International Journal of Engineering Science and Advanced Technology (IJESAT)

IJESAT (Enriching the Research)

Open Access Research Article

Volume: 23 Issue: 07

July, 2023

Apple Leaf Disease Detection: A Comparison of Deep Learning GoogLeNet and Classical Machine Learning Algorithms

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ABSTRACT

Apple leaf disease detection system typically describes a computer vision-based approach for automatically identifying and diagnosing diseases affecting apple trees from digital images of their leaves. The system uses machine learning algorithms and image processing techniques to extract relevant features from the images and train a classification model capable of accurately identifying different types of apple leaf diseases. The accuracy and effectiveness of the system depend on the quality of the dataset used for training and testing, as well as the performance of the underlying algorithms and hardware used to process the images in real-time. Such a system has the potential to significantly improve the efficiency and accuracy of apple disease diagnosis and management, ultimately leading to better yields and more sustainable agricultural practices.

1. INTRODUCTION

Agriculture is one of the most important industries of one country since it plays an essential role in the production of raw materials for other industries. The usage of agricultural products can be in the fields of food, textiles, chemical industry, and so on. However, plant disease detection is still a challenging task for farmers. Each farmer has to be able to identify diseases in plants

Correctly to avoid the potential risk of plant diseases. The farmers can only contact either their peasants or the assistance line for consultation. Also, it is expensive for a team of experts to detect such plant illnesses. The Inability to cure a disease due to lack of knowledge may become a main factor that caused the transferring of plant diseases because they can't be detected at an early stage. To deal with these problems existing in the agricultural field, researchers have made great progress in the diagnosis of plant leaves diseases and pests. In this paper, we use a collected dataset from the "The Plant Pathology Challenge 2020 data set to classify foliar disease of apples" [1], which consists of 3642 images of apple leaves including healthy leaves, rust leaves, grab leaves, and so on. We divided the images into training and testing groups, then we proposed a CNNs-based model: resnet34 to trained the prediction system. We didn't follow the past works which need to train the model start from the beginning with a huge amount of data. To save the training time and remain the accuracy higher, we use the Fastai framework for actual implementation. As a result, we get an accuracy of 93.765% for the identification of apple healthy condition. The following paper is organized into four parts. In section 2, we do a literature review on computer vision of leaf diseases identification. In section3, a detailed approach that we used to train the CNNs-based model is shown. In section 4, there is a processing of the experiment. In section 5, we conclude our system and result, then propose the future development planning.

The Apple Leaf Disease Detection Project is an innovative approach to identifying and diagnosing diseases in apple trees using machine learning and computer vision techniques. Apple trees are susceptible to various diseases, such as apple scab, powdery mildew, and fire blight, which can

significantly reduce crop yield and quality. Traditional methods of disease detection involve visual inspection by experts, which can be time- consuming and costly.

The goal of this project is to develop an automated system that can accurately identify and classify apple leaf diseases using images of the leaves. This system will utilize state-of-the-art deep learning algorithms to analyze the images and provide a diagnosis of the disease. By automating the disease detection process, this project aims to reduce the time and cost associated with manual inspection and improve the accuracy of disease diagnosis.

The potential impact of this project is significant, as it can help apple farmers to identify and treat diseases early, before they cause significant damage to the crops. This, in turn, can improve crop yield and quality, leading to increased profitability for farmers. Moreover, the use of machine learning and computer vision techniques for disease detection can be extended to other crops and plant species, making it a valuable tool for agriculture in general.

2. LITERATURE SURVEY

Convolutional Neural Networks (CNNs) is the most popular architecture to deal with the computer vision problems like image classification in recent years. Since it is better than any other traditional recognition approaches, like Genetic Algorithm(GA), k-Nearest Neighbour Classifier (KNN), and Probabilistic Neural Network(PNN), to do the image classification, CNNs has been widely used in the field of plant diseases classification and identification. There is the review of literature in the following paragraphs a) Literature summary Wan-jie Liang, Hong Zhang et.al combined the machining learning and recognition approaches to do the “Rice Blast Disease Recognition” [2] with the CNNs architecture. They collected 5,808 samples, 2906 of them are positive while 2902 of them are negative, for CNN model training and testing. In this paper, the authors showed how CNNs performed better than local binary histogram (LBPH) and Haar-WT (Wavelet Transform), and it more paired with Softmax and SVM, larger area under curve (AUC), and better receiver operating characteristic (ROC) curves. UDAY PRATAP SINGH et.al had made an innovation in this field. 1,070 images of mango leaves including both the healthy and the infected were collected to build a classification system of the “Mango leaves infected by the Anthracnose fungal disease” [3] . They proposed a new concept of multilayer convolutional neural network(MCNN), which contains both multiple more feedforward layers and pooling layers. In this model, they got an accuracy of 97.13%, which is higher than other advanced technologies. To save the training and testing time of a CNN model, researchers pay more attention to the transfer learning models, a pre-trained model with a large amount of dataset. Liu Bi et. al [4] had collected 107,366 grape leaf images from the field and the public. They proposed a novel recognition approach named DICNN, which combined the transfer learning models of InceptionV3, VGG16, and VGG19 with classifiers such as KNN, Neural Networks, Logistic regression, and SVM. Finally, they realize an accuracy of 97.22% which increases by 2.97% and 2.55% respectively compared to GoogLeNet and ResNet-34. b) Comparison From the previous experience, we found that many of the past works are facing the problem that it takes too much time to train a CNNs model. The main reasons may be that the researchers have to train the model start from the beginning, and even the application of the transfer learning models faces this difficulty because their frameworks like Keras and Tensorflow can’t get a high computation speed sometimes. To deal with these problems, we use the Fastai framework to get higher accuracy with less training time.

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3. EXISTING SYSTEM

Human population steadily continues to grow, and along with it the need for food production increases. According to the UN projections [1], human population is expected to reach 9.7 billion in 2050, 2 billion more than today. Considering that most of the population growth is to occur in the least developed countries (around 80% increase in the next 30 years), where the food scarcity is the main problem, it is easy to conclude that minimizing food loss in those countries is a primary concern. It is estimated that the yield loss worldwide is between 20 and 40 percent [2], with many farms suffering a total loss. Easily spreadable diseases can have a strong negative impact on plant yields and even destroy whole crops. That is why early disease diagnosis and prevention are of very high importance.

Disadvantages: Data Collection Problem, It searches from a large sampling of the cost surface.

4. PROPOSED SYSTEM

Traditional methods for detecting diseases require manual inspection of plants by experts. This process needs to be continuous, and can be very expensive in large farms, or even completely unavailable to many small farm holders living in rural areas. The Plant Village Dataset is used [3]. It consists of images of plant leaves taken in a controlled environment. In total, there are 54 306 images of 14 different plant species, distributed in 38 distinct classes given as species/disease pair.

Classical methods rely on image pre-processing and the extraction of features which are then fed into one of the ML algorithms and deep learning Algorithms such as GOOGLENET. In The Machine Learning algorithms choices are Support Vector Machines (SVM), k-Nearest Neighbours (k-NN), Fully Connected Neural Networks (FCNN), Decision Trees, Random Forests etc

Advantages of proposed system

Machine learning algorithm optimizes both variables efficiently, continuous or discrete. Gives a number of optimum solutions, not a single solution. So different image segmentation results can be obtained at the same time. Large number of variables can be processed at the same time. It can optimize variables with highly complex cost surfaces.

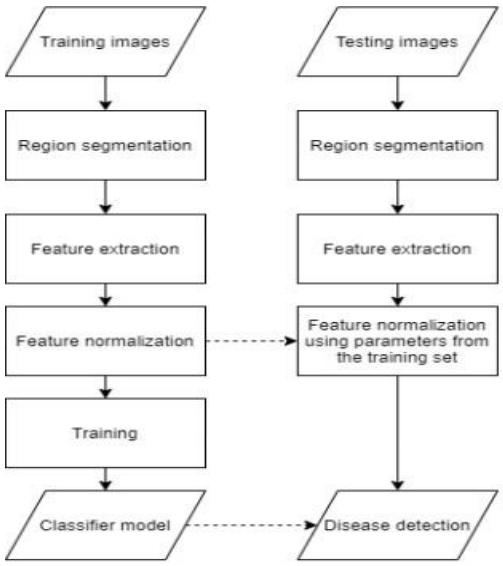

Fig1 System Architecture

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Random Forest Algorithm

Random forest is a popular algorithm used in machine learning for classification and regression tasks. It is a type of ensemble learning method, which combines multiple decision trees to produce a more accurate and robust model. To use the random forest algorithm for apple leaf disease detection, we first need a dataset of labeled images of apple leaves, where each image is labeled as healthy or diseased. The dataset can be collected through various means such as manual labeling or using pre-existing datasets. Once we have the dataset, we can use the random forest algorithm to train a model to classify the images. The algorithm works by randomly selecting a subset of features from the dataset and building a decision tree for each subset. The trees are then combined to create the final model, where the output of each tree is used to make a prediction. To implement the random forest algorithm, we can use a machine learning framework such as scikit-learn in Python. The steps to implement the algorithm are as follows: The random forest algorithm can be an effective method for apple leaf disease detection, as it can handle complex, non-linear relationships between the features and the target variable, and can also deal with noisy and missing data. However, it is important to ensure that the dataset is properly labeled and balanced, and that the hyper parameters are carefully tuned to avoid overfitting.To evaluate the performance of the random forest algorithm, you can use metrics such as accuracy, precision, recall, and F1-score. If the algorithm performs well on the validation set, you can use it to classify new apple leaf images as healthy or diseased.

Convolutional Neural Network

Convolutional Neural Networks (CNNs) are a type of artificial neural network (ANN) that have been designed specifically for image processing and recognition tasks. CNNs use a layered architecture in which each layer performs a different operation on the input data. The most important layers in a CNN are the convolutional layers, which extract features from the input image. The input to a CNN is an image, which is represented as a 3D array of pixel values. The first dimension of this array represents the height of the image, the second dimension represents the width of the image, and the third dimension represents the color channels (e.g., red, green, and blue). Each pixel is represented by a value between 0 and 255.

5. RESULTS

Front end home page to upload image in the web browser.

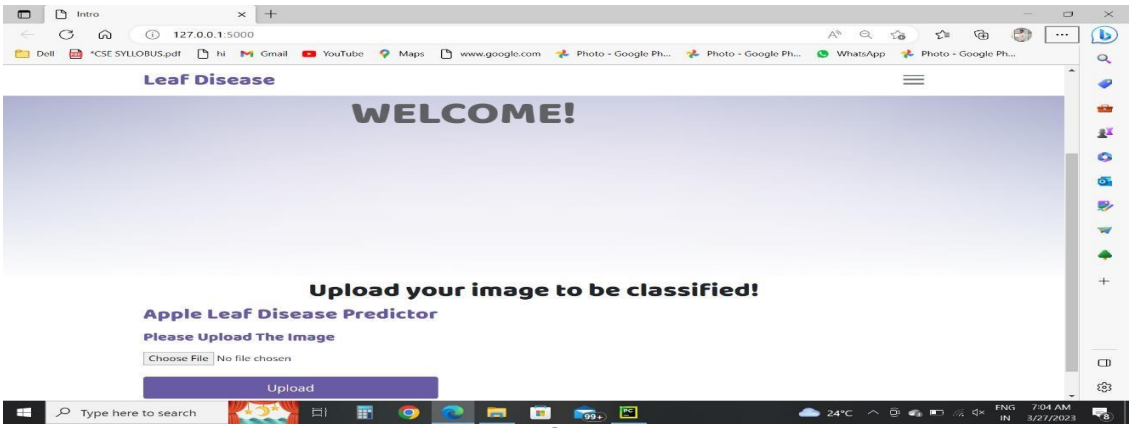

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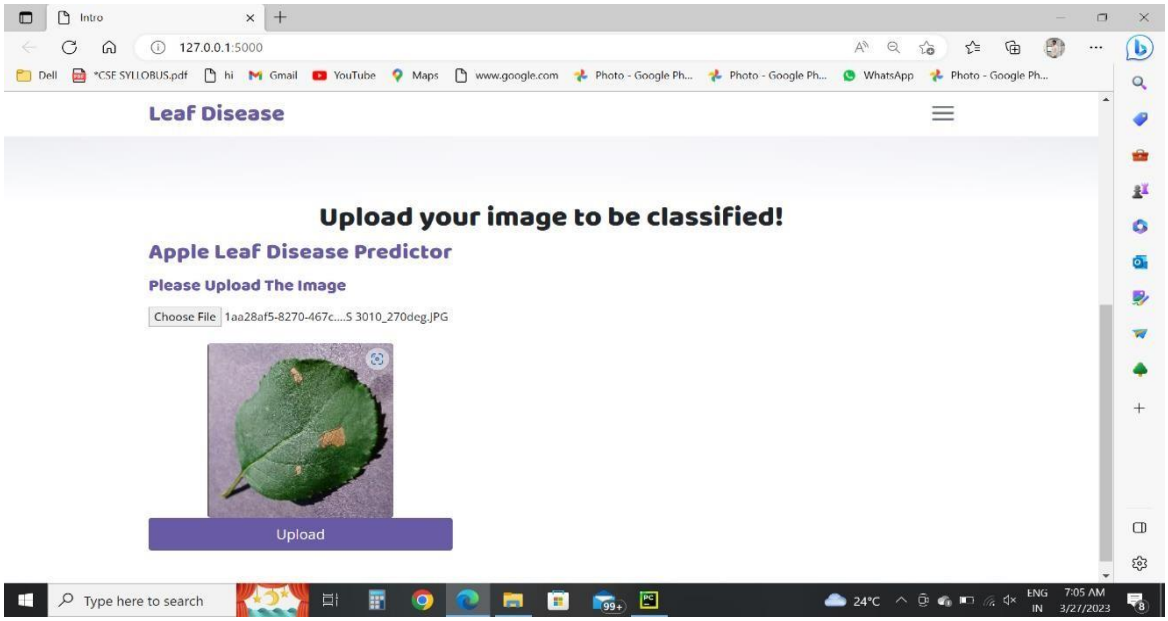
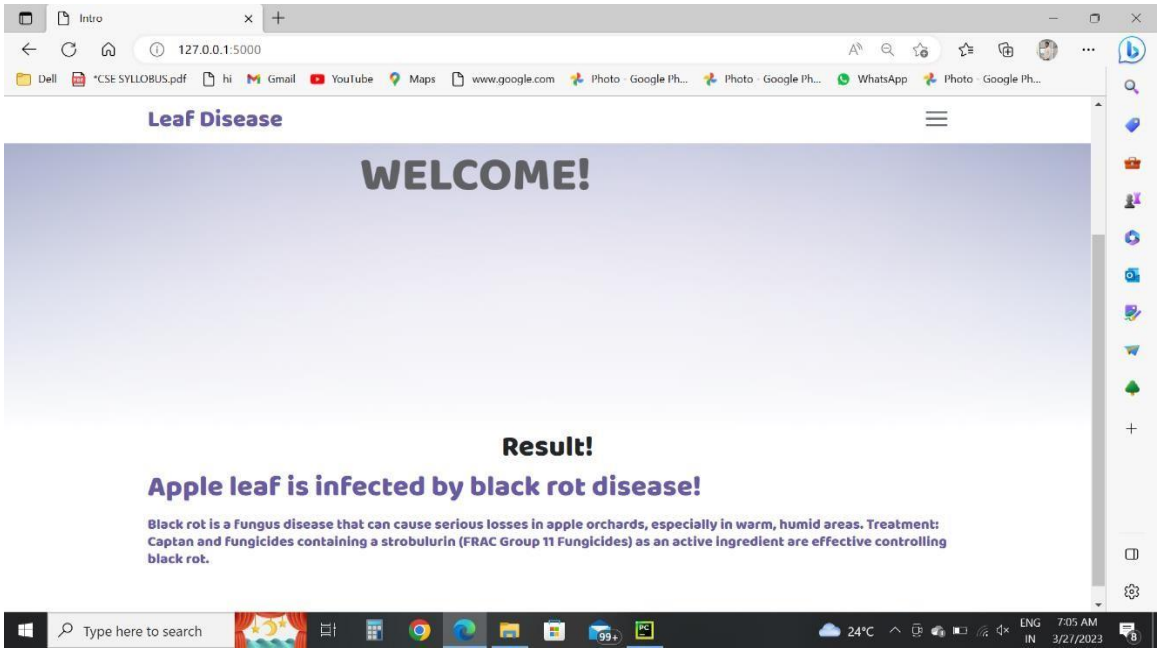
Image uploaded to classify the disease.



Result with classified disease and suitable remedy for that classified disease.



6. CONCLUSION

In recent years, the agriculture industry has seen a significant increase in the use of machine learning and computer vision techniques for crop monitoring, disease detection, and yield optimization. The development of an automated system for apple leaf disease detection using

ISSN No: 2250-3676

IJESAT (Enriching the Research)
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these technologies is a promising example of how innovative solutions can address longstanding challenges in the industry.

The project aims to utilize state-of-the-art deep learning algorithms and convolutional neural networks to analyze images of apple leaves and provide an accurate diagnosis of the disease. By automating the disease detection process, this system has the potential to save time and costs associated with manual inspection and treatment, leading to improved crop yield and quality for farmers.

Numerous studies have demonstrated the efficacy of deep learning algorithms and convolutional neural networks in identifying and classifying various apple leaf diseases. These studies show that automated systems can achieve high accuracy rates in detecting diseases such as apple scab, powdery mildew, and fire blight, among others.

In addition to improving the efficiency and accuracy of disease detection, the use of these technologies can also help farmers identify and treat diseases early, before they cause significant damage to the crops. Early detection can reduce the need for extensive treatment measures, leading to lower costs and a reduced environmental impact.

Furthermore, the use of machine learning and computer vision techniques for disease detection can be extended to other crops and plant species, making it a valuable tool for agriculture in general. As research in this area continues to advance, we can expect to see more innovative approaches to automated disease detection and improved outcomes for agriculture.

This paper presents the dominance of the DL method over the classical ML algorithms. Both the simplicity of the approach and the achieved accuracy confirm that the DL is the way to follow for image classification problems with relatively large datasets.

In conclusion, the development of an automated system for apple leaf disease detection using machine learning and computer vision techniques has the potential to significantly improve the efficiency and accuracy of disease diagnosis in apple crops.

It can save time and costs associated with manual inspection and treatment, lead to improved crop yield and quality, and reduce the environmental impact of treatment measures. The use of these technologies can also be extended to other crops and plant species, making it a valuable tool for agriculture in general.

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