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A Deep Learning-based System for Automated Plant Disease Severity Detection and Fertilizer Optimization

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Abstract: Because food is a basic requirement for all living beings on Earth, agriculture is especially important in our daily life. Agriculture is our main source of food. In addition to plant diseases that impede the growth and quality of food crops, agriculture works to generate food to feed the growing population. We'll look at five plants: bitter gourd, mango tree, spinach, tomato, and hibiscus. This study proposes a CNN-based technique for early plant disease diagnosis. The approach consisted of three steps: image segmentation, feature extraction, and picture pre-processing. The results of these three processes are combined to form a Convolutional Neural Network (CNN) classifier. To research and analyse a plant, an input image of the damaged portions is obtained and compared to the desired dataset. The disease is then anticipated, along with therapeutic treatments. Once the disease has been recognized, the quantity of pesticides, recommended application place, and chemicals themselves will be displayed. It will also identify the nearest location where pesticides are available.
Keywords: Agriculture, Machine Learning, CNN, Image Segmentation, Feature Extraction, Automatic disease Recognition

I. INTRODUCTION

The agricultural industry will become more distinct as a result of recent advances, as it is now widely used in a variety of uses beyond simply producing food for the basic population. In India, people are likely to be interested in farming. This corporation has a large impact on the Indian economy. Agriculture supports around 70% of rural communities. Providing work to 60% of the population accounts for more than 17% of GDP. This study addresses five unique leaf kinds. The expansion phase is when Late Blight and Brown Spot initially appear. The expansion phase is when Bacterial Spot first appears. Septoria Leaf Spot, a disease that causes yellow curls, is most likely to emerge during seeding. Many farmers may lose money as a result of the high productivity losses and expenditures associated with addressing these diseases. This suggests that in order to overcome the old way of identifying agricultural illnesses, industry professionals are required. The classic method employs a convolutional algorithm and image processing techniques. The unsupervised learning technique K-Means clustering uses an iterative approach to partition a dataset into k non-overlapping clusters or subgroups. Using this method, the dataset is divided into K unique, non-overlapping clusters or subgroups based on features, and the process is repeated several times. The goal is to keep the data points between clusters as comparable as possible while preserving the clusters' maximum distance from each other. Clustering occurs when the squared distance between data points and a cluster's centroid is less than a preset value. The centroid of the cluster is the mean of the datapoints. Less variance in the clump indicates homogeneous or equal data points within the group. The RGB color tag specifies a color's speed. Each of the three criteria (red, green, and blue) has a color intensity value between 0 and 255. The HSI color system (hue and saturation) also describes the intensity component of color-carrying knowledge in a graphic image. The HSI replica is an effective tool for building image processing systems that take advantage of sapient color characteristics. CNN has thus emerged as the most widely utilized deep learning technique for heterogeneity reduction, extraction, and classification. Fundamental data features are acquired using convolutional approaches with filters, and frameworks are followed by several-strata perception to generate estimators. CNN can discern pixels in a picture in a way that ANN cannot since it extracts the image's characteristics. Deep learning models outperform statistical models in terms of authenticity and foundation during the creation process. Layer of InCNN. Pooling is also known as down sampling. As the name says, it decreases the amount of data in all aspects derived from the convolutional layer. It stores the most fundamental, useful information. Convolutional and pooling layers are utilized in multiple rounds to ensure that we only receive valid data. Flattening: Another word for fully linked input layers.

One vector is retrieved from the previous layer's output and used as the input for the following layer. The completely connected output layer is used to determine the proper label after weights are applied to the final probability for each layer provided by the linked input layer.

II. LITERATURE SURVEY

To effectively apply all of the basic ideas, a thorough analysis of the literature focuses on learning more about convolutional neural networks and image processing fundamentals. The author of [1] has previously used approaches such as feature extraction, image segmentation, and picture processing. In addition, the KNN algorithm is utilized to classify the results of the three steps of the procedure. A leaf disease diagnosis may provide additional information, such as the affected area, illness name, total accuracy, sensitivity, and elapsed time.

The author of [2] describes all machine learning models that are used to identify plant leaf disease as well as a comparative analysis of a number of plant leaf illnesses. This method was used to prevent the paper from being either too big or too small. A new inquiry has been prompted by the exploration of managing roots, spores, and natural components in this way. Suggestions are categorized into three groups: characterization, severity evaluation, and recognition. As a result, each of these categories contains the calculation's fundamental specialized structure. Plant and vegetable pathologists may find value in the research findings.

Prospective views on plant leaf detection and diagnostic technologies to aid agricultural development were investigated in [3]. The technique is divided into four basic steps: feature extraction, classification, picture acquisition, and image classification. The most commonly utilized approaches included BPNN, SVM, K-means clusters, Otsu's approach, CCM, and SGDM. A variety of procedures are employed to determine whether the leaves are healthy or sick. The problem of this technology is that it relies on intricate photographs taken during severe weather, such as lightning storms. Furthermore, despite some shortcomings, these disease detection techniques enable the leaf disease detection system to function.

The author's Deep CNN Leaning model can identify a wide spectrum of plant ailments (p. 4). Using the datasheets acquired from the plant village (70095) photos, the model was constructed and tested, with 70% of the data used for coaching and the remainder for analysis. This particular model is built using five convolutional layers. Simply put, the model performed flawlessly, achieving 95 percent plus testing accuracy on both the Plant Village datasheet and the corresponding real-time environment image.

[5] presented CNN-based methods for plant disease detection. In terms of time complexity and affected region size, calculating research and sample interpretation are carried out. this. Image processing could be utilized to do this. Twelve of the fifteen case scenarios that the prototype was fed included tainted plant leaves. That's excellent! Computed differently for equivalent but same outputs. As an example, in [6]. To identify plant illnesses, the author advocated for data extraction, image augmentation, image preprocessing, and network learning. Resizing and image enhancement procedures make the color dots on the input image's leaves more visible. The author offered three photo segmentation techniques: K-means clustering, Otsu's classification, and HSI. K-Means clustering shown to be the most effective method for diagnosing plant illnesses in leaf tissue. Before performing K-Means Clustering, the author transformed the RGB image to the Lab Color model to identify relevant leaf segments. This is what you get in terms of color contrast, energy, homogeneity, and correlation between pixels. The author used two machine learning classification approaches, K-Means and SVM, to classify leaves. Both SVM and K-Means perform well on data; however, SVM is typically 94-96 percent accurate, whereas KMeans is approximately 83-85 percent accurate. [7] The author uses a CNN model to categorize the Lady Finger leaves into healthy, damaged, and burned categories. The author purchased 1088 photos of leaves, 509 of which are healthy, 457 are sick, and 122 have burns. Images are pre-processed, sorted, and cleaned before being used to diagnosis plant ailments. The ReLu function processes two fully related layers before activating the output layer using the Softmax function. A 50-epoch model outside of the dropout layer yielded 96% accuracy.

[8] Research. The authors of this study used deep learning to diagnose four different forms of potato leaf diseases based on leaf type. The model was trained using photos from Google's village plant collection, as well as other sources. Two architectural models had confusing matrices, thus a tabulation was completed. In contrast, VGG19's precision was 0.9096244, whereas VGG16's was 0.91131148.

III. SYSTEM ANALYSIS

A. *Existing System*

The author of [1] has previously used approaches such as feature extraction, image segmentation, and picture processing. In addition, the KNN algorithm is utilized to classify the results of the three steps of the procedure. A leaf disease diagnosis may provide additional information, such as the affected area, illness name, total accuracy, sensitivity, and elapsed time.

The author of [2] discusses all of the machine learning models used to detect plant leaf disease, as well as a comparative examination of several plant leaf disorders. This strategy was employed to keep the paper from being overly large or little. The investigation of this method of handling roots, spores, and natural components has sparked a new line of inquiry. Suggestions are divided into three categories: characterization, severity appraisal, and recognition. As a result, each of these groups includes the calculation's basic specialized structure. Plant and vegetable pathologists may benefit from the research findings.

DISADVANTAGES OF THE EXISTING SYSTEM

1) *Limited Generalization:* Models created using specific methodologies, such as image segmentation and picture processing, may be tailored to certain datasets or situations, limiting their applicability to novel or unknown cases of plant leaf disease.
2) *Computer Complexity:* When working with large datasets or high-resolution photographs, the three-step approach of image processing, segmentation, and feature extraction may be required. This could need a significant amount of time and computer resources.
3) *Feature Engineering Dependency:* Extracting meaningful features from plant leaf pictures may involve a large amount of subject expertise as well as human feature engineering. This can be time-consuming and introduce bias into the models.
4) *Sensitivity to Environmental Variability:* In real-world applications, machine learning models trained on specific datasets may be less accurate and reliable due to their sensitivity to variations in environmental parameters such as lighting, humidity, and soil composition.
5) *Interpretation Difficulties:* While machine learning models, such as KNN, may accurately categorize plant leaf diseases, interpretability challenges frequently arise, making it difficult for plant pathologists to understand the underlying causes of the model's predictions. This may limit people's capacity to trust and apply these models in real-world scenarios.

B. Proposed System

The texture of the image is evaluated and then transformed to grayscale to make it more visible. The k-mean technique distinguishes between different materials by analyzing structural data. The k-mean clustering algorithm is used to group the data based on its similarity at the focus point. This database contains a record of every cluster partition. The K sign for clustering implies that the leaf is separated into four sections. The illness may affect one or more of the leaf's four sections or clusters, indicating that the leaf is susceptible to a variety of diseases. We need to enter the group number first before we can use the CNN classifier. The CNN classifier can help us determine the disease's name and location.

IV. SYSTEM DESIGN

SYSTEM ARCHITECTURE

Below diagram depicts the whole system architecture.

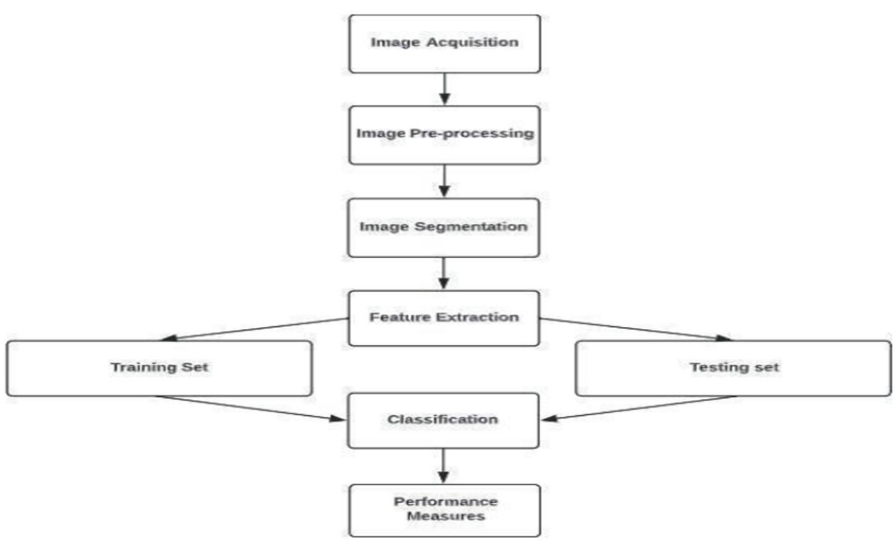

Fig 1. Methodology followed for proposed model

V. SYSTEM IMPLEMENTATION

MODULES

1) *Leaf image dataset:* It is impossible to overstate the importance of measuring and high-quality datasets in ensuring the validity of research work study conclusions. In contrast, plant images for datasets can be taken with a smart camera or a high-resolution digital camera. However, we used photos of tomato leaves from the Kaggle dataset as examples in our research performance analysis.
2) *Image Preprocessing:* Pre-processing improves the quality of your leaf photographs by removing undesirable elements of the input data. These techniques include data translation, reduction, integration, and purification.
3) *Segmentation and Feature Extraction:* Image A process known as segmentation and feature extraction separates a digital image into multiple portions that may be inspected more easily. In computer graphics, RGB is the most used color representation method. We will provide a data set as input for picture segmentation, and cluster data as output. The image is divided using the K-means clustering algorithm. The CNN-based detection framework's feature extractor can be used to extract picture feature vectors related to leaf disease. The feature extraction procedure examines surface roughness, color, and structure in a leaf image.
4) *Classification based on CNN*: To reliably and precisely evaluate new photographs of sick plants and administer the necessary pesticides and insecticides to the farm to treat the disease and prevent the spread of any pathogen, fungus, bacteria, or other infections, we require a classification model to train our data set. In this paper, we trained our dataset with a convolutional neural network.A convolutional neural network can be created and then used to assess model accuracy during both training and validation. Using the trained model, the disease in the test dataset is projected.

VI. RESULTS AND DISCUSSION

The color, shape, and texture of the leaf image are among the characteristics that the feature extraction algorithms look at. This technology allows us to precisely locate different ailments in leaves. The collection includes a range of disease-affected leaf photo regions, including bacterial spot, bacterial blight, brown spot, late blight, Septoria Leaf Spot, and yellow curved disease.

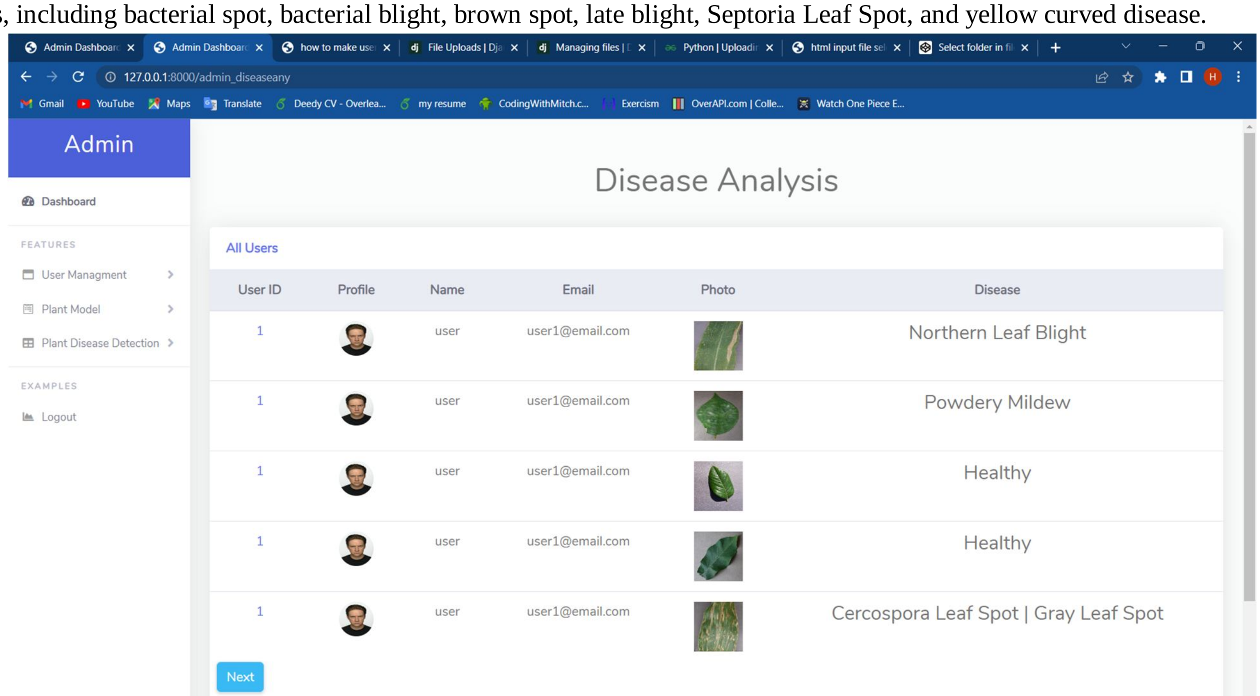

Fig 2. Plan Disease Analysis

VII. CONCLUSION AD FUTURE WORK

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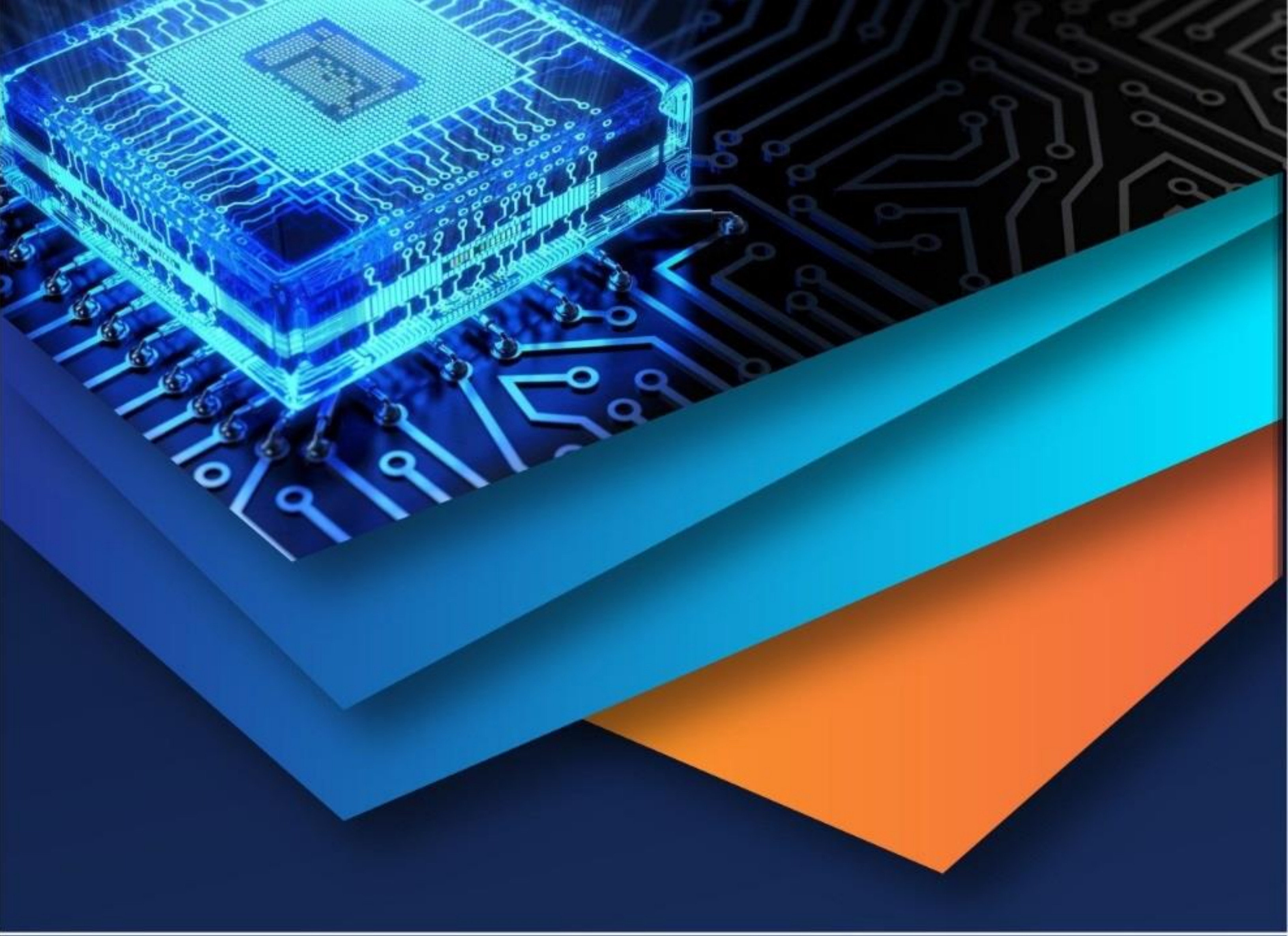

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