Plant Disease Classification

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***Abstract*— This paper explores the efficacy of machine learning in plant disease classification, employing convolutional neural networks (CNNs), pretrained model, Artificial Neural Networks (ANNs) and other models. Using a diverse dataset, we investigate the impact of pre-processing techniques, data augmentation, and model architectures on classification accuracy.**

Our research assesses model generalization across different plant species. Results demonstrate promising accuracy, highlighting the potential of machine learning for automated and scalable plant disease diagnostics, essential for sustainable agriculture.

Keywords—component, formatting, style, styling, insert (key words**)**

I. Introduction (*Motivation*)

Growing plant diseases threaten our food supply, and we need quick ways to identify and tackle them. Traditional methods are slow, so we're turning to machine learning, using smart algorithms to spot diseases faster. Our goal is to create a flexible and practical system that can adapt to different plants and diseases, making it easier for farmers to protect their crops. We also want our system to be easy to understand. Knowing why it makes certain decisions helps people trust it more. This way, we're not just making farming more efficient, but also helping farmers feel confident in managing plant diseases for a more reliable food source.

II. Methodology

Based upon the inputs (attributes) we classify the disease by using Random Forest, KNN classifier, Logistic Regression classifier, Decision Tree, Navie Bayes, ANN, ResNet-50, correlation matrix, confusion matrix.

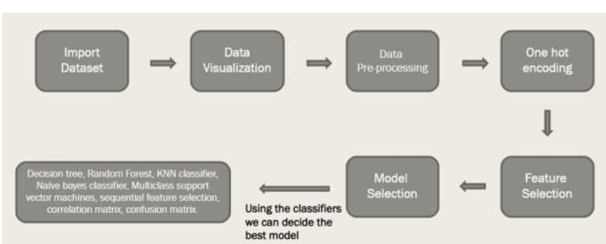

fig (1): Block diagram

1. DATA PRE-PROCESSING

A. CORRELATION MATRIX

The correlation matrix is used to find how strong the relation is between two features/attributes. To reduce the redundancy, the relation of the features is compared and if it is found that these two features have the correlation value near to 1 then one of these features can be dropped without resulting in information loss.

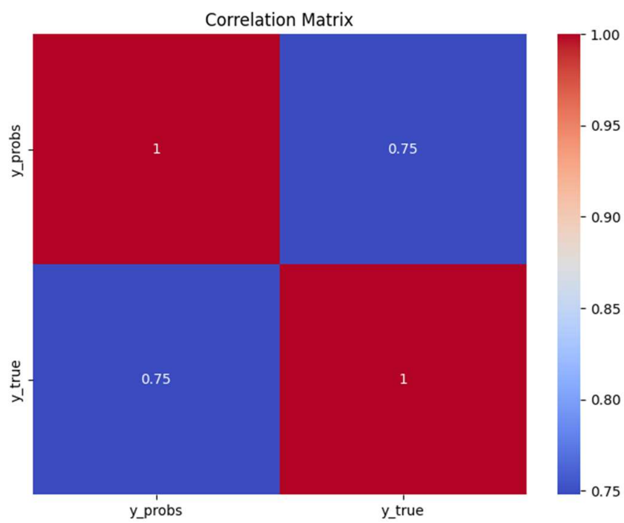

Fig. (2) correlation matrix

B. LABEL ENCODING

Label encoding is defined as a process of converting the categorical labels into a numeric form to convert them into machine-readable language. Machine learning algorithms can then decide in a better way how those labels must be operated. It is an important pre-processing step for the structured dataset in supervised learning.

1. CLASSIFICATION ALGORITHMS

C. DECISION TREE

A decision tree is a type of supervised machine learning used to categorize or make predictions based on how a previous set of questions were answered. The model is a form of supervised learning, meaning that the model is trained and tested on a set of data that contains the desired categorization. Decision trees are useful for categorizing results where attributes can be sorted against known criteria to determine the final category.

D. RANDOM FOREST CLASSIFICATION

Random forest algorithm builds decision trees on different samples and takes their majority vote for classification and average in case of regression. One of the best features of the Random Forest classification is that it easily deals with the categorical data as well besides numerical. This algorithm is useful for both classification as well as regression. It performs well in classification problems as compared to that of regression.

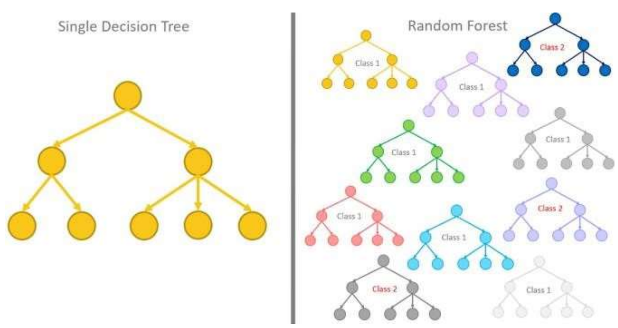

Fig. (3) random forest classifier

E. KNN

K-Nearest Neighbors (KNN) algorithm is a non-parametric algorithm. The principle is that known data are arranged in a space defined by the selected features and when a new data is supplied to the algorithm, the algorithm will compare the classes of the k closest data to determine the class of the new data. This is a supervised learning algorithm and uses proximity measures in the classification process

F. RESNET-50 (PRETRAINED MODEL)

ResNet-50 is a deep learning model with 50 layers, known for its breakthrough use of residual connections. Developed by Microsoft, these connections alleviate training difficulties in deep networks. ResNet-50 excels in computer vision tasks like image classification and object detection, thanks to its ability to learn complex features.

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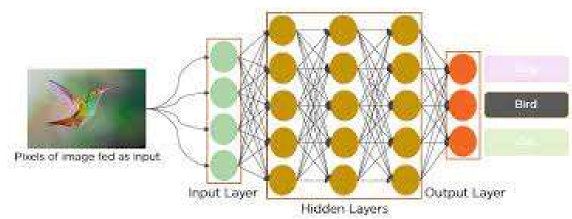
G. LOGISTIC CLASSIFICATION

Logistic regression is a classification technique borrowed by machine learning from the field of statistics. Logistic Regression is a statistical method for analyzing a dataset in which there are one or more independent variables that determine an outcome. The intention behind using logistic regression is to find the best fitting model to describe the relationship between the dependent and the independent variable.

H. CONVOLUTIONAL NEURAL NETWORK

A Convolutional Neural Network (CNN) is a specialized type of artificial neural network designed for image recognition and visual data processing. It breaks down images into smaller components, learning to recognize basic features like edges and colors. Using a hierarchical approach, CNNs then combine these features to understand more complex patterns and objects. The network comprises convolutional layers that apply filters to capture specific features, pooling layers to reduce data size while retaining important information, and fully connected layers for making predictions based on the learned features.



I. GAUSSIAN NAIVE BAYES CLASSIFIER

Naïve Bayes classifier is a statistical classifier. It performs probabilistic prediction which means it predicts the class membership probabilities. This classifier takes the foundation of the Bayes' theorem. Assumptions considered in the classifier: The classes are mutually exclusive and exhaustive. The attributes are independent given the class.

J. ARTIFICIAL NEURAL NETWORK (ANN)

An Artificial Neural Network (ANN) is a computational model inspired by the human brain's structure and functioning. It consists of interconnected nodes (neurons) organized into layers, including an input layer, one or more hidden layers, and an output layer. ANNs are trained on data to recognize patterns, make predictions, or perform various tasks, and they excel in tasks involving complex relationships and non-linear patterns.

3. Feature Extraction Techniques

A. HISTOGRAM FEATURE EXTRACTION

RGB color histogram feature extraction involves analyzing the distribution of red, green, and blue values in an image. The key attributes derived from this histogram include the mean RGB values, representing the average color composition; the standard deviation, indicating color diversity; skewness, reflecting color balance or asymmetry; and kurtosis, describing the peakedness of the color distribution. These attributes offer a compact summary of the image's color characteristics, enabling efficient analysis for tasks such as image processing, segmentation, and content-based retrieval based on RGB color features.

B. COLOR MOMENTS FEATURE EXTRACTION

Color moments are another set of features used in image processing for color representation. They describe various statistical properties of the color distribution in an image. The color moments include the first moment (mean), second moment (variance), and higher-order moments that capture aspects like skewness and kurtosis in the color space. Mean represents the average color, variance indicates color diversity, skewness describes color asymmetry, and kurtosis measures the peakedness or flatness of the color distribution. Analysing color moments provides valuable information for tasks such as image retrieval, color-based segmentation, and content-based image retrieval.

C. GABOR FILTERING

Gabor filtering is a powerful image processing technique used for texture analysis and feature extraction. It applies Gabor filters, which are complex sinusoidal functions with both frequency and orientation parameters, to an image. The filters capture information about local spatial frequency and orientation, making them effective for detecting edges and texture patterns. Gabor filtering is widely employed in computer vision tasks such as face recognition, texture classification, and image analysis. By convolving the image with Gabor filters at different scales and orientations, it extracts features that are robust to variations in texture and provide a detailed representation of the image's structural information.

II. RESULTS

In this section we obtain the confusion matrices for different classifiers. Once we get the confusion matrices, we can calculate the performance estimation metrics such as accuracy, F1 score, recall, precision.

The confusion matrices for some of the classifiers are being listed:

- CONFUSION MATRICES

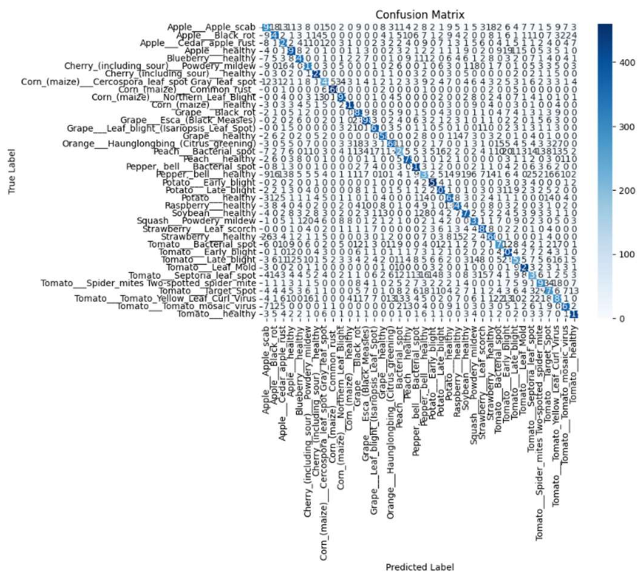


Fig. (5)
confusion matrix for Decision Tree

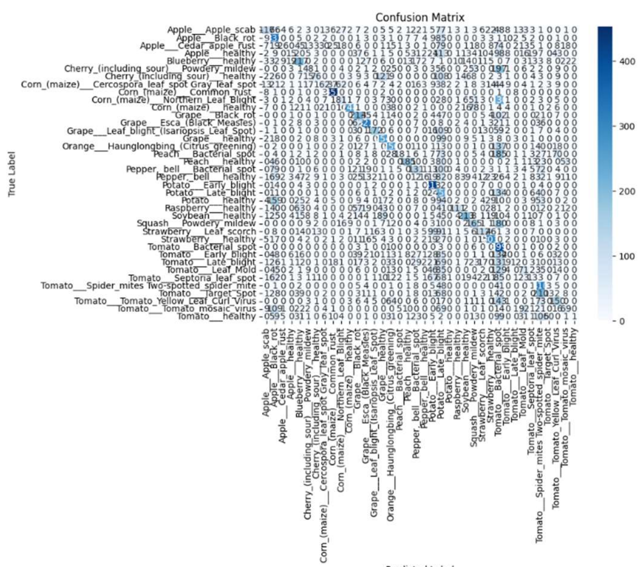


Fig. (6)
confusion matrix for Logistic Regression

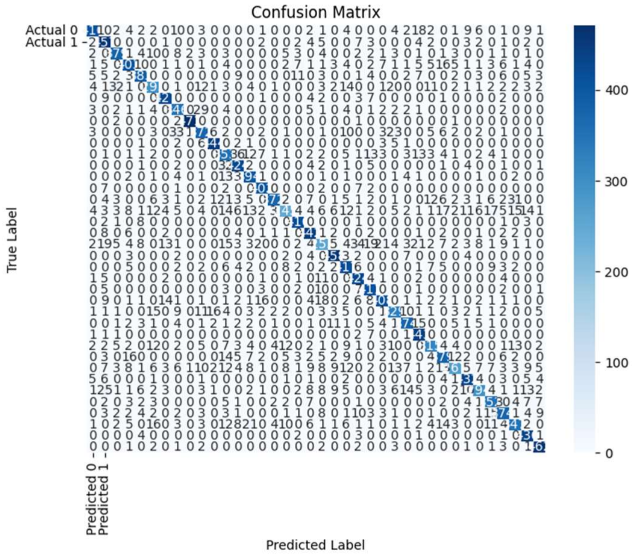


Fig. (7)
Confusion matrix for KNN classifier

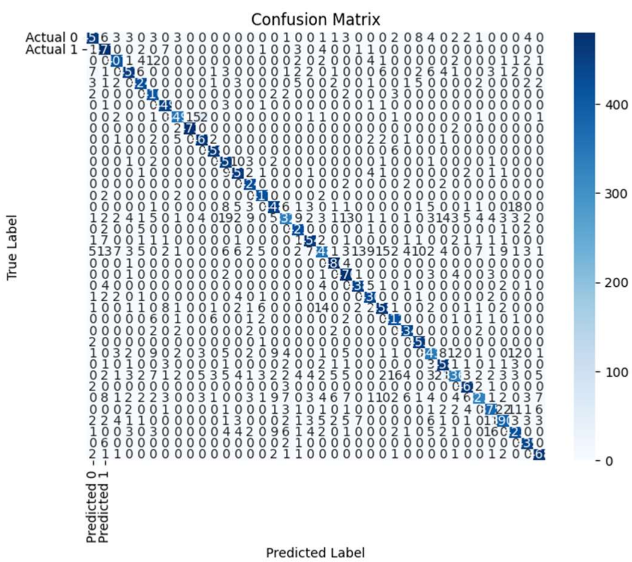


Fig. (6)
confusion matrix for Random Forest classifier

- PERFORMANCE ESTIMATION METRICS

For Histogram Feature Extraction:

- KNN classifier

Accuracy: 0.8314

- Decision Tree

Accuracy: 0.7601
F1 score: 0.76
Recall: 0.76
Precision: 0.76

- Random forest classifier

Accuracy: 0.92
F1 score: 0.92
Recall: 0.92
Precision: 0.92

- ANN

Accuracy: 0.0332
Loss: 6.477

- CNN

Accuracy: 0.90
Loss: 0.29

- Logistic Regression Accuracy: 0.70

F1 score: 0.69
Recall: 0.70
Precision: 0.70

- Naïve Bayes

Accuracy: 0.33
F1 score: 0.31
Recall: 0.33
Precision: 0.40

- ResNet-50

Accuracy: 0.96
Loss: 0.10

These are the results obtained after applying Histogram feature selection.

For Color Moments Feature Extraction:

- KNN classifier

Accuracy: Accuracy: 0.4795

- Decision Tree

Accuracy: 0.7660
F1 score: 0.76
Recall: 0.76
Precision: 0.76

- Random forest classifier

Accuracy: 0.87
F1 score: 0.86
Recall: 0.87
Precision: 0.87

- ANN

Accuracy: 0.4263
Loss: 17.9621

- CNN

Accuracy: 0.7302
Loss: 1.0090

- Logistic Regression

Accuracy: 0.37
F1 score: 0.34
Recall: 0.37
Precision: 0.34

- Naïve Bayes

Accuracy: 0.28
F1 score: 0.25
Recall: 0.28
Precision: 0.29

- ResNet-50

Accuracy: 0.7302
Loss: 1.0090

These are the results obtained after applying Color moments feature selection.

For Gabor Filter Feature Extraction:

- KNN classifier

Accuracy: 0.3579

- Decision Tree

Accuracy: 0.3681
F1 score: 0.36
Recall: 0.37
Precision: 0.36

- Random forest classifier

Accuracy: 0.55
F1 score: 0.53
Recall: 0.55
Precision: 0.55

- ANN

Accuracy: 0.0344
Loss: 6.4568

- Logistic Regression

Accuracy: 0.20
F1 score: 0.17
Recall: 0.20
Precision: 0.18

- Naïve Bayes

Accuracy: 0.15
F1 score: 0.11
Recall: 0.15
Precision: 0.18

- ResNet-50

Accuracy: 0.9569
Loss: 0.1354

These are the results obtained after applying Gabor filter feature selection.

III. CONCLUSION

From the above results, we observe that accuracy obtained for the Random Forest model, Decision Tree algorithm and the KNN classifier using color histogram feature extraction are better compared to other classifiers.

The highest accuracy obtained is for the Random Forest Classifier which is 92.20 percent. It leads us to a conclusion that it performed better than other classifiers for this particular data set.

IV. APPENDIX

Link to access code:
https://drive.google.com/drive/folders/14sjhVFDgAks5Lv4HGrKJdBtOtqvudxm0?usp=sharing

GitHub Link:
https://github.com/HrudayGurijala/PlantDiseaseRecognition

Individual contributions:

Jayaraj Chippada (S20210020263): KNN, Random Forest, Decision Tree, ANN, Logistic Regression, Naïve Bayes, CNN, pretrained model ResNet-50 for Color Histogram feature extraction.

Hruday Chowdary (S20210020278): KNN, Random Forest, Decision Tree, ANN, CNN, Logistic Regression, pretrained model ResNet-50 for Color Moments feature extraction.

Sridhar Chunduri (S20210020266): KNN, Random Forest, Decision Tree, ANN, Logistic Regression, Naïve Bayes, pretrained model ResNet-50 for Gabor Filter feature extraction.

V. REFERENCES

- https://scikit-learn.org/
- https://imbalanced-learn.org/
- https://imbalanced-learn.org/