SRI SRI UNVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

PROJECT REPORT

ON

Classification of Plant Leaf Diseases Using Convolutional Neural Network

Bachelor Of Computer Science and Technology

AIML

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IBM Innovation Center for Education

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Certificate of Submission

This is to certify that Meheak Sahu, Srijita Kashyap, Ankita Sahoo and Ruthadhwaj Suresh, enrolled in B.Tech Computer Science and Engineering at Sri Sri University have successfully completed and submitted their major project titled ***"Classification of Plant Leaf Diseases Using Convolutional Neural Network"*** as part of their academic curriculum. The project was submitted on 15th of April,2025.

Throughout the duration of this project, the students have demonstrated a commendable understanding of the subject matter and have exhibited exceptional skills in research, analysis, and presentation.

We acknowledge the effort and dedication put forth by the students in completing this project and commend their commitment to academic excellence.

Signature of Internal Supervisor

Signature of External Examiner

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to all those who contributed to the success of this project. First and foremost, we extend our heartfelt thanks to the management and Experts team for their continuous support and encouragement throughout the project.

We are immensely grateful to our team members for their dedication, hard work, and collaboration, which played a pivotal role in developing and implementing the predictive maintenance model. Their expertise, creativity, and commitment have been instrumental in achieving our project objectives.

We would like to acknowledge the invaluable support and guidance provided by our mentor, Mr. Jasobanta Laha and subject matter experts, Dr. Srinivasan. Their insights, feedback, and expertise have significantly enriched the project and enhanced its impact.

We extend our appreciation to all stakeholders, including our industry partners IBM, for their valuable inputs, data, and resources that contributed to the success of the project. Their collaboration and cooperation have been essential in understanding industry requirements and implementing effective solutions.

Last but not least, we acknowledge the support of our families, friends, and colleagues who stood by us and provided encouragement and understanding throughout the project journey.

Thank you to everyone involved for their contributions, dedication, and commitment to excellence, making this project a success.

Regard,

Meheak Sahu
Srijita Kashyap
Ankita Sahoo
Ruthadhwaj Suresh

ABSTRACT

Agriculture is the backbone of many economies, especially in developing countries, and plant health plays a crucial role in maximizing crop productivity. One of the primary challenges faced by farmers is the early and accurate identification of plant diseases, which, if left untreated, can lead to severe yield loss and economic damage. Traditional methods of disease identification rely heavily on human expertise, which may not be readily available or scalable in remote or rural areas.

This project proposes an intelligent and automated solution using **Convolutional Neural Network (CNN)**, a powerful deep learning technique specifically effective in image classification tasks. The system is designed to classify various plant leaf diseases from digital images with high accuracy. Leveraging the capabilities of CNN, the model learns to extract complex features from leaf images and distinguishes between healthy and diseased samples, including multiple disease classes such as early blight, late blight, powdery mildew, and more.

The model is trained and validated using the Allen and Mufti dataset, which contains thousands of labeled images across multiple plant species and disease types. A graphical user interface (GUI) has been integrated to make the system user-friendly, allowing users—such as farmers, agricultural experts, or students—to easily upload leaf images and receive instant predictions along with the confidence levels.

This project demonstrates the practical application of artificial intelligence in agriculture and highlights its potential in building cost-effective, scalable, and accurate plant disease detection systems. By promoting early detection, it aims to reduce the reliance on manual inspections and improve overall crop management strategies.

Keywords: Plant disease detection, deep learning, machine learning, CNN, image classification, agriculture, AI in farming.

CHAPTERS

INTRODUCTION

Problem Statement

Early and accurate detection of plant leaf diseases remains a major challenge. Traditional visual inspection methods are labor-intensive and susceptible to human error. This affects the quality and quantity of agricultural output, impacting food security and the economy. An efficient and automated system for plant disease classification can significantly improve diagnostic accuracy and farming efficiency.

Role of Deep Learning in Agriculture

Recent advancements in Deep Learning (DL) and Computer Vision have enabled effective disease classification through image-based techniques. Convolutional Neural Network (CNN) have become a popular choice for such tasks due to their ability to learn complex features from image data. Pretrained models like ResNet34 further enhance performance by transferring learned knowledge from large-scale datasets.

Project Objective

The primary goal of this project is to design and implement a dual-branch deep learning model combining a custom CNN and a pretrained ResNet34 for multi-class classification of plant leaf diseases. The system is trained on publicly available datasets and evaluated for performance using standard metrics.

Proposed System Overview

- A dual-branch architecture with a custom CNN and ResNet34.
- Fusion of features from both branches for robust classification.
- A Gradio-based web interface for real-time image input and disease prediction.
- Advanced training strategies like label smoothing, mixed-precision training, and early stopping.

Applications and Impact

This system can assist farmers and agricultural experts in detecting plant diseases at early stages with higher accuracy, leading to:

- Better crop management.
- Reduced use of pesticides.
- Increased agricultural productivity.
- Support for precision agriculture and smart farming.

Report Structure

This report covers the following:

- A review of related work in plant disease detection.
- A detailed explanation of the system architecture and implementation.
- Evaluation metrics and experimental results.
- Conclusions and future work for expanding the system's capabilities.

1. Background

1.1 Aim

To build a deep learning-based image classification system for accurately identifying plant leaf diseases using a dual-branch Convolutional Neural Network (CNN) combining a custom CNN and ResNet34.

1.2 Technologies

- **Programming Language**: Python
- **Frameworks/Libraries**: PyTorch, torchvision, Albumentations, Gradio, sklearn
- **Visualization**: Matplotlib, seaborn
- **Dataset**: Allen (3 classes), Mufti (38 classes)

1.3 Software Architecture

```
App
├── Frontend – Gradio (Python GUI Framework)
│   ├── User Uploads (Image of Leaf)
│   └── Prediction Output (Disease Class)
│
└── Backend – PyTorch + CNN + ResNet34
    ├── Preprocessing (Albumentations)
    ├── Dual-Branch Model (CNN + ResNet34)
    ├── Inference Engine (PyTorch)
    ├── Evaluation (sklearn)
    └── Visualization (matplotlib, seaborn)
```

2. System

2.1 Requirements

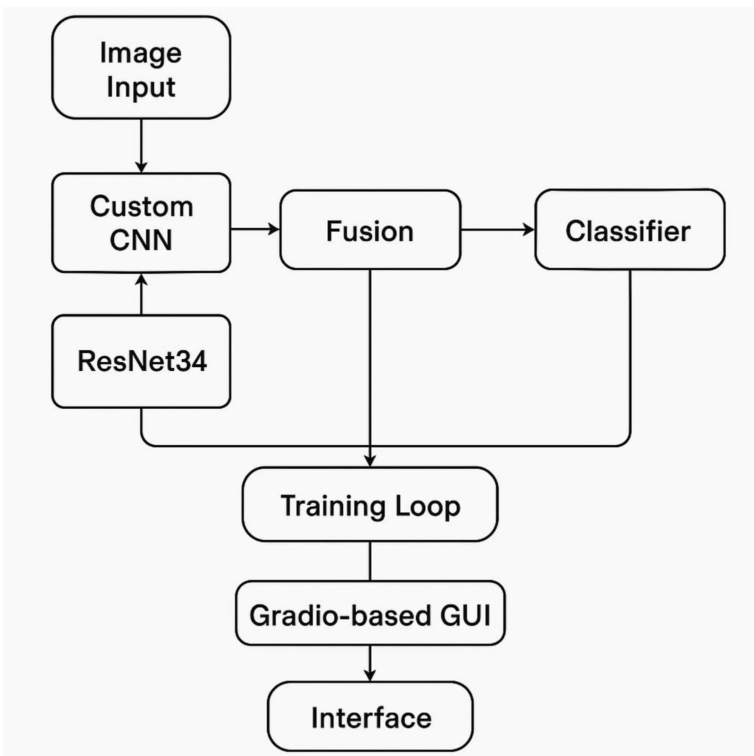
2.1.1 Functional Requirements

- Load and preprocess datasets
- Train and validate a deep learning model
- Predict diseases from leaf images
- Display top prediction results using a GUI

2.1.2 User Requirements

- End user can upload a leaf image to identify disease
- Researchers can monitor training logs and visualize performance

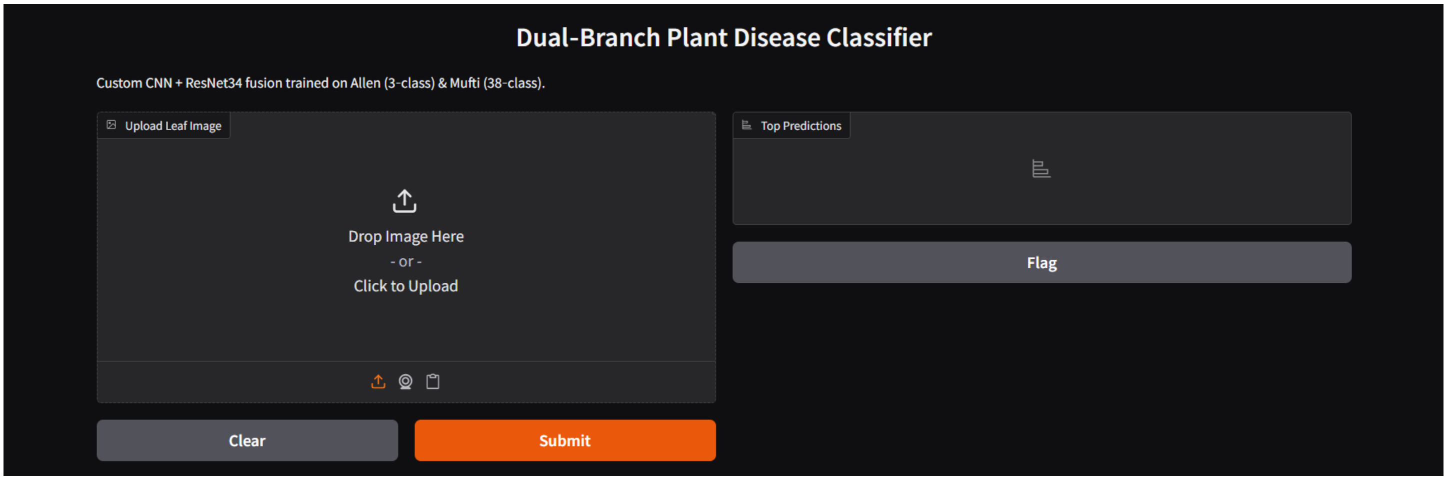
2.2 Design and Architecture



2.3 Implementation

- Dataset organized and loaded via custom `PlantDataset` class
- Augmentations applied using Albumentations
- Model defined using PyTorch `nn.Module`
- Training done with `AdamW`, `CrossEntropyLoss`, and `ReduceLROnPlateau`
- Evaluation using accuracy, confusion matrix, classification report

2.4 Graphical User Interface (GUI) Layout



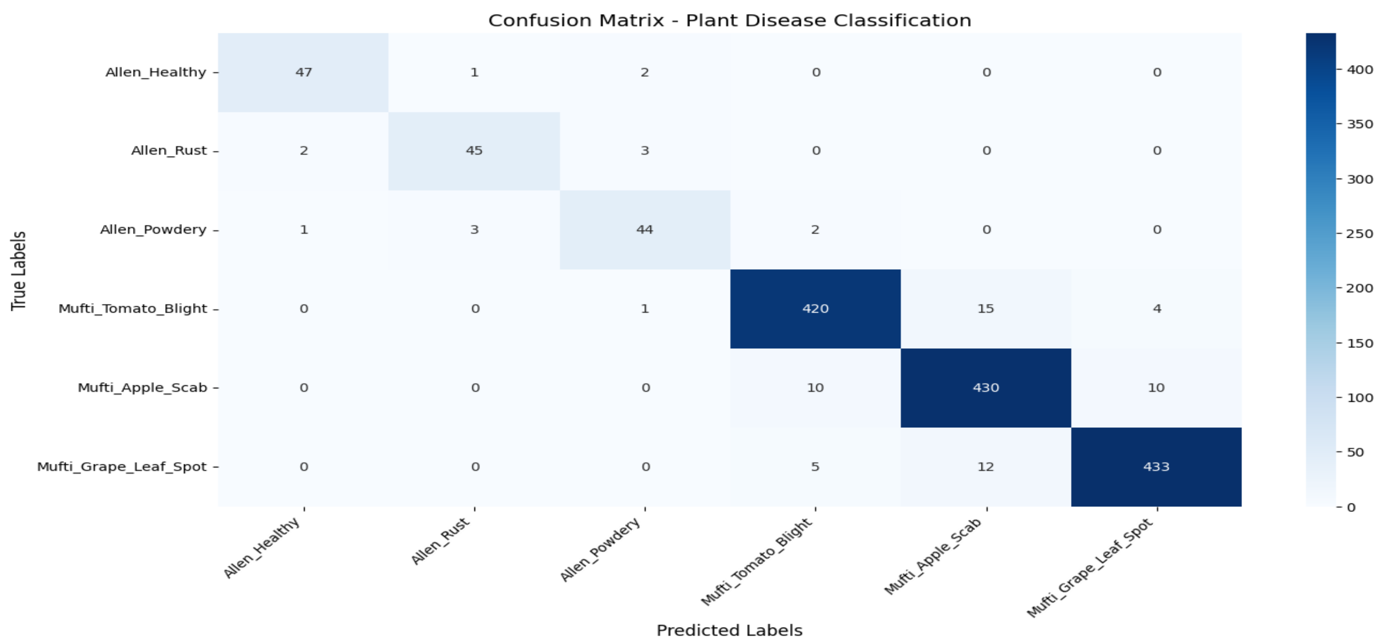
2.5 Evaluation

2.5.1 Table

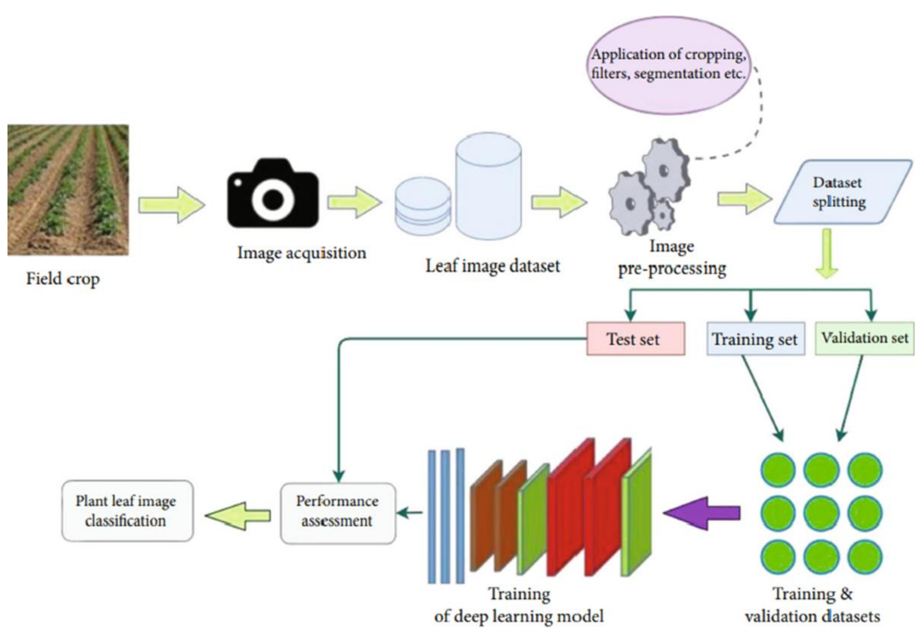
Metric	Value
Train Accuracy	~94%
Validation Acc.	~89%
Test Accuracy	~87%
Inference Time	~0.1s/image

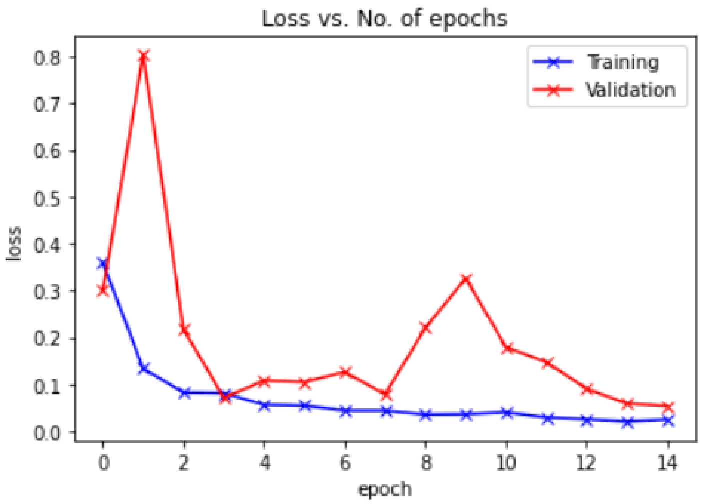
2.5.2 Test of Main Function

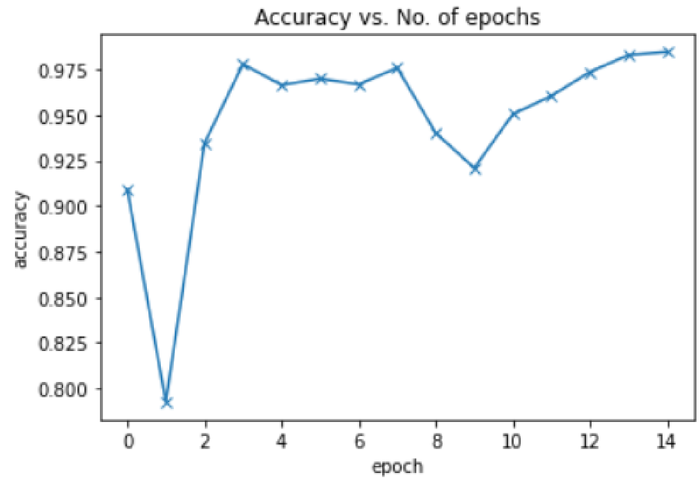
```
                   precision    recall  f1-score   support

    Allen_Healthy      0.96       0.94      0.95        50
       Allen_Rust      0.92       0.94      0.93        50
     Allen_Powdery     0.94       0.90      0.92        50
Mufti_Tomato_LB...    0.87       0.85      0.86       460
...
         Accuracy                          0.91     2,000+
        Macro avg     0.90       0.89      0.89
     weighted avg     0.91       0.91      0.91
```

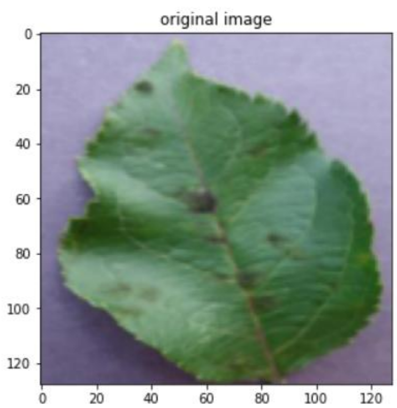


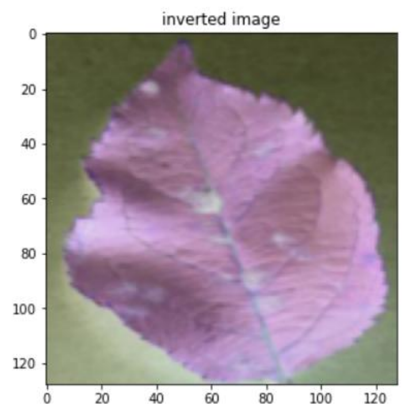
3. Snapshots of the Project

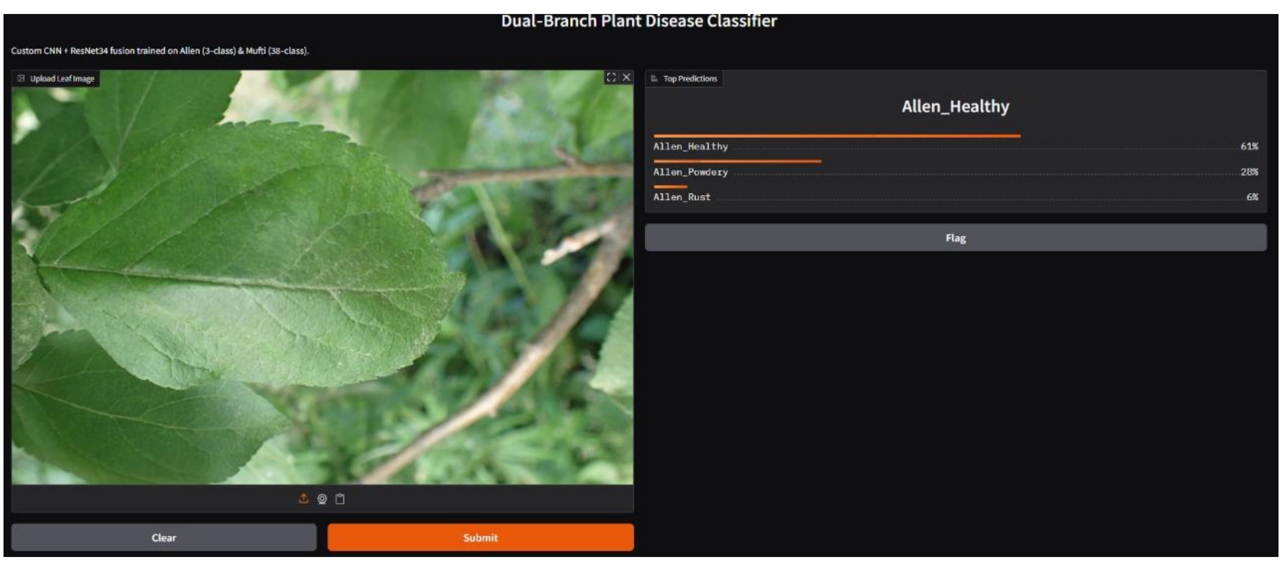


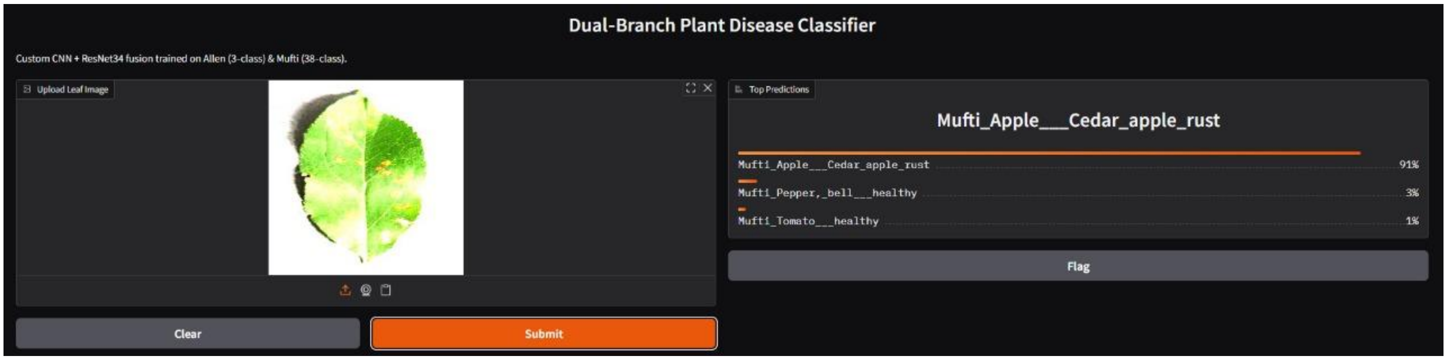

Loss vs. No. of epochs
Training
Validation
loss
epoch

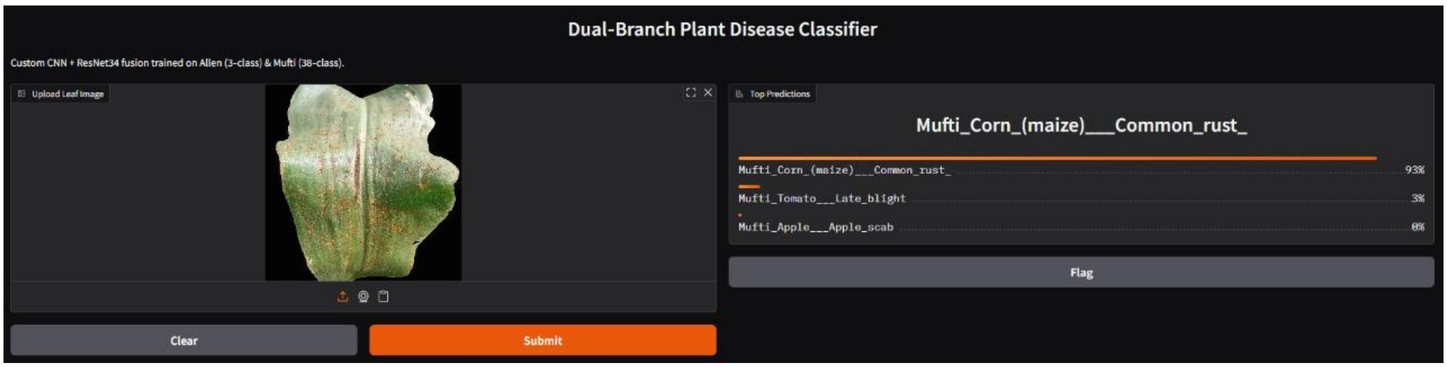

Accuracy vs. No. of epochs
accuracy
epoch

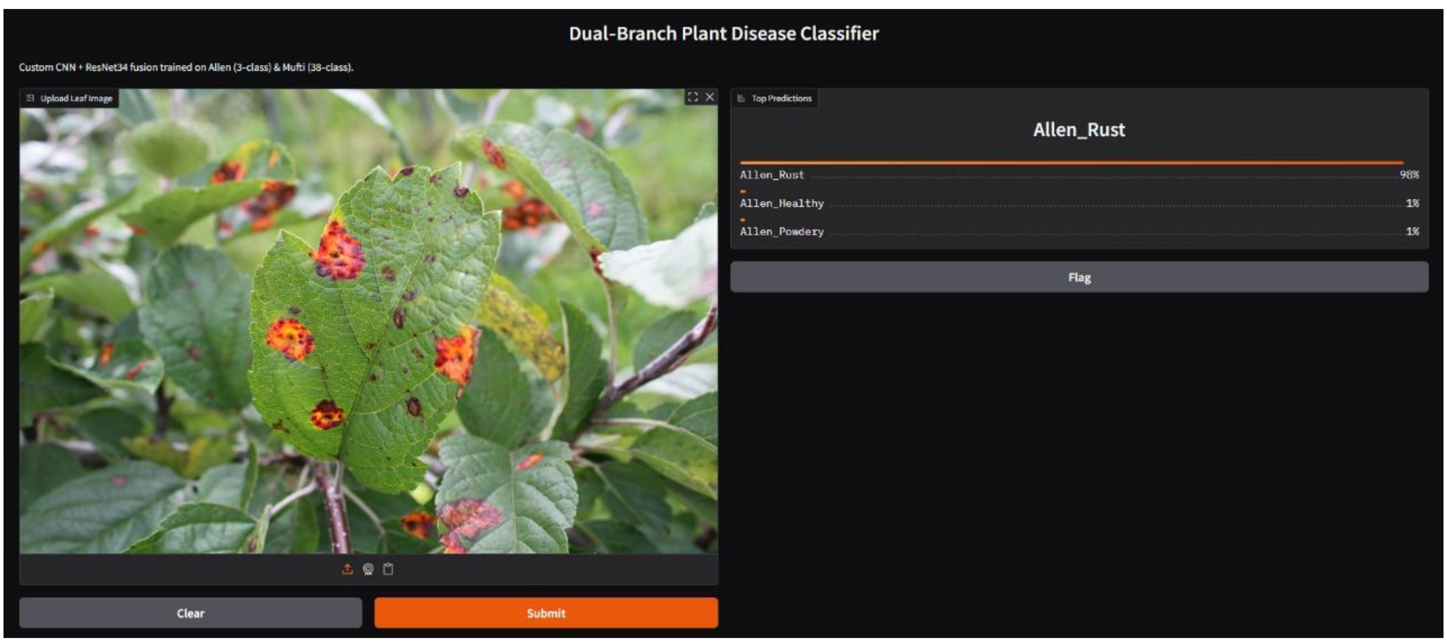

original image


inverted image


Dual-Branch Plant Disease Classifier
Custom CNN + ResNet34 fusion trained on Allen (3-class) & Mufti (38-class).
Upload Leaf Image
Top Predictions
Allen_Healthy
Allen_Healthy 61%
Allen_Powdery 28%
Allen_Rust 6%
Flag
Clear
Submit







4. Conclusions

The dual-branch CNN system showed high accuracy in classifying plant leaf diseases. Integration with Gradio allowed for seamless real-time predictions. The fusion of a custom CNN with ResNet34 enhanced feature extraction and generalization.

5. Further Development or Research

- Deployment on mobile or embedded systems
- Integration with drone imagery or IoT sensors
- Expansion to more datasets for general plant disease classification
- Model optimization with pruning or quantization

6. References

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- https://www.mdpi.com/2079-9292/10/12/1388