iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: V Month of publication: May 2025

DOI: https://doi.org/10.22214/ijraset.2025.71320

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

AI-Driven Corn Disease Detection and Recommendation System Using Machine Learning and Deep Learning

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Abstract: Corn is one of the most harvested crops. However, corn leaf diseases can reduce yield and damage its growth, which can lead to financial losses for farmers. Early detection of these diseases must be a top priority. This article uses leaf images on an ai-based system to identify disease and provide pesticide recommendation using machine learning and deep learning models. A Convolutional Neural Network (CNN) model is used to analyze leaf images and correctly classify the disease. As a result, the system provides the pesticide recommendation based on the disease detected. The Ai-driven approach helps farmers improve yield quality and make better decisions.
Keywords: Corn disease detection, deep learning, machine learning, convolutional neural network, AI in agriculture

I. INTRODUCTION

Corn is a major crop grown worldwide, and its health is important for food supply and farming businesses. However, corn plants can get infected with diseases like leaf blight, rust, and gray leaf spot, which can reduce their growth and quality. Farmers have historically examined the plants to check for illnesses, but this process is labor-intensive, time-consuming, and not necessarily reliable. To solve this problem, a system of prediction and recommendations on corn disease, which uses machine learning (ML) and deep learning (DL), is designed. This method uses artificial intelligence to analyze photographs of corn leaves, detect disease and design optimal actions such as the use of certain pesticides or fertilizers. We help farmers quickly recognize problems and take the necessary measures to protect their crops, increasing the efficiency and productivity of agriculture. Precision agriculture (PA) aims to improve crop production in challenging and multifaceted environments. In recent years, there has been an increase in various leaf diseases of plants, resulting in a decrease in average potential crop yield and food availability. However, traditional plant leaf disease diagnosis methods have some deficiencies, such as human fatigue, and are time consuming and labor intensive [1]. Plant diseases pose a significant risk to global food security, leading to a decline in crop yield worldwide. Reports indicate that plant diseases are responsible for 20–40 percent of crop losses globally, highlighting the importance of timely and accurate diagnosis to prevent their spread and minimize economic losses in agriculture. Therefore, the diagnosis of plant diseases plays a crucial role in preventing their spread and minimizing their impact on agriculture[2]. Crops can also experience damage on plant leaves that depend on crop types, sensitive physical properties, water logging, drought, low soil fertility, insects, viruses, weeds, and the presence of pathogens. Disease ridden plants tend to show different abnormalities and unique noticeable patterns such as cuts, wounds, marks or lesions on fruits, flowers or leaves. Plant leaves are the primary source of these abnormalities, and most disease symptoms appear on leaves at early stages.

At early stages, the detection and prevention of plant leaf diseases are fully developed and of great significance. In totality, this effective treatment and knowledge may lead to experiencing fewer complications, which play an essential role in growing at the excessively appropriate rate. So, the right decision can assist farmers in accurately achieving higher crops at the appropriate times and locations . Therefore, an accurate and automatic plant leaf disease detection and classification system ensures a high yield that eludes manual detection procedures in the field.

It can also help conserve land resources and improve farmers' profits[1].The main aim of this work is to develop a system using machine learning algorithms such as SVM, Random Forest, Decision tree, logistic regression and deep learning algorithm such as convolutional neural network(CNN) used to identify diseases on corn leaf and recommend the pesticides or fertilizers on identified disease.

II. LITERATURE REVIEW

Due to the time, effort, and potential errors associated with traditional approaches, an automated approach is crucial for the identification of leaf disease of plants. In addition, deep learning, particularly CNN, has significantly improved the accuracy of disease classification; ResNet, VGG, and AlexNet are examples of popular designs. In order to enhance detection performance, recent research has concentrated on multicontextual feature fusion to merged image-based and environmental data. Internet of Things (IoT),sensor networks to collect pertinent environmental data, improve real-time surveillance of diseases [1]. Technologies such as machine learning (ML) and the Internet of Things (IoT) transform the detection of corn and corn disease by allowing timely identification and automated control. Algorithms such as KNN, SVM, RF, DT, CNN and LSTM have been widely used, while the CNN models have achieved the highest accuracy. IoT supporting systems automate the disease identification, notification of sending and checking the application of pesticides at a distance. Architecture such as VGG-16 and Inceptionv3, which use CNN, further increase accuracy. Cloud solutions make it easier to process extensive data, improve classification. This progress promotes intelligent agriculture, reduces losses and improves agriculture efficiency[2]. Scientists have conducted many research on the use of machine learning and deep learning to identify and classify corn leaves. Convolutionary neural networks (CNN) were very accurate in detecting plant disease. Models such as Alexnet, Resnet50 and Resnet-18, especially in the use of transmission learning, were highly effective in recognizing common dis eases such as gray puff stain, northern corn leaves and rust. Techniques such as data augmentation that include overturning and rotating images help improve the performance of the model. Studies suggest that deep learning can allow early disease detection, reduce crop loss and increase agricultural productivity. This progress emphasizes the potential of AI solution driven for real-time disease monitoring and smarter agricultural procedures.[3]. Corn disease can significantly reduce crop yields, so it is important to properly identify and classify for proper treatment. Traditional methods rely on visual control of plants, which requires a lot of time and can lead to mistakes. However, recent advances in deep learning, especially using convolutional neural networks (CNN), have made more accurate and reliable disease detection. Image processing methods, including extraction and increasing elements, further increase model performance.. Research has shown that deep learning models, especially CNN, overcome machine learning techniques such as decision-making tree, random forest and svm. AI-based monitoring systems make it easier to detect disease diseases in real time. This development underlines the promise of AI-based solutions to increase crops' health, reduce losses and help precise agriculture[4]. The use of image processing and machine learning for automated identification of corn plant disease has grown in popularity. Scientists have focused on a number of image processing methods for extraction of elements such as RGB, histogram of oriented gradients (HOG), oriented quickly and rotated short (orb), transformation of inventive (SIFT) and accelerated robust features (Surf). Machine learning models such as Naive Bayes (NB), Random Forest (RF), decision making trees (DT) and support vector machines (SVM) were used for classification tasks. The importance of color detection is emphasized by research that shows that RGB-based features provide the highest accuracy. In order to increase the accuracy of detection without sacrificing efficiency, future research could focus on improving the methods of extraction of elements and exploring hybrid models[5].

III. PROPOSED METHODOLOGY

1) Machine Learning: Various kinds of machine learning algorithms are used to train the model to ensure the accuracy and efficiency.
2) Support Vector Machine:A support vector machine (SVM) is a supervised learning algorithm commonly used for classification and predictive modeling tasks. SVM algorithms are popular because they are reliable and can work well even with a small amount of data. SVM algorithms work by creating a decision boundary called a hyperplane. In two-dimensional space, this hyperplane is like a line that separates two sets of labeled data. The goal of SVM is to find the best possible decision boundary by maximizing the margin between the two sets of labeled data. It looks for the widest gap or space between the classes. Any new data point that falls on either side of this decision boundary is classified based on the labels in the training dataset.
3) Random Forest: Random forest algorithm is an ensemble of decision trees used for classification and predictive modeling. A random forest combines the predictions from multiple decision trees to make more accurate predictions. In a random forest, numerous decision tree algorithms are individually trained using different random samples from the training dataset. Once trained, the random forest takes the same data and feeds it into each decision tree. Each tree produces a prediction, and the random forest tallies the results.
4) Decision Tree: Decision tree algorithms are popular in machine learning because they can handle complex datasets with ease and simplicity. The algorithm's structure makes it straightforward to understand and interpret the decision-making process.

5) K Nearest Neighbor(KNN):KNN is used for prediction tasks. Instead of assigning a class label, KNN can estimate the value of an unknown data point based on the average or median of its K nearest neighbors.
6) Logistic Regression: Logistic regression is typically used for binary categorization rather than predictive modeling. It enables us to assign input data to one of two classes based on the probability estimate and a defined threshold. This makes logistic regression a powerful tool for tasks such as image recognition where we need to categorize data into distinct classes.
7) Deep Learning: The deep learning's Convolutional neural network(CNN) is used to classify the leaf into blight, gray leaf spot ,rust or healthy leaf images and based on the identified disease the pesticides or fertilizers are recommend to farmers.

IV. PROPOSED WORK

The corn disease detection system presented in this study utilizes the machine learning and deep learning algorithm to identity disease and recommend the pesticides based on the disease identified. The implementation include several key stages: data loading, data preprocessing, data preparation, model training, testing.Each of this stage is essential for ensuring the accuracy of the prediction.

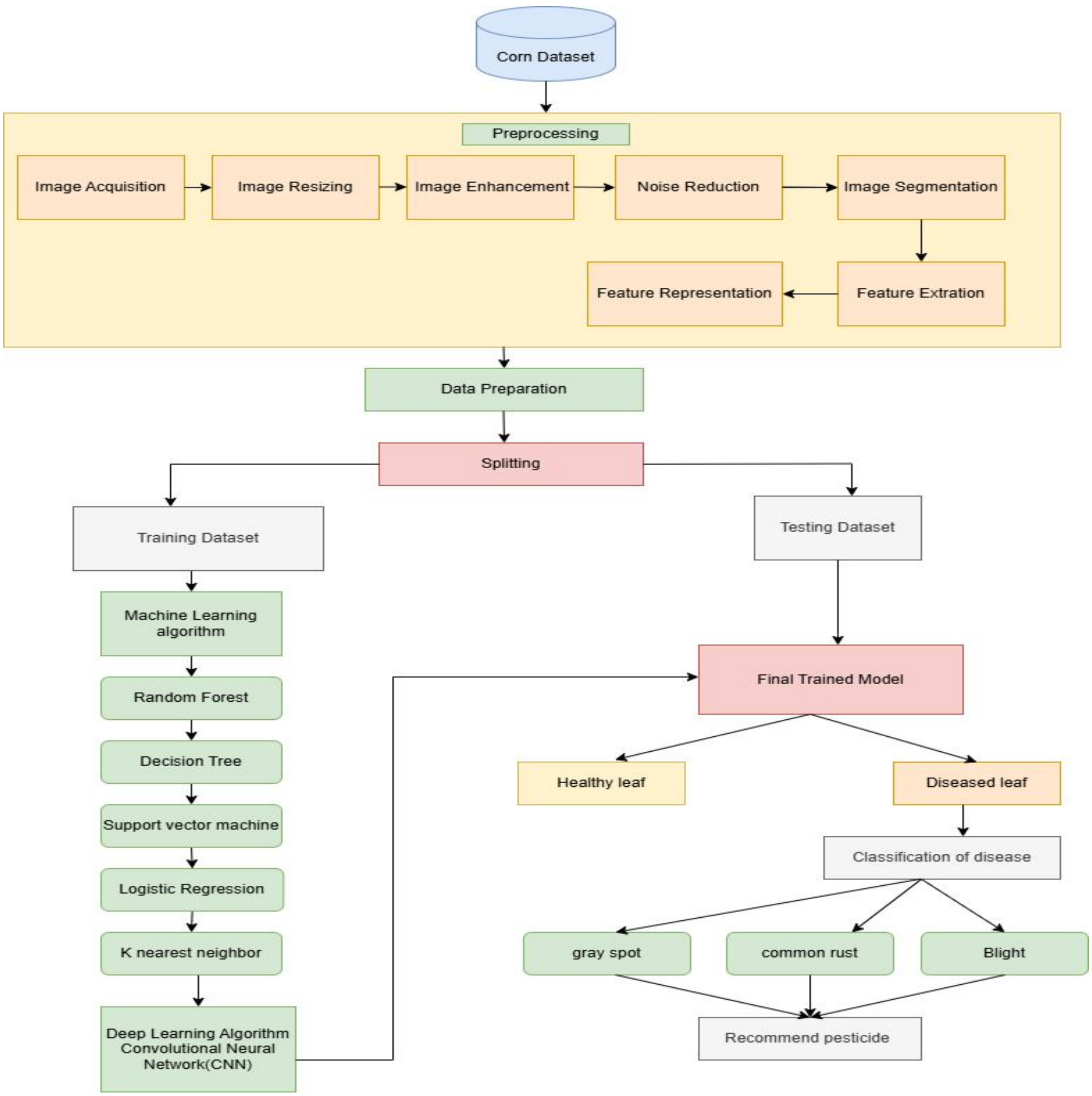

Fig. 1. System Architecture of proposed work

1) Data Collection: The first step is data collection which consist of corn dataset with blight, common rust, gray leaf spot and healthy leaf images.

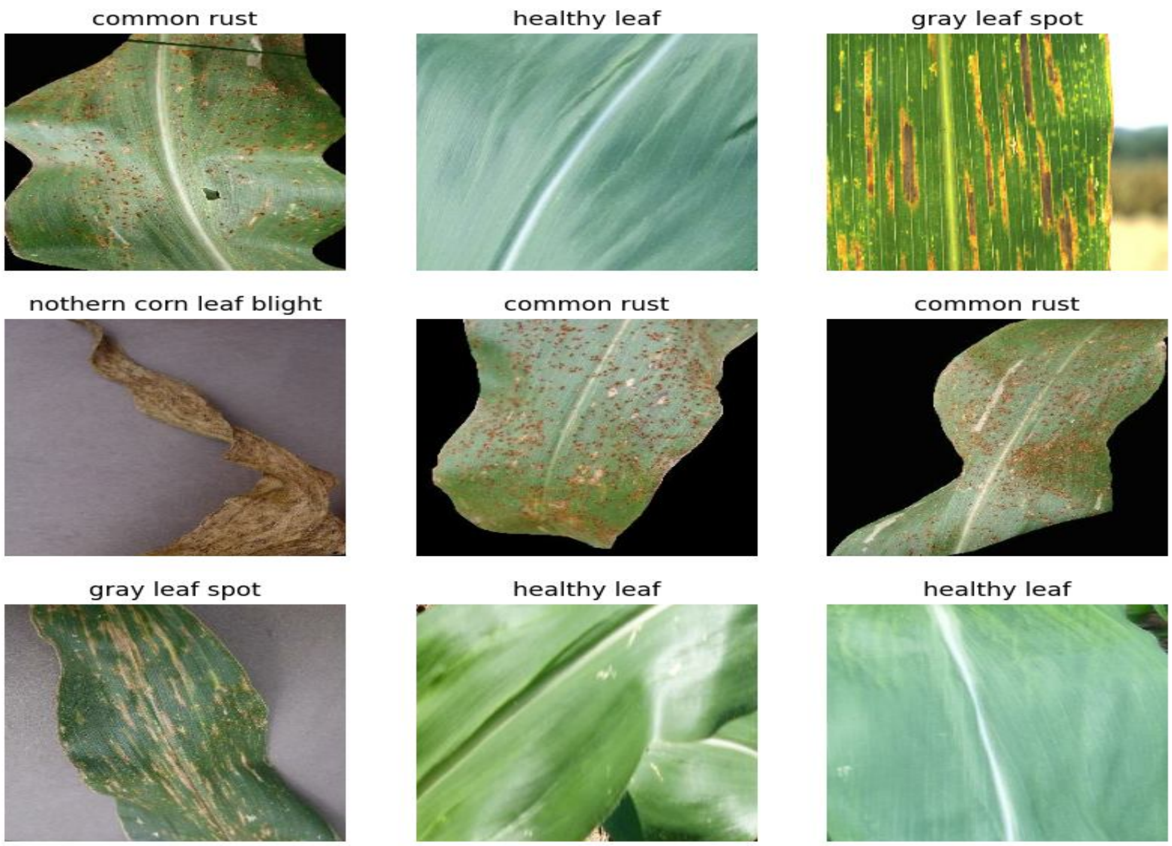

Fig. 1 Dataset

2) Data Preprocessing: Data preprocessing is used to eliminate noisy data, resize images, and extract features. To enhance the model's performance, images are resized to ensure an uniform input size.
3) Data Preparation: Once the data is preprocessed it is divided into training and testing sets.This allows a robust evaluation of the models as the training set is used to train the models and testing set is used for predictive performance.
4) Model Training: The machine learning models and deep learning models are trained on the training dataset with accuracy, precision and recall score as metrics.Various machine learning algorithms are used, including logistic regression, random forest, K nearest neighbor, support vector machine, decision tree, and deep learning's convolutional neural network algorithm.
5) Model Testing :For testing purposes, the algorithm that shows higher accuracy, precision, recall, and F1 score based on the performance metrics of different machine learning and deep learning algorithms is chosen.
6) Result Analysis :The analysis of results is conducted based on the identified disease, and related pesticides or fertilizers are recommended. To represent the result various visualization tools are used such as bar charts, heat map.

V. RESULTS AND DISCUSSION

A system of detection and recommendations of corn has been tested to find out how well it works through various measures such as accuracy, precision, and recall. These tests help control how the system properly detects corn disease and suggests treatment. The results show that machine learning models (ML) and Deep Learning (DL) are very effective in identifying corn diseases and providing useful recommendations to farmers. The system was tested using a data set of corn leaf images, categorized in healthy and non healthy leaf as blight, rust, gray leaf spot. Different ML and DL models have been trained and evaluated to determine the most powerful approach.

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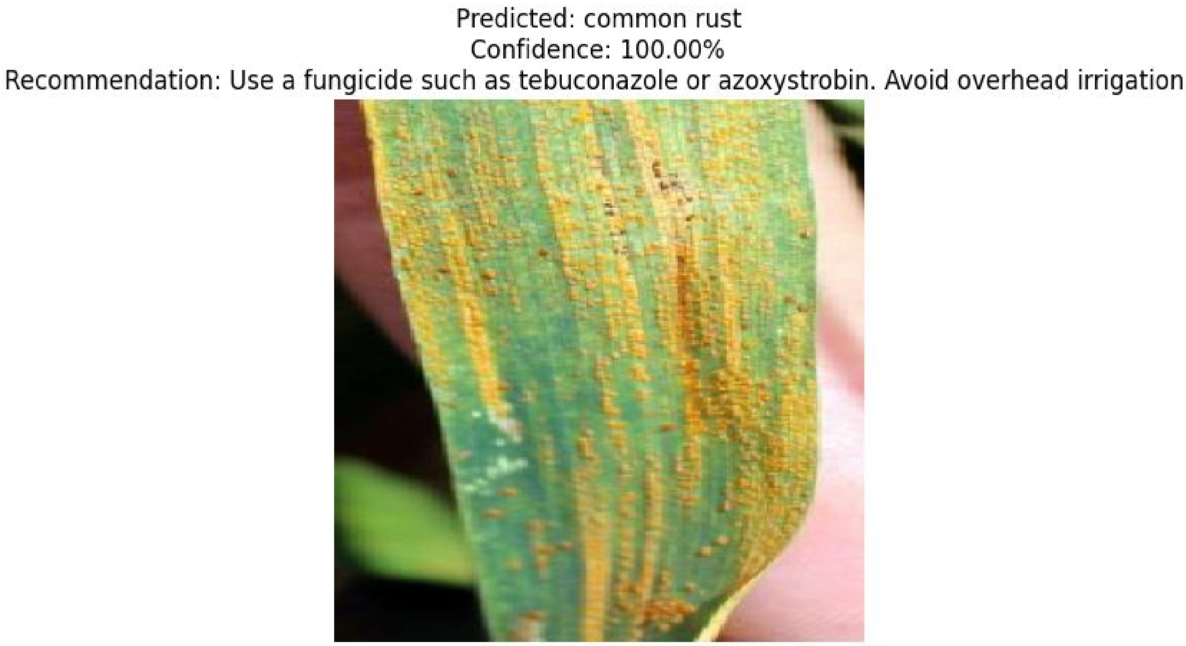

Fig. 3. Pesticides recommendation for common rust

Figure shows a corn leaf with common rust, a fungal disease, gets reddish-brown spots that spread and make plant weaker. The system recommends using fungicides such as tebuconazole or azoxystrobin to treat this disease. It also tells farmers not to water their crops from above because too much water can make the sickness worse.

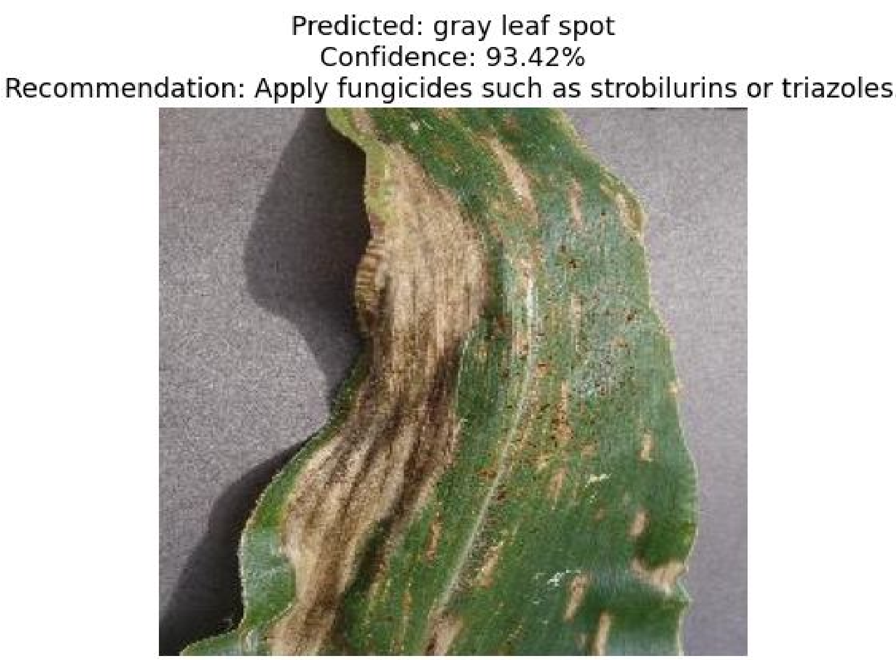

Fig. 4. Pesticides recommendation for gray leaf spot

F igure shows the corn leaf affected by a gray leaf, a fungal disease that causes brown or gray spots on the leaves. The system suggests the use of fungicides such as strolin or triazoles to control infection.

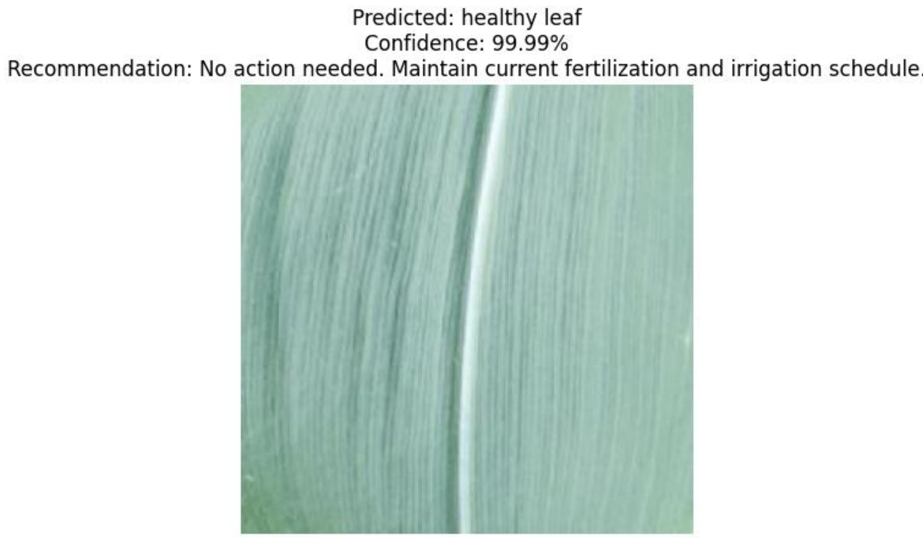

Fig. 5. Pesticides recommendation for health leaf

Figure shows a corn leaf in good health and shows no symptoms of the disease. Nothing can be done because the leaf is healthy.In order to maintain the health of the plant, farmers should stick to their current irrigation and fertilization. By mon itoring the health of crops and ensuring early identification of the disease, the AI based solution helps to increase agricultural productivity to farmers.

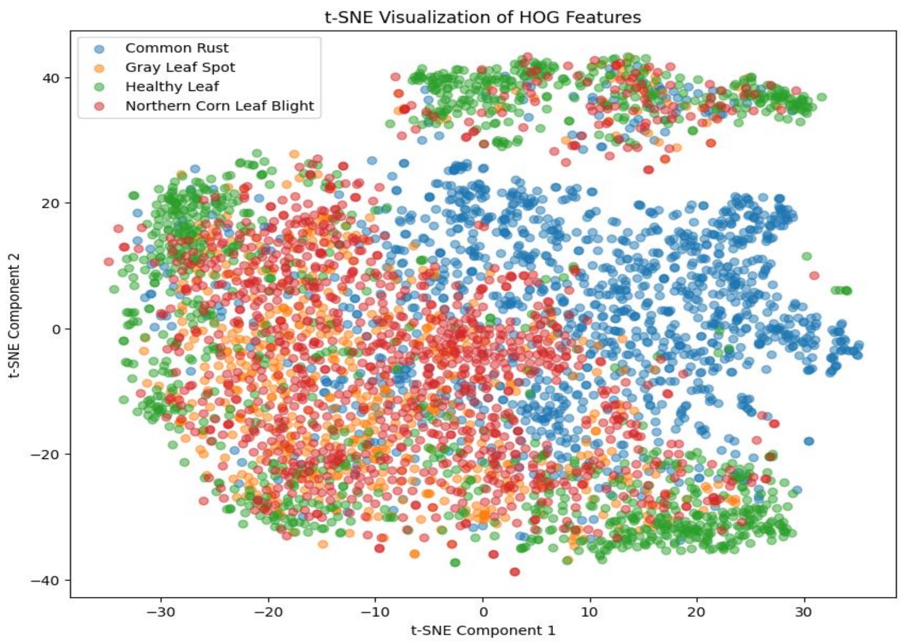

Fig. 6. Feature Representation of HOG Features

Figure shows Use of HOG (HOG histogram-oriented gradients), functions from the pictures of corn leaf visualized by the T-Sne scattering. Colors indicate different categories and each dot shows a picture of the leaves: Common rust represent blue Gray spot of leaves = orange Green indicates a healthy leaf.Northern Corn List List Blight = Red.The method called T-Sne (T-Distributed insertion of a stochastic neighbor) simplifies complicated data into two dimensions to improve visualization. The aim is to prove how the model uses extracted information to distinguish between different types of leaf. The ability of the model to distinguish between different leaves of leaves is proven by grouping dots of similar colors. Some overlapping areas are more difficult classifications that mean some diseases have comparable characteristics. This illustration helps to understand the distinction between damaged and healthy leaves.

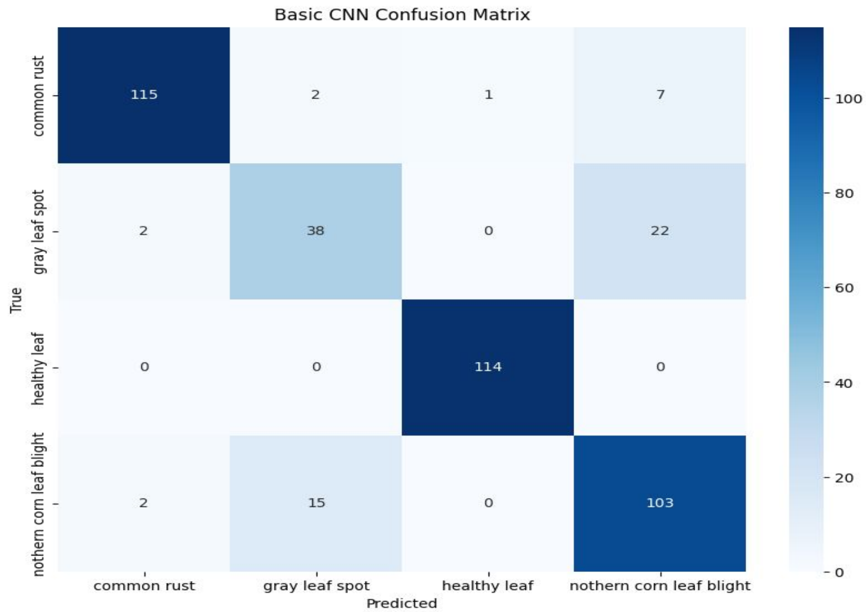

Fig. 7. Confusion matrix

The confusion matrix shows the ability of the CNN to distinguish between different types of corn leaves. While the lines represent the real condition of the leaf, the columns reveal the estimated state of the model. The numbers along the diagonal (from the top left at the top of the bottom) show which leaves are properly categorized. The model correctly identified 115 instances of common rust, 114 healthy leaves and 103 cases of maize mold. But the model incorrectly identified 22 instances of gray leaves as a northern sheet and 15 instances of northern corn leaves as gray leaf stains. Healthy leaves were categorized with accuracy and perfection.

Fig. 8. Treatment recommendation for common rust

The web application uses artificial intelligence to identify disease in corn leaves. To find diseases, users can upload a photo of corn leaf and let it analyze. In this particular case, AI identified a common rust, a sponge that damages corn crops. The application suggests the use of fungicides such as triazoles and routine crop monitoring to help manage this disease. Farmers benefit from the instrument because it allows timely identification and offers protective measures for their crops, increasing agricultural productivity.

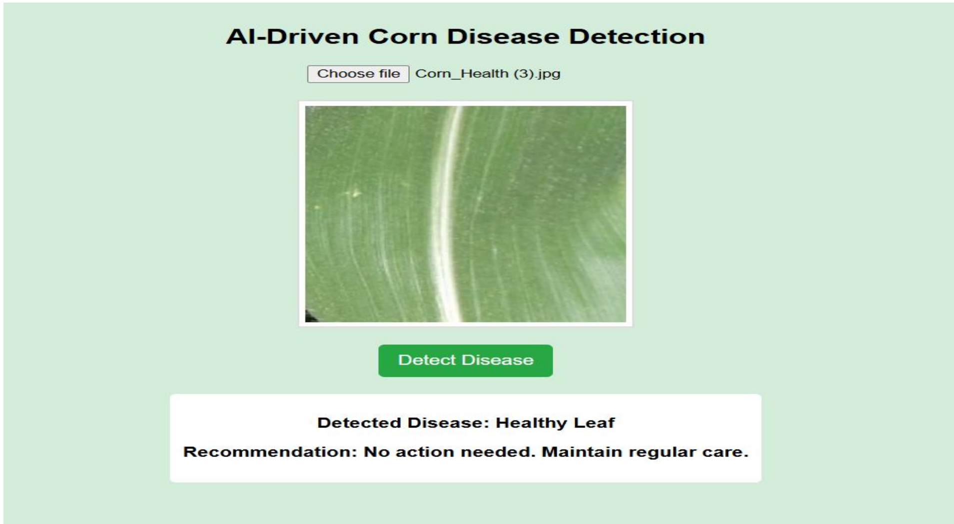

Fig. 9. Treatment recommendation for healthy leaf

The web application helps farmers to control the health of their corn leaves using AI. The user can use a picture of the corn leaf and the system analyzes it to determine whether there is any disease. In this image, AI detected healthy leaf, which means there are no signs of disease. The recommendation is simple No action is needed, continue regular care. This tool is useful for crop monitoring and ensuring that they remain healthy.

VI. CONCLUSION

The corn disease detection and recommendation system offers a reliable and efficient way of recognizing traditional corn leaves and recommendations of suitable treatment. This technology uses high-end machine learning and deep learning algorithms to accurately classify the pictures of leaf as healthy or harmful. It also provides recommendations that help farmers in implementing rapid measures. The findings show a remarkable improvement in the detection of the disease, reduce crop loss. Future improvements that include real-time training and monitoring into greater diversity of data files could significantly improve the accuracy of the model. This method creates higher yields and healthier crops, making it a valuable tool for contemporary agriculture.

VII. ACKNOWLEDGEMENT

The authors express their gratitude to the computer Engineering Department at Sanjivani college of engineering kopargaon Maharashtra, sIndia for their support and guidance. They extend their sincere appreciation to the faculty members, laboratory staff, and administrative personnel who provided technical assistance and access to necessary resources during the research process. Special thanks are also due to the numerous researchers and professionals whose valuable insights and constructive discussions have significantly contributed to the development of this study.

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