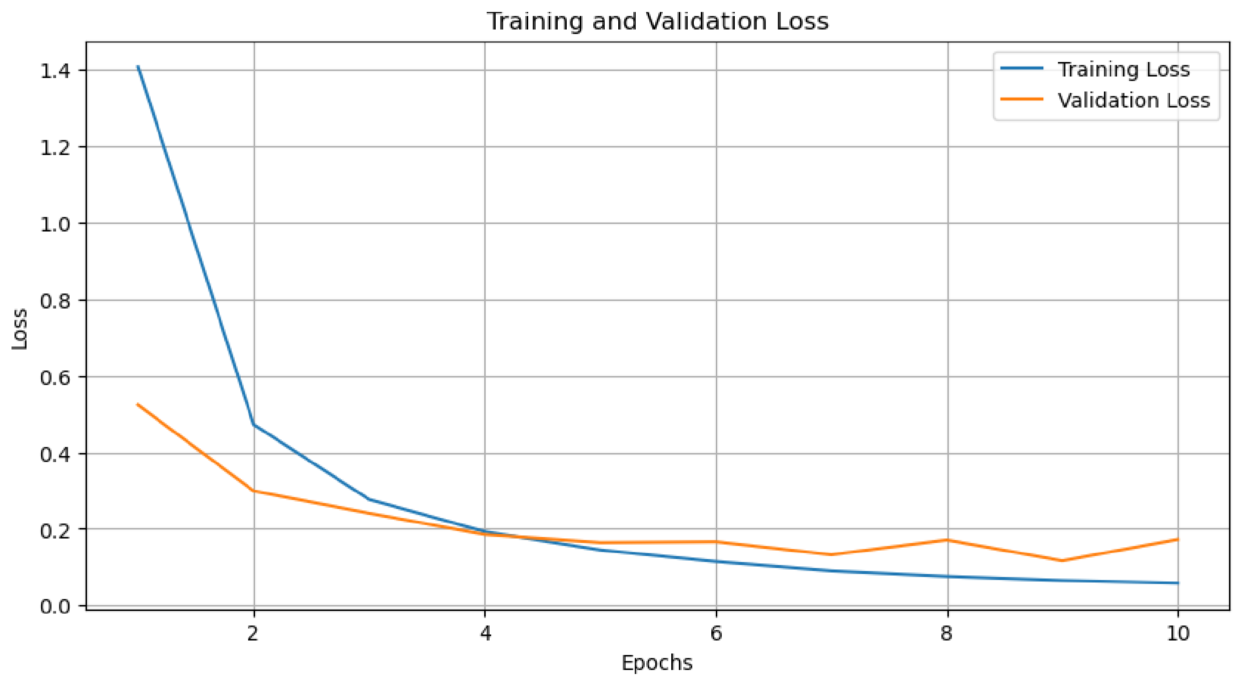
Result & Discussion

The results of the experiments conducted in this study demonstrate the effectiveness of CNNs in detecting plant leaf diseases. The trained models achieve high levels of accuracy in distinguishing between diseased and healthy leaves, with performance comparable to or surpassing that of human experts in some cases. Furthermore, the models exhibit robustness to variations in lighting conditions, leaf orientation, and disease severity. However, challenges such as dataset imbalance, limited generalization to unseen diseases, and interpretability of model decisions remain areas for further research and improvement. Nevertheless, the findings of this study underscore the potential of CNNs to revolutionize plant disease detection and management practices, paving the way for more sustainable and resilient agricultural systems.

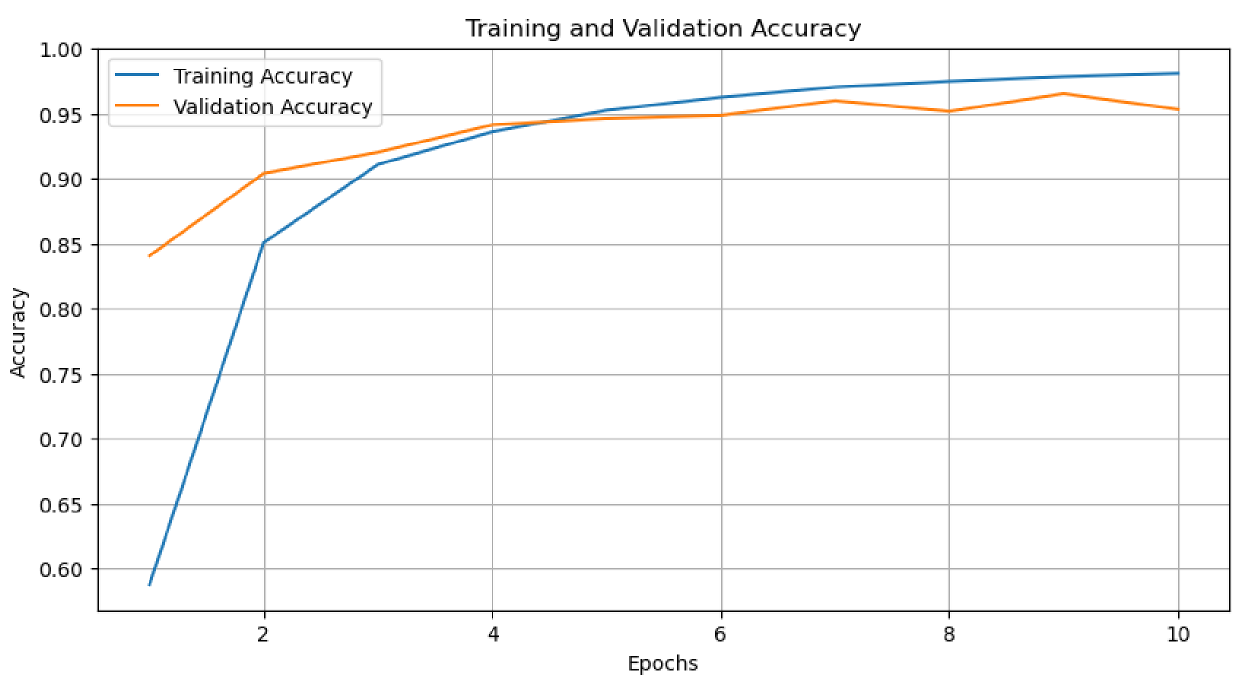
- **Training accuracy:** 0.983483910560
- **Validation accuracy:** 0.953448653221

Graphs:

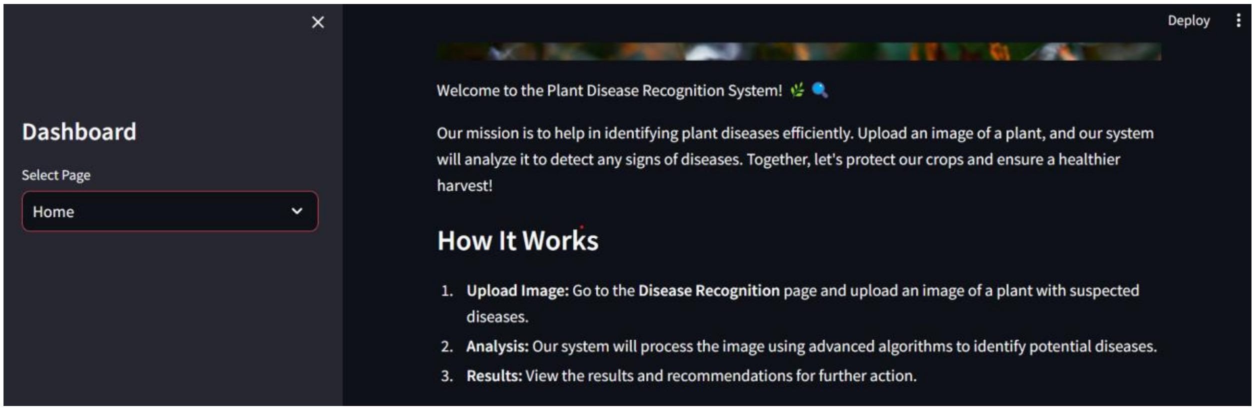
Training and Validation loss

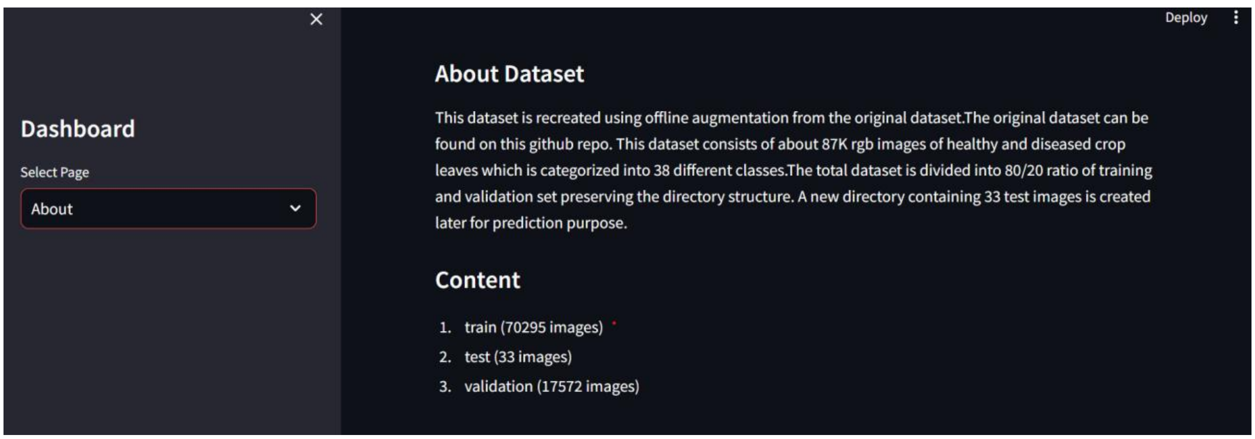


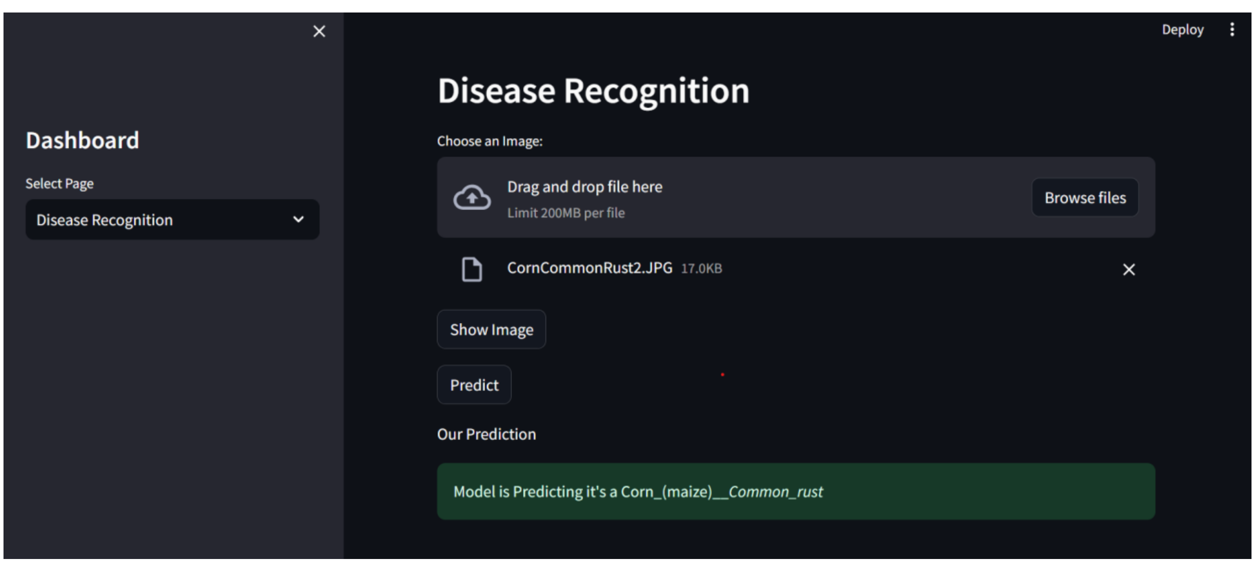
Training and Validation Accuracy



Webpage:


Deploy
Dashboard
Select Page
Home
Welcome to the Plant Disease Recognition System!
Our mission is to help in identifying plant diseases efficiently. Upload an image of a plant, and our system will analyze it to detect any signs of diseases. Together, let's protect our crops and ensure a healthier harvest!
How It Works
1. Upload Image: Go to the Disease Recognition page and upload an image of a plant with suspected diseases.
2. Analysis: Our system will process the image using advanced algorithms to identify potential diseases.
3. Results: View the results and recommendations for further action.


Deploy
Dashboard
Select Page
About
About Dataset
This dataset is recreated using offline augmentation from the original dataset.The original dataset can be found on this github repo. This dataset consists of about 87K rgb images of healthy and diseased crop leaves which is categorized into 38 different classes.The total dataset is divided into 80/20 ratio of training and validation set preserving the directory structure. A new directory containing 33 test images is created later for prediction purpose.
Content
1. train (70295 images)
2. test (33 images)
3. validation (17572 images)


Deploy
Dashboard
Select Page
Disease Recognition
Disease Recognition
Choose an Image:
Drag and drop file here
Limit 200MB per file
Browse files
CornCommonRust2.JPG 17.0KB
Show Image
Predict
Our Prediction
Model is Predicting it's a Corn_(maize)__Common_rust

Conclusion:

In conclusion, this dissertation has provided an overview of the application of Convolutional Neural Networks (CNNs) in the detection of plant leaf diseases.

- In conclusion, the project demonstrated the effectiveness of deep learning techniques in detecting plant leaf diseases. The project achieved high accuracy rates in classifying the different types of plant leaf diseases using a Convolutional Neural Network (CNN) architecture.

- Furthermore, the project's helps farmers make informed decisions about the most effective treatment for their crops.

- With further advancements in technology and the integration of precision agriculture techniques, the future of plant leaf disease detection and agriculture can become more efficient, sustainable, and productive.

Bibliography

1. Shrestha, G., Das, M., & Dey, N. (2020, October). Plant disease detection using CNN. In *2020 IEEE applied signal processing conference (ASPCON)* (pp. 109-113). IEEE.

2. Deepalakshmi, P., Lavanya, K., & Srinivasu, P. N. (2021). Plant leaf disease detection using CNN algorithm. *International Journal of Information System Modeling and Design (IJISMD)*, *12*(1), 1-21.

3. Lu, J., Tan, L., & Jiang, H. (2021). Review on convolutional neural network (CNN) applied to plant leaf disease classification. *Agriculture*, *11*(8), 707.