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Identification of Plant Leaf Diseases using Deep Convolutional Neural Networks

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Abstract - **Agriculture is the most important part of the global economy as it presents food safety. However, in modern years, it has been noted that plants are broadly infected by various infections. The manual examination of plant, fruit and leaf diseases is a complicated process which can be reduced by using automated processes for detection of plant diseases at the first stage. In the field of horticultural information, the automatic identification moreover diagnosis of maize leaf diseases are extremely desired. For increasing growth and productivity of the crop field, farmers need automatic monitoring of disease of plants instead of manual. Standard monitoring of disease do not produce a satisfactory outcome as natural eye observation is the old process needs more extra time for disease identification also need specialist hence it is not effective. Curvularia leaf spot, Brown spot, Mosaic, Grey spot, and Rust are five popular types of leaf diseases. To overcome the drawbacks of regular eye observing procedure, we used digital image processing method for active and accurate disease detection of the plant. To develop the identification accuracy of leaf diseases and decrease the number of parameters, the improved GoogLeNet and Cifar10 models based upon deep learning are proposed for leaf disease identification in this paper. Two improved standards that are employed to train and test nine varieties of maize leaf images are obtained by changing the parameters, adjusting the pooling combinations, combining dropout operations and rectified linear unit functions, and decreasing the number of classifiers. The enhanced processes have probably improved the accuracy of leaf disease and decreased the convergence repetitions, which can efficiently increase the model training and identification capability.**

Keywords- **Deep learning, deep convolution neural networks, identification, image processing, leaf diseases.**

I. INTRODUCTION

Maize, Rice, Wheat and Plant Leafs are highly valuable food and feed crop. Its plant field and total production are the largest in the world except for rice and wheat. However, in modern years, the number of varieties of maize diseases and the level of harm they cause have grown, largely due to changes in farming systems, the variety of pathogen species, and ineffectual of plant protection measures. Usually, there are five kinds of common leaf diseases, including Curvularia leaf spot, Brown spot, Mosaic, Grey spot, and Rust.

Most seriously, maize leaf disease is dangerous and will harm maize production and people's lives. Plant Leaf diseases have different symptoms. It may be more painful for fresh farmers to diagnose diseases than for professional plant pathologists. As a verification mode in disease diagnostics, an automatic method that is designed to recognize plant diseases by the plant's appearance and visual signs could be of excellent guidance to farmers.

Numerous efforts have been implemented to the fast and accurate diagnosis of leaf diseases. By using digital image processing techniques, support vector machine (SVM), neural networks and additional methods, we can identify and analyse leaf diseases. An SVM - based multi - classifier was introduced by Song et al. and was implemented to recognize a variety of maize, rice and wheat leaf diseases. The best identification accuracy was 89.6%.

The method of classification using SVM is particularly applicable to tiny samples, for a huge number of samples; it cannot produce high identification accuracy. The proposed method for the identification of plant leaf diseases based on image processing technology and a probabilistic neural network (PNN). The best identification accuracy of this method was 90.4%. However, for the PNN classifier, the identification accuracy and speed of this process reduces as the number of training samples increases. A process of plant leaf disease identification based on adaptive weighting multi-

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classifier fusion was introduced. The proposed methods using digital image processing techniques based on Fisher discriminate, Retinex algorithms joined with principal component analysis (PCA) and SVM, and quantum neural network (QNN) and aggregate features for identification of plant leaf disease. Deep learning has made huge advances in the past several years. It is presently able to obtain useful feature representations from a huge number of input images. Deep learning presents an opportunity for detectors to recognize crop diseases in a timely and proper manner, which will not improve the efficiency of plant protection but also extend the scope of computer vision in the area of precision agriculture. Most of the researchers were used several pooling operations, filter sizes, and algorithms to recognize 10 common plant leaf diseases.

The proposed convolution neural networks (CNNs) – based model achieved an accuracy of 95.48%. This proposal addressed the challenge of insufficient data and the multiple variations that seem in images of field - grown plants. In this research, two improved deep convolution neural network models, GoogLeNet and Cifar10, are exhibited to improve the identification accuracy of plant leaf diseases and develop the conventional identification methods with high convergence times and huge numbers of model parameters. The two models that are related to train and test 9 kinds of maize leaf and other leaf images are collected by adjusting the model parameters, changing the pooling combinations, adding the dropout operation and rectified linear unit function, and reducing the number of classifiers.

Finally, the experimental results are matched with those of the unmodified model. The beginning detection of these indications are very helpful to grow the fruits and seeds quality and production. In the field of computer vision, it is an effective examination area to find out the plant conditions and newly several methods are introduced for plant leaf and fruit diseases detection by image processing and machine learning algorithms.

II. EXISTING SYSTEM

The present method for plant disease detection is naturally naked eye observation by specialists through which identification and detection of plant infections is done. For doing so, a great team of specialists as well as consecutive monitoring of plant is needed, which costs extremely high when we do with extensive farms. At the same time, in some countries, farmers do not have individual facilities or even idea that they can communicate to experts. Due to consulting the specialists, it's costly as well as time consuming too. In such conditions, the suggested method shows to be beneficial in observing large fields of crops. Automatic detection of the diseases by just observing the symptoms on the plant leaves makes it easier as well as cheaper. This also supports machine vision to provide image based automatic method control, inspection, and robot guidance.

III. MATERIALS AND METHODS

1. Dataset:

A suitable dataset is needed at all stages of plant leaf recognition research, beginning from the training phase to estimating the performance of identification algorithms. A total of 500 images are obtained from various sources, such as the Plant Village and Google websites, including several periods of occurrence of plant leaf diseases, which are divided into 5 different categories. 5 categories are representing infected maize, rice and wheat leaves and a category representing healthful leaves.

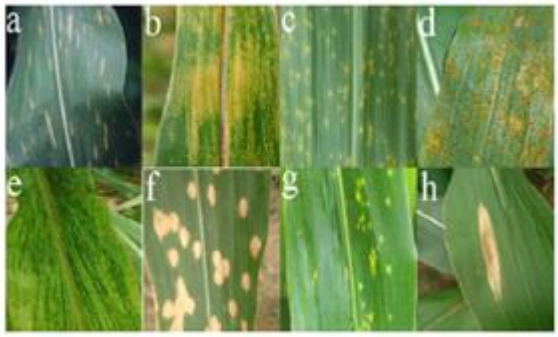

Fig .1.Eight common maize leaf diseases a: southern leaf blight; b: brown spot; c: Curvularia leaf spot; d: rust; e: dwarf mosaic; f: gray leaf spot; g: round spot; h: northern leaf blight.

2. Augmentation:

Training CNNs needs substantial data. The more extra data the CNNs have to learn, the more extra characteristics it can achieve. Since the original leaf image dataset obtained in this study is not satisfactory, it is essential to extend the dataset by different methods to distinguish the different disease categories.

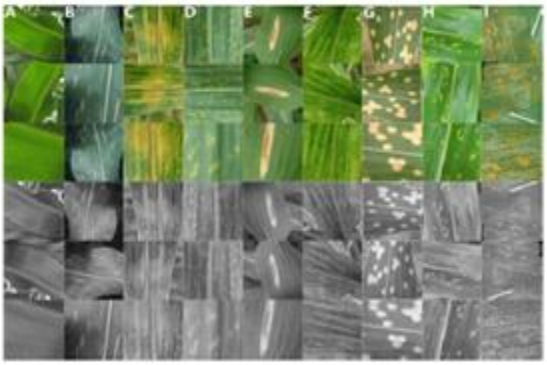

Fig.2. Part of the image samples after augmentation process Part A shows a healthy maize leaf after rotation, cutting, and grayscale. Part B-I show eight kinds of maize leaf disease images.

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3. Image Preprocessing and Labeling:

To increase feature extraction and improve consistency, the models in the dataset for the deep CNNs classifier are pre-processed before the model is trained.

One of the several significant operations is the normalization of image size and format. In this research, all images are resized to 224 x 224 pixels and 32 x 32 dots per inch, which are automatically computed by MATLAB scripts.

IV. ALGORITHM METHODOLOGY

The block diagram of the proposed system is shown in below fig. 3. The step by step proposed approach consists of plant leaf and fruit image database collection, pre-processing of those images, segmentation, feature extraction of those images using Improved Deep Convolution Neural Networks. First, the images of various leaves are acquired using a high-resolution camera to get better results & efficiency. Then image processing techniques are applied to these images to extract useful features which will be required for further analysis.

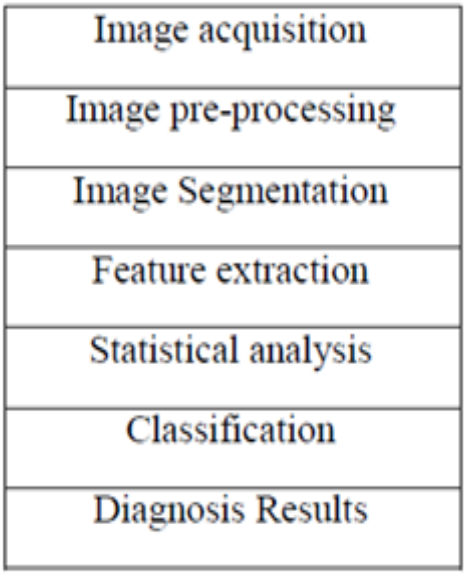

Fig.3. Block Diagram of proposed approach.

1. Image Acquisition

Image acquisition is the primary method of digital image processing and it is defined as capturing the image through digital camera and stores it in digital media for further MATLAB operations. It is also an act of regaining an image from the device, so it can be passed through the additional process. In our work, using the digital camera we captured healthy and diseased images of leaf & fruit as shown in fig. 4 for MATLAB image processing system.

Fig .4. Original image of diseased leaf and fruit.

2. Image Pre-Processing

The main objective of image pre-processing is to develop the image data contained unwanted distortions or to become some image characteristics for additional processing. Pre-processing process uses different ways such as adjusting image size and shape, filtering of noise, image conversion, improving the image and morphological operations. In this work, we used different MATLAB code to resize the image, to improve contrast and RGB to grayscale conversion as shown in fig. 5 for further operations like building clusters in segmentation.

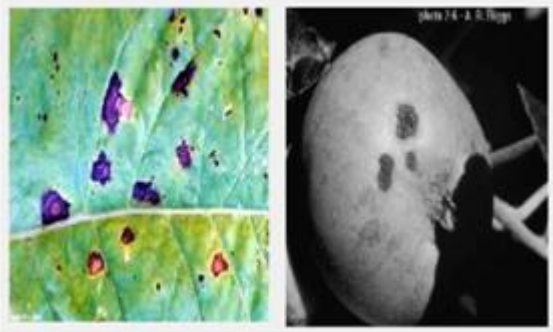

Fig .5. Contrast enhanced and RGB to gray converted image.

3. Image Segmentation

Image segmentation is the process for the reformation of the digital image into many segments and rendering of an image into something for more accessible analysis. Using image segmentation is used for finding the objects and bounding line of that image.

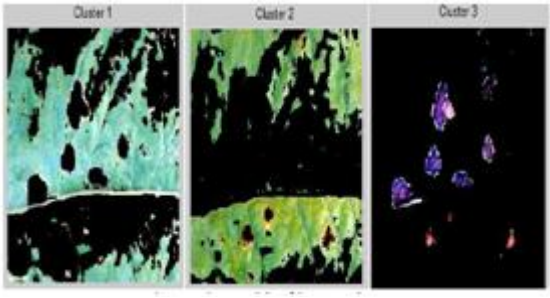

Fig.6. Diseased leaf image clusters.

4. Feature Extraction

In feature extraction, wanted feature vectors such as color, texture, morphology and structure are extorted. Feature

extraction is a method for involving the number of resources required to define a large set of data exactly.

5. Image Classification

The convolution neural network (CNN) is a type of deep learning neural networks. CNN represents a tremendous breakthrough in image recognition. They're most generally used to investigate visual representation and are continually working behind the scenes in image classification.

V. EXPERIMENTAL RESULTS

In this in this paper, we have counted results up to three conditions. Graphical user interface (GUI) is developed for the system to move out various image processing steps. Dataset folder is built consisting of various images of leaves under test. The crops we have elected for experimental purpose are tomato and potato.

In stage 1, an input model image is elected from the dataset folder as shown in Fig 4. Color transformation structure is formed from RGB to CIELAB color space. Then color-based segmentation utilizing the k-means clustering is implemented to receive the infected area of interest. The choice of selection of the number of clusters is user-dependent. Commonly, the best outcomes come up with either 3 or 4. The example results of clustering on Septoria Leaf Spot (fungal) of Tomato are displayed in next Matlab figures. We can see that Fig 5, 6 & 8 represent the healthy pieces of leaf whereas Fig 7 consists of the infected portion of the leaf. This is the field of interest for additional processing.

Fig.7. Input test image.

In stage 2, an infected cluster is elected. Green pixels are disappeared based on the threshold value set. Also, Pixels on the boundaries are also excluded as they both do not add to the infection identification process. Then the resultant image is transformed from RGB to HSI color format.

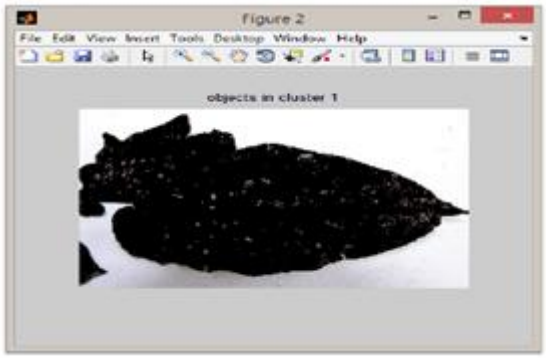

Fig.8. Objects in cluster 1.

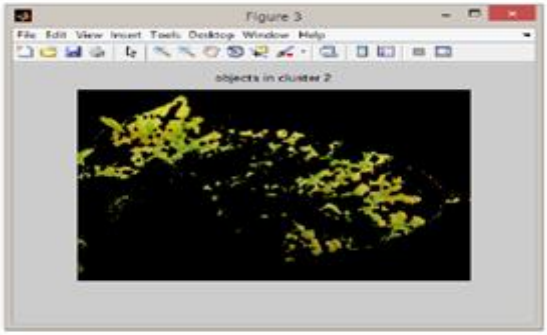

Fig.9. Objects in cluster 2.

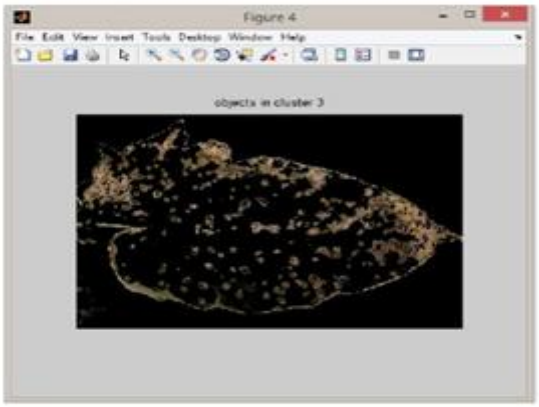

Fig .10. Objects in cluster 3 (infected).

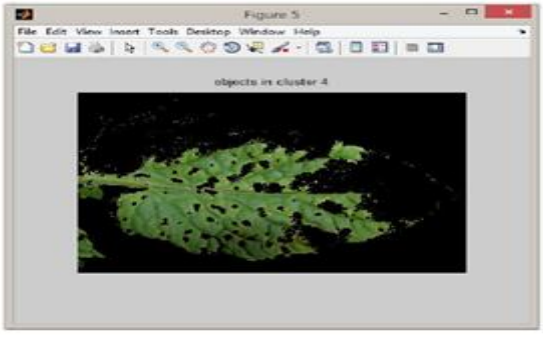

Fig .11. Objects in cluster 4 (green area).

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In phase 3, feature extraction & statistical analysis on changed infected cluster collected in the early phase is carried out. In practice, an investigation can be done on five distinct models also called as color features. The reason behind this preference is the variation inaccuracy that we notice during the neural network-based classification.

VI. CONCLUSION

In this research, when recognizing nine types of maize, rice, wheat leaves, the two improved deep convolution neural networks models, GoogLeNet and Cifar10, can obtain high identification accuracy, 98.9% and 98.8%, respectively. When the train - test set is 80 - 20 (80% of the whole dataset used for training, and 20% for testing), the classification algorithms used in this research support the systems to obtain a diversity of sample conditions with strong robustness. Experiments reveal that it is likely to develop recognition efficiency by increasing the diversity of pooling operations, the reasonable addition of a Relu function and failure operations, and including many arrangements of the model parameters. In future research, we will recognize more varieties of plant leaf diseases, insects and combine the latest algorithms and other deep learning structures for the training and testing of the model. Meanwhile, to enable agricultural farmers to make quick and understandable reports about crop disease data, the trained model can be flexibly combined with mobile devices.

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