IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 7.301
Volume 3, Issue 4, April 2023

Plant Disease Detection using Machine Learning

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Abstract: *Plant diseases are a major threat to agricultural production and food security worldwide. Early detection and accurate diagnosis of plant diseases are crucial for effective disease management. Machine learning techniques, particularly deep learning algorithms such as convolutional neural networks (CNNs), have shown great potential for plant disease detection. In this study, we propose a plant disease detection system that utilizes image processing and CNNs for real-time detection of plant diseases. The system takes an image of the diseased plant as input and uses image processing techniques to extract relevant features from the image. These features are then fed into a CNN model, which is trained on a large dataset of plant disease images, to classify the disease. The proposed system can help farmers detect and manage plant diseases early, thereby reducing crop losses and improving agricultural productivity.*

Keywords: Agriculture, Plant diseases, Prediction, Machine Learning, CNN.

I. INTRODUCTION

Plant diseases have always been a major concern in the agriculture industry, as they can lead to significant losses in crop yields and revenue. Traditionally, farmers have relied on visual inspection to identify diseased plants, which can be time-consuming and often inaccurate. With the advent of machine learning and computer vision technologies, however, there is a growing interest in using these tools to automatically detect and diagnose plant diseases. By leveraging algorithms that can analyze plant images and identify patterns associated with different types of diseases, farmers can quickly identify diseased plants and take appropriate action to prevent the spread of the disease.

The use of machine learning in plant disease detection has shown promising results in recent years, with many studies reporting high levels of accuracy in identifying various types of diseases. In addition to traditional machine learning algorithms, such as support vector machines and decision trees, deep learning algorithms such as convolutional neural networks (CNNs) have emerged as particularly effective tools for image classification and object recognition. By training CNNs on large-scale datasets of plant images, researchers have been able to develop models that can accurately classify diseased plants with high accuracy rates, outperforming traditional machine learning algorithms in many cases. With continued advancements in machine learning and computer vision technologies, the potential benefits of plant disease detection using machine learning are vast, and could ultimately help to revolutionize the agriculture industry.

II. LITERATURE REVIEW

Plant disease detection using machine learning is a rapidly growing field with a lot of potential for improving crop yield and quality. Several techniques have emerged from the literature that can be applied to plant disease detection. One of the most commonly used techniques is image processing, which involves a detection system designed to enable the detection and identification of plant diseases. In this case, the user must provide an image of the infected plant part, then the input is pre-processed and filtered to remove noise and segmented to extract lesions. Finally, image features are extracted and classified to classify the infected area. This technique has proven to be effective in detecting plant diseases, especially when coupled with machine learning algorithms.

Machine Learning is another essential technique in the detection of plant diseases. It involves using algorithms to learn from data, evaluate and predict provided data, and give accurate results in a very short time. Existing techniques for the detection of plant diseases using machine learning include ANN (Artificial Neural Network), BPN (Backpropagation Network), and SVM (Support Vector Machine). These algorithms can be used to train models that can accurately detect the presence of a particular disease based on input data.

Convolutional Neural Networks (CNNs) have also been used for plant disease detection. CNNs have proven to be very effective in image classification tasks and have been used to build models that can detect plant diseases with high accuracy. CNNs work by using a series of convolutional layers that can detect patterns in the input image, followed by pooling layers that reduce the size of the feature maps. Finally, fully connected layers are used to classify the image based on the extracted features.

Deep learning techniques, including artificial neural network algorithms, have also been used for plant disease detection. These algorithms are inspired by the structure of the brain and can learn from large amounts of data to accurately detect the presence of plant diseases. They have been used to build models that can detect plant diseases with high accuracy, making them an essential tool for plant disease detection.

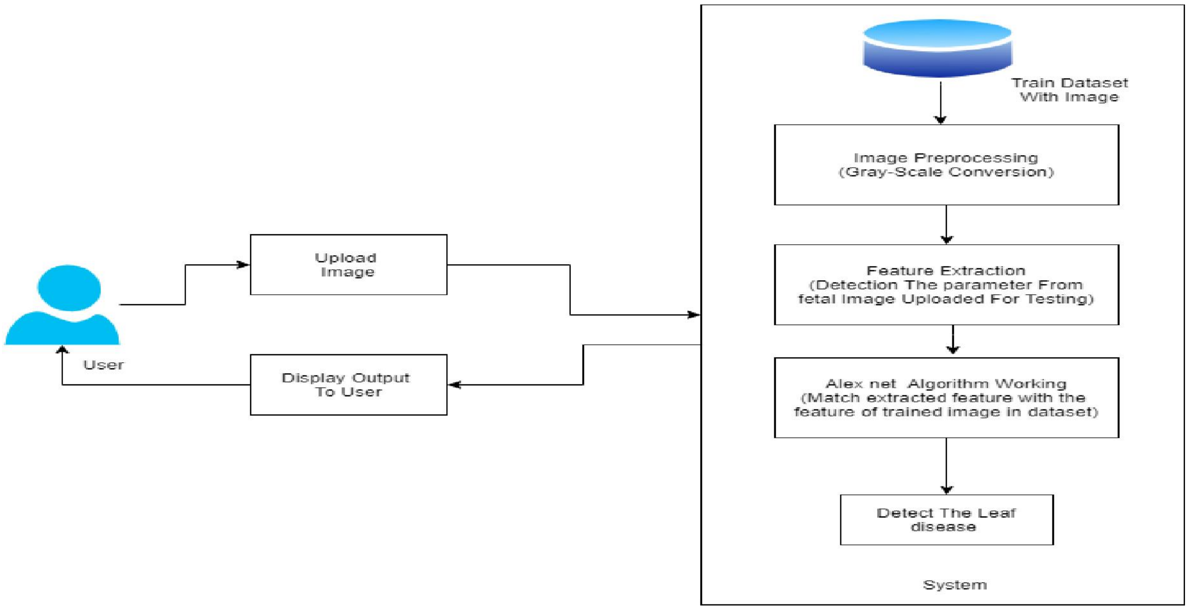
Computer Vision techniques have also been applied in plant disease recognition, where plant disease recognition is done by image processing and machine learning techniques. The user provides the image of the infected plant part as input, and as the next step, image preprocessing technique is performed, and feature values are extracted from the image. Then, the model classifies the type of disease based on the extracted features. This technique is beneficial, especially for areas that do not have access to specialized plant disease detection facilities

III. SYSTEM ARCHITECTURE

Plant disease detection using machine learning is a rapidly growing field that has the potential to revolutionize agriculture by enabling early detection and prevention of crop diseases. The system architecture of plant disease detection using machine learning can be divided into the following main phases:

1. **Image Acquisition:** The first step in the process is to capture images of the plant leaves. This can be done using a smartphone or a camera.
2. **Training Data Set:**. The next step is to collect and prepare a training dataset. This dataset consists of a large number of images of healthy and diseased plant leaves. The dataset is used to train the machine learning model to recognize the features of healthy and diseased leaves.
3. **Image Pre-processing:** The collected images are pre-processed to remove any noise or irrelevant information. This step involves converting the images to grayscale, resizing them, and normalizing the pixel values.
4. **Feature Extraction:** In this step, various algorithms such as convolutional neural networks (CNN) are used to extract the features of the images. The extracted features are then used to train the machine learning model.
5. **Detection of Parameters:** In this step, a fetal image is uploaded for testing. The parameters of the uploaded image are detected using various techniques such as edge detection and thresholding.
6. **Activation of AlexNet Algorithm:** AlexNet is a deep neural network architecture that is commonly used for image recognition tasks. The pre-trained AlexNet model is used to match the extracted features of the test image with the features of the images in the training dataset.
7. **Leaf Disease Detection:** In the final step, the machine learning model identifies the type of disease present in the plant leaves by comparing the features of the test image with the features of the images in the training dataset. If the test image is classified as diseased, the system can suggest appropriate measures for disease prevention or treatment.

In conclusion, the system architecture of plant disease detection using machine learning is a complex process that involves several phases, including image acquisition, dataset preparation, image pre-processing, feature extraction, parameter detection, activation of the AlexNet algorithm, and leaf disease detection. The accuracy of the system depends on the quality of the training dataset, the effectiveness of the pre-processing techniques, and the performance of the machine learning algorithms used. The use of machine learning in plant disease detection has the potential to significantly improve the efficiency and accuracy of disease diagnosis and management in agriculture.



IV. ALGORITHM USED

The Convolutional Neural Network (CNN) is a deep learning algorithm that is commonly used for image recognition and processing. It is a type of neural network that assigns importance (learnable weights and biases) to different aspects and objects in an image, and compares them with each other to detect and classify objects in images.

4.1 CNN for Plant Disease Detection

CNNs are specialized for image and video recognition applications, and are commonly used for analyzing visual images in plant disease detection. The algorithm is used to process the data using a grid-like topology, and detect and classify the various diseases present in plant images.

4.2 Types of Layers in a CNN:

There are three main types of layers in a convolutional neural network:

1. **Convolutional layer**: This layer is responsible for detecting features in the input image by applying a set of learnable filters (kernels) to the image.
2. **Pooling layer**: This layer reduces the dimension of the feature map by grouping the neighboring pixels together and selecting the maximum value or average value within each group.
3. **Fully connected layer**: This layer is responsible for the final classification of the input image. It takes the output of the last pooling or convolutional layer, flattens it, and passes it through a set of fully connected neurons.

4.3 Training a CNN for plant disease detection:

The training of a CNN for plant disease detection involves several steps:
The first step is to acquire a dataset of images of healthy and diseased plants.
The dataset is divided into training and testing sets.
The training set is used to train the CNN by adjusting the weights and biases of the filters in the convolutional layer.
During training, the CNN learns to detect the features that distinguish healthy and diseased plants.
The testing set is used to evaluate the accuracy of the trained model.

4.4 Feature Extraction

In feature extraction, the CNN algorithm extracts relevant features from the input image using convolutional and pooling layers. These features are then used to classify the input image as healthy or diseased.

4.5 Activation of the CNN

After feature extraction, the CNN algorithm compares the extracted features with the features of the trained dataset using fully connected layers. This comparison helps to determine the probability of the input image being healthy or diseased.

4.6 Leaf disease detection

The final step of the CNN algorithm is leaf disease detection. In this step, the algorithm classifies the input image as healthy or diseased based on the probability calculated in the previous step.

In conclusion, the Convolutional Neural Network (CNN) algorithm is a powerful tool for plant disease detection using machine learning. The algorithm works by detecting and classifying features in the input image using convolutional and pooling layers, and comparing them with the features of the trained dataset using fully connected layers. This approach can help to accurately detect and classify plant diseases, and potentially prevent the spread of plant diseases in agricultural settings

V. MATHEMATICAL MODEL

Let S be the whole system, consisting of an input I, a procedure P, and an output O:

S = {I, P, O}

The input I is defined as the image dataset used for training and testing the system:

I = {image dataset}

The procedure P involves using the input image dataset to perform operations and utilizing the CNN algorithm for plant disease detection:

P = {I, operations, CNN algorithm}

The output O is the system's ability to detect plant diseases accurately:

O = {system detects plant disease}

To summarize, the mathematical model shows that the image dataset is used as input to the system, which performs operations and utilizes the CNN algorithm to detect plant diseases. The output of the system is its ability to detect plant diseases accurately.

VI. EXISTING SYSTEM

Plant disease detection using machine learning has been an active research area in recent years. Several studies have been conducted to develop efficient and accurate models for identifying and diagnosing plant diseases. The existing systems in this field vary in their approaches, algorithms, and datasets used. For instance, some studies have utilized CNNs for image classification, while others have used multilayer neural networks or Gabor capsule networks. Some studies focused on a specific crop such as apple, maize, or mango, while others aimed at identifying diseases in various plants. The models proposed in these studies have achieved promising results and can be used to assist farmers in detecting and managing plant diseases. However, there is still a need for further research to enhance the accuracy and efficiency of these models and to develop new techniques that can address the challenges and limitations of the current approaches.

VII. PROPOSED SYSTEM

Our proposed system for plant disease detection is a machine learning-based system that uses a convolutional neural network (CNN) to classify plant diseases. This system achieved an accuracy of 89% on a dataset of plant images. The system involves two main modules: data collection and disease classification.

The data collection module involves acquiring and processing the plant images. The processed images are then

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segmented and fed into the classifier engine. The classifier identifies the type of disease that the image contains by comparing it to the dataset available.

Compared to existing systems, our proposed system provides more accurate results in identifying different types of diseases. This system also helps users gain better knowledge of identifying plant diseases. The accuracy of the system increases as the size of the dataset increases. A larger dataset provides more data to refer to, resulting in better disease identification and increased accuracy.

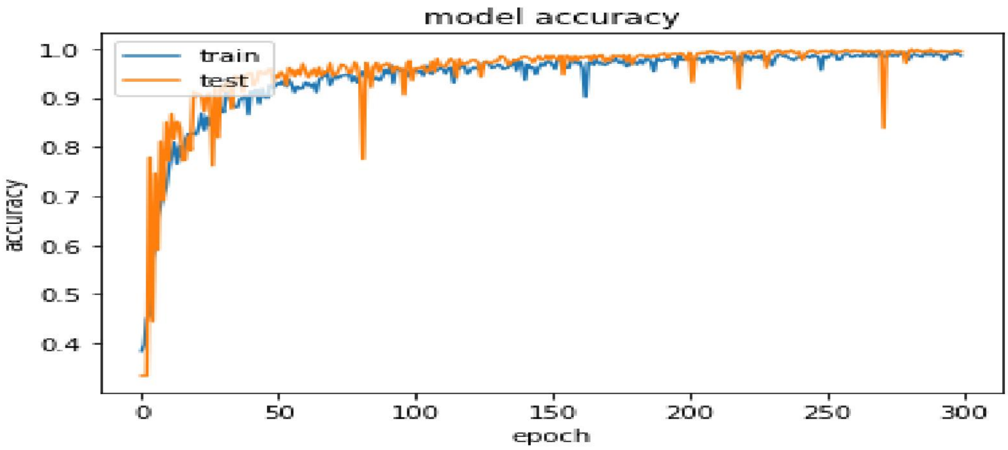
Overall, our proposed system for plant disease detection using machine learning is a significant step towards improving disease detection and classification accuracy. It provides a more efficient and effective way to identify and diagnose plant diseases, which ultimately leads to better crop management and increased yield.

VIII. RESULTS

Our proposed system for plant disease detection using machine learning achieved an initial accuracy of around 89%. The system was tested for five diseases and was able to accurately classify them. We believe that this accuracy can be further improved by using a larger dataset, which could potentially increase the accuracy to over 90%.

The output generated by our system, which identifies the plant diseases, is displayed in a graphical user interface(GUI) that provides a user-friendly way to interpret the results. With this system, users can easily identify the type of disease affecting their plants, allowing for faster and more accurate treatment.

Overall, the results of our proposed system demonstrate its potential to be a valuable tool for farmers and researchers in the field of agriculture. By using machine learning and image processing techniques, we can accurately and efficiently identify plant diseases, which can ultimately help to improve crop yields and food security.



IX. FUTURESCOPE

The future scope of the plant disease detection system using machine learning is vast. With the advancement of technology, more efficient algorithms can be implemented to increase the accuracy of the system. The system can be trained with a larger dataset to identify more types of diseases, which would enable early detection and prevention of crop loss.

Furthermore, the system can be extended to include a mobile application that can be used by farmers to detect diseases in their crops on the go. This would provide instant results, saving time and money. Moreover, the system can be integrated with other agricultural technologies such as drones and automated irrigation systems to create a comprehensive smart farming system.

X. CONCLUSION

In conclusion, the plant disease detection system using machine learning is a promising technology that can revolutionize the agriculture sector. The system has shown impressive accuracy in identifying diseases in crops and can potentially reduce the loss of crops due to disease.

However, there is still room for improvement in terms of accuracy, dataset size, and integration with other agricultural technologies. Future researchers should focus on addressing these issues to create a more efficient and effective system that can benefit farmers and the agricultural industry as a whole..

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