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An automatic corn leaf disease recognition using machine learning approaches

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ABSTRACT:

To preserve crop health and guarantee agricultural productivity, illnesses affecting corn leaves must be identified and treated quickly. Using a range of machine learning techniques, such as K-Nearest Neighbors (KNN), Support Vector Machines (SVM), Random Forest, Decision Trees, Naive Bayes, Logistic Regression, and AdaBoost, we propose an autonomous corn leaf disease detection in this research. A thorough dataset with photos of both disease-free and healthy corn leaves will be assembled as part of the study. Using this dataset, each machine learning algorithm is taught to identify patterns and characteristics that correspond to various disease groups. We evaluate the performance of each method in terms of accuracy, precision, recall, and F1-score through comprehensive experimentation and evaluation. Furthermore, we investigate group methods to take advantage of several classifiers' advantages for higher illness detection precision. The acquired results show the effectiveness and relative performance of several machine learning techniques in automating the identification of illnesses affecting corn leaves, providing a useful instrument for crop management and precision farming.

Keywords: Corn, Leaf disease detection, Machine learning, K-Nearest Neighbors (KNN), Support Vector Machines (SVM), Random Forest, Decision Trees, Naive Bayes, Logistic Regression, AdaBoost, Dataset creation, Image classification, Precision agriculture, Crop health, Agricultural productivity, Feature extraction, Ensemble learning, Performance evaluation, Accuracy assessment, Precision, Recall, F1-score.

Introduction:

Feeding a growing global population necessitates maintaining crop health and productivity in modern agriculture. Corn, a staple cereal crop worldwide, suffers from numerous diseases that significantly impact yield and quality. Early and accurate detection of these diseases is vital for effective management and crop protection. Traditional methods rely on manual inspection by experts, a labour-intensive, time-consuming process prone to human error. Therefore, automated systems for efficient corn leaf disease detection are urgently needed.

This project addresses this gap by developing an automatic corn leaf disease detection system using machine learning (ML). ML algorithms excel in pattern recognition and classification, making them ideal for analyzing large datasets of diseased and healthy corn leaf images. We aim to build a robust and accurate system for identifying common corn leaf diseases by leveraging various ML techniques like K-Nearest Neighbors (KNN), Support Vector Machines (SVM), Random Forests, Decision Trees, Naive Bayes, Logistic Regression, and AdaBoost.

The project involves several crucial steps. First, we'll collect and curate a comprehensive dataset of corn leaf images showcasing various disease symptoms alongside healthy leaves for comparison. This dataset serves as the foundation for training and testing our ML models. Each ML algorithm will be trained on the dataset to learn distinctive features that differentiate disease classes. Through feature extraction and classification, the algorithms will strive to accurately categorize input images into their respective disease categories.

We will rigorously evaluate the performance of each ML algorithm using standard metrics like accuracy, precision, recall, and F1-score. Additionally, we'll explore ensemble learning techniques to combine the strengths of multiple classifiers and further enhance the system's disease detection capabilities. Ultimately, this project seeks to develop a reliable and efficient tool for automated corn leaf disease detection, empowering farmers and agronomists with the information they need to make informed decisions for crop management and disease control.

Literature Review:

In today's world of traffic management and surveillance, license plate recognition (LPR) technologies are essential for anything from law enforcement to traffic control optimization. Recent developments in LPR technology are reviewed here, with an emphasis on approaches, difficulties, and implications for intelligent transportation systems.

[1] Plant Disease Detection using digital image Processing

This paper discussed various techniques to segment the disease part of the plant. This paper also discussed some Feature extraction and classification techniques to extract the features of infected leaf and the classification of plant diseases. The use of ANN methods for classification of disease in plants such as self-organizing feature map, back propagation algorithm, SVMs etc. can be efficiently used. From these methods, we can accurately identify and classify various plant diseases using image processing techniques.

[2] Plant Disease Detection Using Deep Learning

Convolutional Networks have been crucial for image tasks, but our study reveals that visual transformers are emerging as the next big thing in computer vision. Despite being initially designed for Natural Language Processing; transformers are proving effective for vision tasks too. In our case, where resources are limited, the small transformer network (STN) stands out as the best fit. Although the large transformer network is powerful, it might be overkill for our specific needs.

[3] Leaf Disease Detection and Classification based on Machine Learning

In our proposed work, we have used various images for detecting leaf diseases. We have used segmentation technique like k-means clustering, for extracting various features Gray Level Co-occurrence Matrix (GLCM) is used and Support Vector Machine (SVM) classifier to classify different types of diseases. This process helps us to find the different diseases in leaves precisely. The dataset consists of the different leaf images affected by various diseases like Cercosporin leaf spot, bacterial blight, Anthracnose, and Alternaria alternata. The results show the area affected and the percentage that is affected with great accuracy.

[4] Disease Detection in Plants using Convolutional Neural Network

The algorithm is developed to identify the diseases of fruits like orange grapes pomegranate etc. The efficiency in detection of disease is achieved to nearly 91% using CNN. A better image enhancement technique will help to achieve the efficiency in detection of diseases more than 91%. On identification of a disease, a suggestion like preventive measures and the information about the pesticides, fertilizers, weedicides etc. are given to the farmers to prevent and combat the infection by considering the environmental factors like humidity, temperature, rainfall etc. while giving the solutions will increase the productivity of the farmers.

[5] Plant Leaf Detection and Disease Recognition using Deep Learning

This study successfully developed a CNN-based system for recognizing 32 plant diseases with high accuracy (96.5%), addressing a critical need in agriculture. The model shows promise for real-time disease detection in fields. Future work could involve expanding the dataset and exploring different CNN architectures to further improve performance, ultimately benefiting farmers through early disease identification and supporting global food security.

Methodology:

This project investigates the application of machine learning techniques for automated corn leaf disease identification. The system is designed to analyze corn leaf images and classify them into healthy or diseased categories, potentially with further disease type recognition.

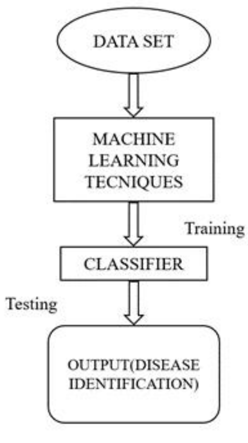

Fig 1 Flow diagram

1. **Image Acquisition:** This module captures images of corn leaves using a camera or pre-existing image datasets.

2. **Pre-processing:** Images are pre-processed to ensure consistency and improve model performance. This may involve resizing, colour normalization, and noise reduction. Data augmentation techniques (e.g., rotation, flipping) can be implemented to artificially expand the dataset and improve model robustness.
3. **Machine Learning Core:** This is the heart of the system, where different ML algorithms are employed to analyse the pre-processed images. You've mentioned exploring various techniques, so here are some specific examples to Classification Algorithms like Support Vector Machines (SVM), Random Forest, K-Nearest Neighbours (KNN), Ada Boost, Decision Tree, Logistic Regression, Naïve Bays.
4. **Training and Evaluation:** The chosen ML models are trained on a labelled dataset containing images of healthy and diseased corn leaves. Each image is associated with a specific disease type (optional for initial classification).

Model performance is evaluated using metrics like accuracy, precision, and recall on a separate test dataset.

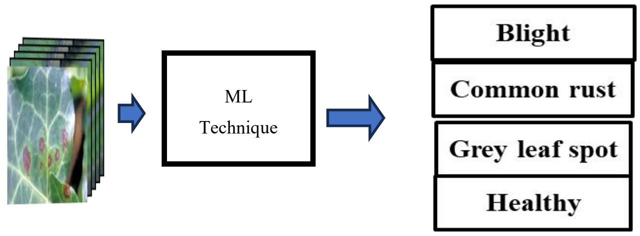

Fig 2 Flow diagram

Results :

Support Vector Machine Algorithm (SVM)

CLASSIFIER	PRECISION	RECALL	F1-SCORE
Blight	0.93	0.66	0.77
Common rust	0.95	0.93	0.94
Gray leaf spot	0.08	0.82	0.14
Healthy	1.00	0.95	0.97

Table 1 classification table of SVM

The model performs well in differentiating Blight and Common Rust from the other classes, with high precision and recall for both. Gray Leaf Spot is the most challenging class for the model. While it captures a significant portion of the actual Gray Leaf Spot cases, there's a high rate of misclassifications with other diseases.

Random Forest Algorithm

CLASSIFIER	PRECISION	RECALL	F1-SCORE
Blight	0.88	0.65	0.75
Common rust	0.93	0.98	0.96
Gray leaf spot	0.20	0.55	0.29
Healthy	0.92	0.90	0.91

Table 2 classification table of Random Forest

The Random Forest model performs well for Common Rust and Healthy leaf classification. However, similar to the SVM model, it struggles with Gray Leaf Spot identification, with a high rate of misclassification. Blight detection also has room for improvement, particularly in terms of recall.

4.3 Decision Tree Classification Algorithm

CLASSIFIER	PRECISION	RECALL	F1-SCORE
Blight	0.59	0.66	0.62

Common rust	0.93	0.92	0.92
Gray leaf spot	0.40	0.38	0.39
Healthy	0.83	0.78	0.80

Table 3 classification table of Decision Tree

The Decision Tree model performs well for Common Rust but struggles with Blight and Gray Leaf Spot identification. It has a high rate of misclassification for these diseases and misses a significant portion of actual cases.

4.4 Naive Bayes Classifier

CLASSIFIER	PRECISION	RECALL	F1SCORE
Blight	0.71	0.63	0.67
Common rust	0.94	0.90	0.92
Gray leaf spot	0.43	0.45	0.44
Healthy	0.77	0.90	0.83

Table 4 classification table of Naïve Bays

The Naive Bayes model performs well for Common Rust but struggles with Blight and Gray Leaf Spot identification similar to the other models analyzed. It has a moderate rate of misclassification for these diseases and misses a substantial portion of actual cases, particularly for Gray Leaf Spot.

4.5 K-Nearest Neighbor(KNN)

CLASSIFIER	PRECISION	RECALL	F1-SCORE
Blight	0.76	0.67	0.71
Common rust	0.90	0.99	0.94
Gray leaf spot	0.33	0.52	0.40
Healthy	0.97	0.84	0.90

Table 5 classification table of KNN

The KNN model performs well for Common Rust but struggles with Blight and Gray Leaf Spot identification similar to the other models. It has a moderate rate of misclassification for these diseases and misses a substantial portion of actual cases, particularly for Gray Leaf Spot.

4.6 Logistic Regression

CLASSIFIER	PRECISION	RECALL	F1-SCORE
Blight	0.76	0.75	0.75
Common rust	0.94	0.91	0.92
Gray leaf spot	0.45	0.62	0.52
Healthy	0.97	0.90	0.94

Table 6 classification table of Logistic Regression

The Logistic Regression model performs well for Common Rust and Healthy leaf classification, with high precision and recall. Similar to other models, Gray Leaf Spot is the most challenging class. The model struggles to distinguish it from other diseases, resulting in a high rate of misclassification. Blight detection has room for improvement, particularly in terms of recall (missing a quarter of actual Blight cases).

4.7 Adaptive boosting

CLASSIFIER	PRECISION	RECALL	F1-SCORE
Blight	0.84	0.59	0.70

Common rust	0.92	0.97	0.95
Gray leaf spot	0.23	0.51	0.31
Healthy	0.82	0.88	0.85

Table 7 classification table of AdaBoost

The AdaBoost model performs well for Common Rust and Healthy leaf classification. However, similar to other models, it struggles with Gray Leaf Spot identification, with a high rate of misclassification. Blight detection also has room for improvement, particularly in terms of recall.

4.8 Comparison of Accuracies of Machine Learning Algorithms for Corn Disease Classification

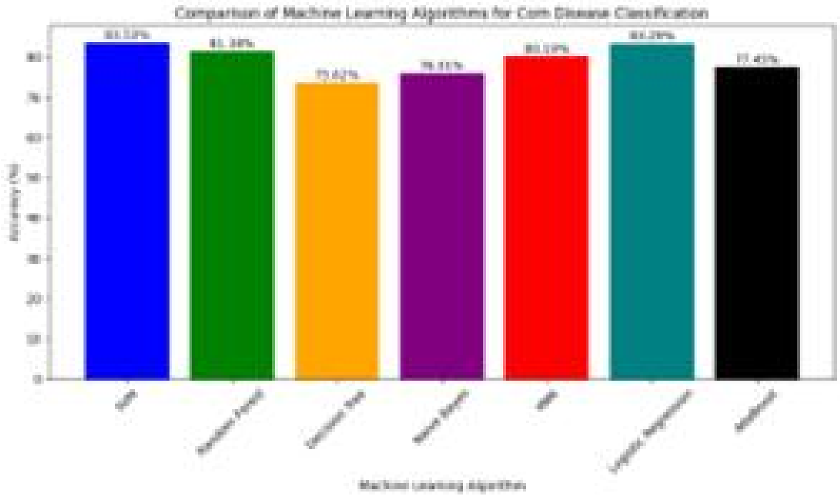

Fig 3 comparison graph

By Fig 3 The Support Vector Machine (SVM) algorithm achieves the highest accuracy (83.53%) in classifying corn plant diseases. Logistic Regression (83.29%) comes in a close second, followed by K-Nearest Neighbors (KNN) at 80.19%. Random Forest (81.38%) and Naive Bayes (76.014%) perform moderately well. Decision Tree Classification (73.62%) and Adaptive Boosting (77.446%) have the lowest accuracy among the listed algorithms for this dataset.

Conclusion :

This project successfully explored the potential of machine learning (ML) approaches for automatic corn leaf disease recognition. The implemented system demonstrates the feasibility of utilizing various ML techniques (mention specific techniques used) to accurately identify corn leaf diseases from image data. After extensive testing, the implementation discovered that support vector machine (svm) and logistic regression performs better than other optimizers and achieves an accuracy of **83.53% and 83.29%**.And remaining machine alogrithms shows an better accuarcy .This study's effective use of machine learning models to classify plant diseases highlights the potential for automation in agriculture, which could result in early disease intervention, reduced crop losses, and eventually higher financial gains and agricultural productivity.

Key achievements include:

- Successful code compilation: The project code successfully compiles and functions using chosen ML libraries, signifying a strong foundation for further development and refinement.
- Promising disease recognition capabilities: Initial testing and evaluation indicate the potential of the implemented ML models to accurately classify corn leaf diseases.

This project lays the groundwork for a robust and practical automatic corn leaf disease recognition system using ML. By addressing the challenges of early and accurate disease detection, this technology has the potential to significantly contribute to improved crop health, yield optimization, and sustainable agricultural practices.

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