CornLeafNet:Based on K-Means Clustering and Deep Learning

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Outline Of The Presentation

Introduction

- Agricultural Significance
- Precision Agriculture Needs
- Impact on Food Security
- Technological Advancements

Problem Statement

- Effectively segmenting the corn leaf from complex backgrounds poses a challenge for accurate disease detection. The problem is addressed by implementing data augmentation techniques and employing a K-means algorithm for segmentation,followed by a Deep Neural Network(DNN) for precise and efficient classification in corn leaf disease detection.

Motivation

- Identifying Corn Leaf Diseases
- Data-driven Agriculture
- Global Food Security
- Application of Deep Learning Models

Objectives

- To develop a robust method for accurately diagnosing three common corn leaf diseases (gray spot, leaf spot, and rust) using a combination of K-means clustering and deep learning models.
- Dataset Pre-processing, i.e. resizing, normalization.
- To do data augmentation in order to achieve a uniform distribution in all classes.
- To develop an efficient deep learning based classification algorithm based on CNNs.
- Evaluate and compare the performance of multiple deep learning models (VGG-16, ResNet18, Inception v3, VGG-19, and an improved deep learning model) for corn disease classification

Overall Workflow

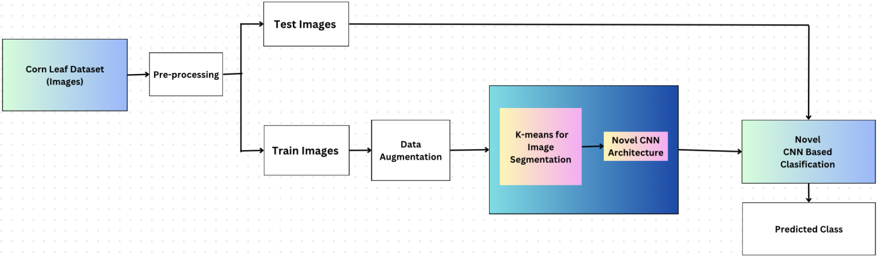


Figure 1: Workflow of CornLeafNet

Phenotypic Corn Dataset

- **Type of Data** - Corn Leaf Images
- **Train Dataset Size** - 900 images
- **Test Dataset Size** - 176 images
- **Data Source Location** - Challenger AI 2018

Table 1: **Train Dataset of Corn Leaf Images**

S. No	Disease Name	Number of Images
1	Gray Spot	300
2	Leaf Spot	300
3	Rust	300

Table 2: **Test Dataset of Corn Leaf Images**

S. No	Disease Name	Number of Images
1	Gray Spot	51
2	Leaf Spot	62
3	Rust	63

Samples of Corn Leaf

Table 3: **Samples of Corn Diseased Leaf Images**

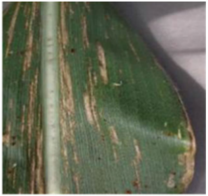
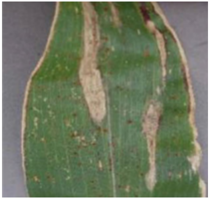
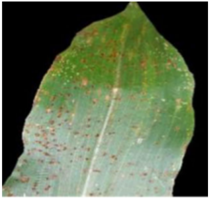
		
Gray Spot	Leaf Spot	Rust

Table 4: **Samples of Corn Diseased Leaf Images**

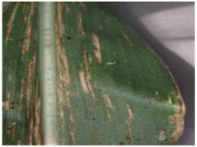
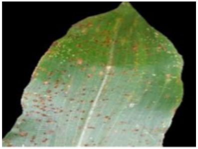
S. No.	**Disease Name**	**Image**	**Symptoms**	**Cause**
1	Gray Spot		The initial stage of the disease is light brown spots in the shape of water stains, which extend parallel to the veins and are often rectangular.	Fungal Infection
2	Leaf Spot		These are oval or rectangular, spindle-shaped lesions on the leaves, with yellow-brown halos around them, 5-10cm long and 1.2-1.5 cm wide. In severe cases, several lesions are connected, and the leaves die early.	Fungal Infection

Table 5: **Samples of Corn Diseased Leaf Images**

S. No.	**Disease Name**	**Image**	**Symptoms**	**Cause**
3	Rust		It occurs in the middle and upper leaves of the plant. At first, small light-yellow dots scattered or clustered on the front of the leaf, then protruded and expanded to round to oblong, yellowish-brown, or brown, and the surrounding epidermis turned up.	Fungal Infection

Data Pre-processing

- Resizing - In order to make the images the same size
- Normalization
  - To ensure that each input pixel has a similar data distribution
  - To scale the normalized data in the range [0,1] or [0, 255]
  - Ensures faster convergence while training the network

CornLeafNet:Steps

- Data Augmentation Techniques
  - Image Augmentation
- Segmentation Techniques
  - K-Means Clustering [1]
- Convolutional Neural Networks (CNNs)
  - VGG16 [2]
  - ResNet18 [3]
  - VGG19 [4]
  - Inception v3 [5]
  - Proposed Model [4]
  - CornLeafNet[6]
- Evaluation Metrics
  - Accuracy
  - Precision
  - Recall
  - F1-score

K-means Algorithm

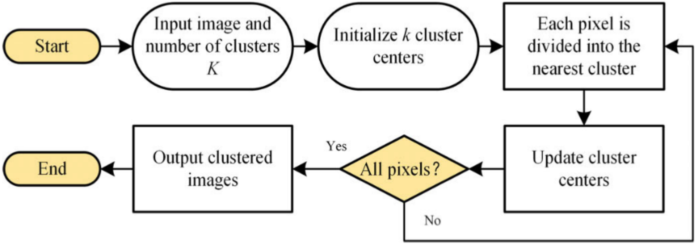


Figure 2: Workflow of K-means algorithm

K-means Algorithm

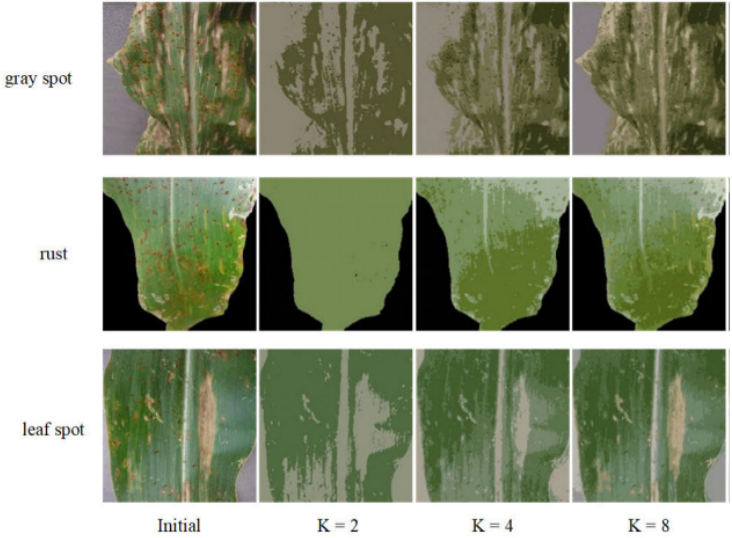


Figure 3: Workflow of K-means algorithm

VGG16

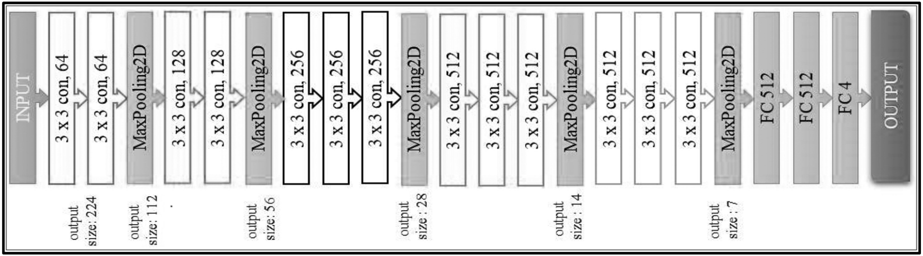


Figure 4: Architecture of VGG16

1

[1] A. S. Paymode and V. B. Malode, "Transfer learning for multi-crop leaf disease image classification using convolutional neural network vgg," *Artificial Intelligence in Agriculture*, vol. 6, pp. 23–33, 2022, ISSN: 2589-7217.

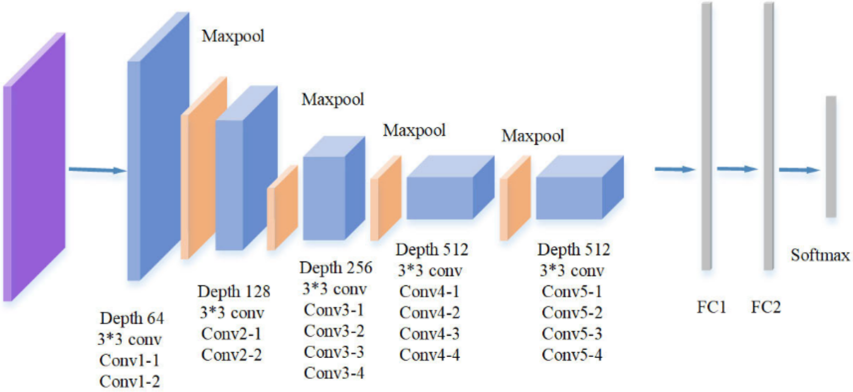


Figure 5: Architecture of VGG19

2

[2] H. Yu *et al.*, "Corn leaf diseases diagnosis based on k-means clustering and deep learning," *IEEE Access*, vol. 9, pp. 143 824–143 835, 2021.

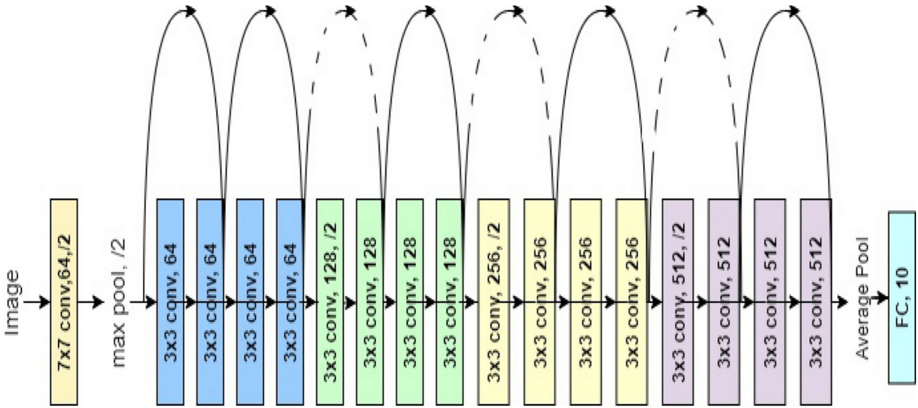


Figure 6: Architecture of ResNet18

3

[3] F. Ramzan *et al.*, "A deep learning approach for automated diagnosis and multi-class classification of alzheimer's disease stages using resting-state fmri and residual neural networks," *Journal of Medical Systems*, vol. 44, Dec. 2019. DOI: 10.1007/s10916-019-1475-2.

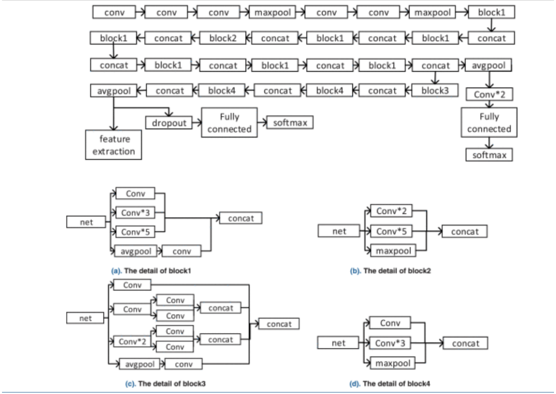


Figure 7: Architecture of Inception-v3

4

[4] C. Wang *et al.*, "Pulmonary image classification based on inception-v3 transfer learning model," *IEEE Access*, vol. 7, pp. 146 533–146 541, 2019. DOI: 10.1109/ACCESS.2019.2946000.

Proposed CNN Framework

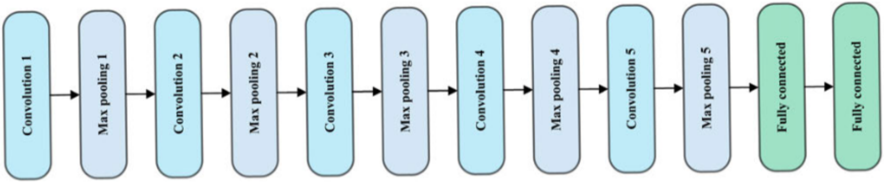


Figure 8: Architecture of Proposed CNN Framework

5

[5] H. Yu *et al.*, "Corn leaf diseases diagnosis based on k-means clustering and deep learning," *IEEE Access*, vol. 9, pp. 143 824–143 835, 2021.

Our proposed model comprises the following layers:

1. **Convolutional Layers**
2. **Dilated Convolutional Layers**
3. **Global Average Pooling & Fully Connected Layers**
4. **Output Layer for 3-Class Classification**

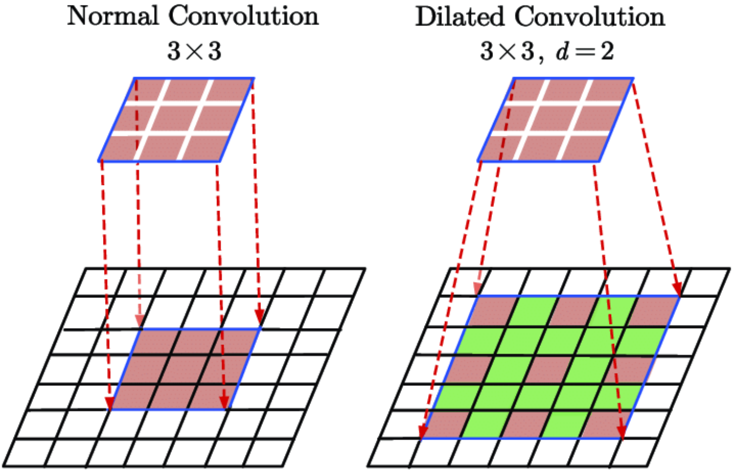


Figure 9: Illustration of 2-D Dilated Convolutional Layer

6

[6] J. Du *et al.*, "Brain mri super-resolution using 3d dilated convolutional encoder–decoder network," *IEEE Access*, vol. PP, pp. 1–1, Jan. 2020. DOI: 10.1109/ACCESS.2020.2968395.

Table 6: Summary of Dataset Results for k=2

Model	Training Accuracy	Testing Accuracy
VGG-16	71.88%	69.8%
VGG-19	62.0%	65.9%
ResNet 18	95.97%	77.84%
Inception v3	93.0%	78.9%
Proposed Model	80.0%	79.5%
CornLeafNet	84.59%	79.54%

Experimental Results

Table 7: Summary of Dataset Results for k=4

Model	Training Accuracy	Testing Accuracy
VGG-16	93.75%	85.7%
VGG-19	93.75%	85.2%
ResNet 18	94.72%	83.0%
Inception v3	96.8%	81.8%
Proposed Model	81.0%	79.5%
CornLeafNet	88.33%	86.36%

Table 8: **Summary of k=2 Dataset Results:F1 score**

Model	Gray Spot	Leaf Spot	Rust
VGG-16	0.17	0.69	0.97
VGG-19	0.62	0.12	0.98
ResNet18	0.71	0.66	0.95
Inception v3	0.63	0.77	0.94
Proposed Model	0.70	0.66	0.99
CornLeafNet	0.67	0.73	0.95

Table 9: **Summary of k=2 Dataset Results:Recall**

Model	Gray Spot	Leaf Spot	Rust
VGG-16	0.10	0.94	0.95
VGG-19	0.96	0.60	1.00
ResNet18	0.90	0.55	0.90
Inception v3	0.57	0.87	0.89
Proposed Model	0.84	0.55	1.00
CornLeafNet	0.73	0.65	1.00

Table 10: **Summary of k=2 Dataset Results:Precision**

Model	**Gray Spot**	**Leaf Spot**	**Rust**
VGG-16	0.62	0.54	0.98
VGG-19	0.46	0.80	0.97
ResNet18	0.59	0.83	1.00
Inception v3	0.71	0.68	1.00
Proposed Model	0.61	0.83	0.98
CornLeafNet	0.63	0.83	0.91

Table 11: **Summary of k=4 Dataset Results:F1 score**

Model	**Gray Spot**	**Leaf Spot**	**Rust**
VGG-16	0.78	0.79	0.98
VGG-19	0.78	0.78	0.98
ResNet18	0.81	0.82	0.99
Inception v3	0.65	0.84	0.89
Proposed Model	0.59	0.79	0.92
CornLeafNet	0.78	0.80	0.99

Table 12: **Summary of k=4 Dataset Results:Recall**

Model	**Gray Spot**	**Leaf Spot**	**Rust**
VGG-16	0.80	0.76	1.00
VGG-19	0.82	0.73	1.00
ResNet18	0.88	0.76	1.00
Inception v3	0.49	0.90	1.00
Proposed Model	0.47	0.85	1.00
CornLeafNet	0.84	0.74	1.00

Table 13: **Summary of k=4 Dataset Results:Precision**

Model	Gray Spot	Leaf Spot	Rust
VGG-16	0.76	0.82	0.97
VGG-19	0.74	0.85	0.95
ResNet18	0.75	0.90	0.98
Inception v3	0.96	0.78	0.81
Proposed Model	0.80	0.74	0.84
CornLeafNet	0.73	0.87	0.98

Tasks

Completed Tasks

- Data Pre-Processing.
- Applied CorrnLeafNet on Phenotypic Corn Dataset.

Future Tasks

- Extending CornLeafNet for large datsets.
- Exploring different values of k in k-means clustering for image segmentation to optimize accuracy and efficiency.
- Extending CornLeafNet to classify additional corn leaf diseases

References I

[1] N. Dhanachandra, K. Manglem, and Y. J. Chanu, "Image segmentation using k -means clustering algorithm and subtractive clustering algorithm," *Procedia Computer Science*, vol. 54, pp. 764–771, 2015, ISSN: 1877-0509.

[2] A. S. Paymode and V. B. Malode, "Transfer learning for multi-crop leaf disease image classification using convolutional neural network vgg," *Artificial Intelligence in Agriculture*, vol. 6, pp. 23–33, 2022, ISSN: 2589-7217.

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[6] J. Du, L. Wang, Y. Liu, Z. Zhou, Z. He, and Y. Jia, "Brain mri super-resolution using 3d dilated convolutional encoder–decoder network," *IEEE Access*, vol. PP, pp. 1–1, Jan. 2020. DOI: 10.1109/ACCESS.2020.2968395.

THANK YOU