A DEEP NET APPROACH FOR THE SEGMENTATION & DETECTION OF INFECTED REGIONS IN PLANT LEAVES

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ABSTRACT

Agriculture is the main source of income of about more than half of the population of India. Farmers work hard to produce different crops but the plant diseases contributes in the reduction of the production as the farmers are not aware of the diseases occurred to different plants. Different techniques have been designed till now to detect the diseases at the early stage so that the production can be enhanced by taking preventive measures. A recent study analyzed the infected mango leaves by the disease (Anthracnose) that is one of the fungal diseases. Although the existing model is capable of providing better results but there are some limitation such as a large number of processing layers was utilized that increased the complexity. Thus, to cope with the issues, a novel model using histogram equalization and region of interest is proposed. The novelty of using Histogram equalization (HE) technique increased the efficacy of the model. The simulation is performed in the MATLAB and the results successfully surpassed the existing system in terms of accuracy, missing report rate and false report rate.

KEYWORDS: HE, Image Processing, Plant Disease Detection, Region of Interest

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1. INTRODUCTION

Nearly 70 % population of India relies on agriculture to meet their basic needs. It has cultivated land. There is a huge range available for the farmers to select a variety of appropriate crops according to the climate and to choose the pesticides for plants accordingly. However, Farmers face difficulties while cultivating any crop in terms of plant diseases. The most terrifying situation is when the farmers have no idea about the disease and this gives rise to the considerable abatement in the quality as well as the quantity of the products based on agriculture. The diseases on the plants are recognized by discovering the observable patterns on the plants [1].

Advancements in the technology have developed a significant number of approaches to control the disease of the plants. Although, the conventional methods of agricultural management believed that crop fields have homogenous factors that induced that applications of pesticides and management of crop health are explicitly not same in regards with the predicament of current disease management. Taking into account that the diseases in the plants occurs due to certain environmental factors, It is witnessed that diseases often reveal heterogeneity with respect to the distribution in the fields and to determine the diseases of the plants in the initial phase, the approaches of optical sensing are proves to be effective[2]. In addition, the amalgamation of optical techniques with the advanced data analysis methods can be beneficial in targeting the programs for sustainable crop production [3].

However, the task of diagnosing the affected leaves by using optical observation is a very complex task. Because of such complexity in the mechanism for huge plant cultivation and their present phyto-pathological

challenges, even the professional plant pathologists and agronomists have attained failure to perform effectual diagnose of specific diseases which in turn results in the wrong conclusions. If the automated model for determining the plant disease diagnosis is designed, it would provide the professionals a better assistance to perform the diagnosis by using optical inspection of infected leaves [4]. The ease of accessibility of the model using mobile application may perhaps be proved as a significant contrivance for farmers where no proper infrastructure is available for provisioning of agronomic and phyto pathological counsel. Apart from this, cloud system could be integrated with automatic agricultural devices designed for large cultivation in order that the issues can be spotted o time and with accuracy by carrying out continuous image capturing. All this, naturally, is valid provided that, in a cultivation field, the system can achieve high performance in the detection, diagnostic and mobile application (an initiative taken towards that guided direction was prepared for the specific wheat case) [5], and can be operated through appropriate, simple and comprehensible mobile applications.

In recent years, computer systems have developed, and particularly GPU embedded processors, that resulted in explanatory growth in the development of new methodologies and models, that developed the Deep Learning [6]. In comparison to the “swallowers”, infrastructure of conventional methods of neural network, deep learning is the utilization of artificial neural network having a huge number of processing layers. In the current scenario, deep learning model has increased the attention in the different sectors such as image recognition [7], voice recognition, and different complex methodologies that cope with the scrutiny of the large data. The applications such as self-driving cars, machine translation, interpretation etc, are tremendously enhanced and utilize these processes. These profound teaching methods have only begun in recent years and in a relatively limited way in agriculture, especially in the field of diagnosis of plant diseases [8]. Deep learning and convolutional neural network is most used technologies in this field.

This paper presented a method to detect the infected leaves of mango trees that suffers from the diseases. Different works done by the researchers are studied and presented in the section 2 of the paper. Further, in the third section, the phases involved in the disease diagnosis using image processing are delineated. Section 4 and 5 presents the problem formulation and he proposed work along with its results defined. The main purpose of this paper is to ensure the efficacious performance of the proposed model to detect the plant diseases specifically of mango leaves.

2. LITERATURE SURVEY

This section delineates the research work that has been performed in the domain of image processing in terms of detecting the infected plants amongst all of them.

UdayPartap Singh et al. (2019) [9] proposed a model for the classifying fungal disease infected mango leaves and utilized a multi-layer convolution neural network (MCNN). In contrast with the other existing methods, the results anticipated greater classification precision of the proposed MCNN model.

Jagadeesh D. Pujari et al. (2013) [10] introduced Artificial Neural Network (ANN) and Support Vector Machine (SVM) to identify and classify different cereals like maize, wheat, and jowar infected with fungal disease. Different symptoms such as Leaf blight, powdery mildew, leaf spot, rust, and smut are taken into account to for their detection.

M. A. Khan et al., (2019) [11] developed a new scheme for the identifying and recognizing apple diseases. The preprocessing, spot segmentation and extraction and classification of features have been followed by three pipeline procedures that ensured the effectiveness of this model.

S. Kaur, et al., (2019) [12] scrutinized the findings of state-of-the-art technologies to classify strategies that appear to be working well across a variety of crops or crop groups. In this article. When the manuscript discovered a collection of suitable techniques, many areas of evaluation and the course for future research were highlighted.

Kavya RM et al. (2016) [13] carried out a literature survey of different methods available as in order to detect the diseases manually, a lot of time is consumed as it requires continuous monitoring leaves, stems of plants. This survey was performed with the aim of providing information about various techniques used for image processing to identify and detect the plant leaf and stem diseases.

K. Golhani, et al., (2018) [14] discussed advanced techniques available to the Neural Network (NN) to practice hyperspectral data for the detecting plant disease.

P. Lottes, et al., (2018) [15] suggested a new system for the classification of crop weeds, which relies on an encoder-decoder structure and includes spatial data through the consideration of picture sequences.

Ahmed Mahmoud Ismail et al. (2012) [16] performed a study of mango leaves collected during 2009 and 2010 and the diseases were analyzed in Italy. The analysis of performed in terms color, mycelium appearance, size, length, shape, count of apical and the basal appendages.

2.1. Research Gap

The aforementioned researches have show that a significant work has been done in the field of plant diseases detection and some limitation of the work raised the need to develop a new model. In recent years, deep learning (DL) was mostly used in agriculture and is widely accepted. This principle is important for the development, control, maintenance and enhancement of agricultural production. Following are some challenges faced during the working under the area of plant disease detection:

- Large number of variations under different types of plants and leaves.
- No such defined structure or shape associated with any infected leaf region.
- No such automated procedure or technique existed to detect the infected portion.
- Not very high recognition rates existed with current proposed solutions by different authors.

2.2. Present Work

Classification of the plant diseases using image segmentation has emerged as popular techniques. CNN is familiar deep learning model that is deployed in such techniques. The existing model for classifying diseased mango leaves comprised an intricate structure as there are number of layer for information processing. But as mentioned earlier, there are several pitfalls that raise the need for designing the novel model. Therefore, a novel model is anticipated for the classifying Mango leaves infected. The major aim of the developed model is to detect fungal disease known as Anthracnose. This architecture of the model is designed by keeping in mind the drawbacks. A new histogram equalization technique (MMBEBHE) is introduced that takes into account the contrast and brightness of the image.

Minimum mean brightness error bi-histogram equalization (MMBEBHE) is utilized in the proposed work as:

- It is responsible for preserving the image brightness.
- The noise in the image is removed.

- It performs better enhancement of the image.
- It is also capable of preserving the background colors of the image in a better way.

The second limitation will be resolved by removing the central square crop method and introducing region of interest (ROI). ROI extracts the essential information from the image by detecting the edges. It is the section of the image that is selected to be used in the operation or not.

In addition, on the images obtained in the original state, the validation of the effectiveness of proposed model is checked. The images from the dataset are preprocessed with the help of an HE approach that balances the invariability of real images. Then, the MCNN based ternary classification model is to be trained and tested for identifying the disease.

To start with, firstly, Image Acquisition is performed and its general purpose is to turn a Real World Data image into a numerical collection of data that can later be manipulated on a computer until a camera can start video or image processing and convert it into a controllable object [17]. For this a data set is utilized.

2.3. Data Set

Throughout all stages of object recognition research, suitable data sets are needed including training process till the performance assessment of recognition algorithms. For the work presented in this paper, plant village data set [18] is taken into consideration. In this data set, different images of the leaves of various plants are stored. The images are taken for both infected and non infected images. Some of the images demonstrated the multiple leaves in a single image. This data set assists in determining the performance of the model.

2.4. Preprocessing

Further, the next step is to perform is preprocessing. It is the procedure of capturing or generating digital image using image sensors. It is a simple process in which an image is selected from the dataset and the noise or other object removal from the image is performed. This stage involves preprocessing such as scaling. Image scaling is applied because it reduces the pixel size. So, it requires less time for further accessing [19]. The image is sent to the model for preprocessing, where the image is enhanced using image enhancement technique. MMBBHE is the histogram equalization model that is used to this end.

MMBEBHE Is Delineated as the Following Methods:

- Compute AMBE for every threshold level.
- Determine the level of threshold X_r .
- Further, separate the input histogram into two based on the X_y found in step 2 and equalized them independently as in BBHE

The image is enhanced in order that the required part to be processed can be highlighted. MMBBHE offers better enhancement of the images and the parts of the leaves are available to be seen. Thus, image segmentation is performed on the preprocessed image. It is the method to divide an image into its constituent's parts/segments. Segmentation is done to recognize the objects from an image. If it makes more accurate there will be successful recognition. So detected images are segmented by applying different techniques and output is used for next process i.e. feature extraction.

However, to achieve the effective output, one more technique is applied. There is a possibility that the images

may constitute of different or unnecessary objects that can eventually lead to false interpretation. Thus to avoid such consequences, region of interest is introduced which utilize only the affected part of the leaves.

ROI extracts the essential information from the image by detecting the edges. ROI is a process of automatic detection using segmentation techniques. The process of extracting the region of interest from the original image is demonstrated in figure 2. Each image is chosen and sent to the image processing model. Here, the image is first processed and further the image segmentation is applied on the processed image and eventually, ROI is fetched from the segmented image. The snapshot for image is taken to demonstrate the process of image processing. Figure 2 displays the process of pre-processing to the extraction of region of interest.

Figure 1 shows after this process, the feature selection of the segmented parts is performed. It is executed after the preprocessing phase of pattern recognition system. In pattern recognition process, a pattern is taken as an input and is classified as one of the output classes possible in most accurate way. Eventually the classification phase is the last phase in which convolution network is utilized.

Figure 1: Image processing of Different Mango Leaves.

2.5. Convolutional Neural Network

CNN are analogous to the Artificial neural network in which neurons receives input and operations are performed using non-linearity. It is the type of network used to process data in grid topology. The deep learning model used to solve complex pattern recognition and classification problems with large numbers of datasets is a CNN. A novel model is proposed in this research that comprises of four different layers such as convolutional, batch normalization and average pooling layers. The diagram of the model of CNN used in the proposed model is demonstrated in figure 3.

The convolution layer is similar to the feature extraction. The mathematical formulation is performed using matrix in this layer. Further, Rectified Linear Unit (ReLU) layer is applicable on the cells of the output matrix.

Figure 2 shows Further, The Pooling layer consists of extracting from a set of values, generally the maximum value or the average value of all the values, a certain value. The proposed work used average pooling and it reduces the spatial size to diminish the computation in the network.

Eventually, the last layer (fully connected) receives output from the above layer. It is responsible for performing the classification task. In other words, it will classify the disease on the processed images of mango leaves.

In order to process the images, the setup is designed in which different factors and parameters are utilized for convolution neural network. These parameters are recorded in a tabular form and represented in Table 1.

Figure 2: Structure of Proposed CNN.

Table 1: Training Setup

Sr. No.	Training Parameters	Values
1	Max Epochs	30
2	Initial Learn Rate	1e-3
3	Learn Rate Schedule	piecewise
4	Learn Rate Drop Factor	0.1
5	Learn Rate Drop Period	20
6	Shuffle	every-epoch
7	Plots	training-progress
8	Verbose	false

3. TRAINING AND TESTING

Training and testing of data set is executed in CNN. A certain ratio of images in data set is used for training and testing purpose, such as 80:20, 80% for training and remaining for testing. CNN training is the process of simultaneously predicting and finding the effects or errors via the model from the input layer to the output layer. If the forecast is incorrect, the reverse order is distributed back, e.g. from last layer to first layer.

During the complete process, all the remaining 20% images were untouched. Each image is provided as an input to the Multilayer Convolution Neural network model from the normalized training data set for the extraction of the features. This model is designed to predict the class mark of each training picture.

Further, the snapshot in Figure 4 represents the training process that shows RMSE and LOSS attained for training and validation process with respect to different iterations. The total number of iterations taken into account is 90. RMSE is

the root mean square error that basically computes the error of the model that predicts the quantitative data. RMSE is the standard that defines how effective the data is presented according to the line of best fit.

After performing all the operations of the proposed model, the results are obtained

Figure 3: Training Process of Designed Model.

4. RESULTS

The determination of the plant diseases at the initial stage may be helpful for the farmers to manage the productivity of the plants. The model utilized HE technique and region of interest (ROI) to achieve better results. Thus, this section discusses the outcome of the proposed model that is attained in the MATLAB environment.

The simulation of the model is carried out and the graphs are obtained that demonstrates the effectiveness of the model. The comparison with existing techniques is also performed. Three following parameters are taken into consideration for analysis.

- **Accuracy:** The accuracy of the model is computed using following equation:

$$\text{Accuracy} = \frac{\text{number of accurate classified data}}{\text{total data}} \times 100\%$$

- **Missing Report Rate:** is the attained because of the vulnerabilities present in the dataset used for disease detection.
- **False Report Rate:** as cleared from the name is the falsify data present in the dataset and may lead to wrong results.

4.1. Comparative Analysis

This section elaborates the comparison performed with the techniques using different algorithms such as PSO, SVM, RBFNN, and MCNN. Three different parameters are considered for comparing their performance with respect to different algorithms.

The results of proposed model (P-MCNN) are compared in terms of accuracy which is exemplified in Figure 4. The graph reveals that the accuracy for PSO is the minimum and that for proposed P-MCNN is the highest among all the existing techniques that constituted to 99.5 %. Accurateness of the results made P-MCNN, a better model to detect the diseases of the plant leaves.

The Missing Report rate (MRR) is also generated for the existing as well as proposed method of detecting the diseases of plant leaves. The bar graph in Figure 5 demonstrates the values achieved for the MRR. It is observed that the highest MSR is experienced by PSO based method and the minimum MSR is achieved for proposed P-MCNN approach. The minimum value accounted to 0.7 approximately and the highest MRR is more than 11. Less the MRR, more is the

stability and reliability of the model.

Eventually, the comparison of accuracy, False Report Rate (FRR) and Missing Report rate (MRR) is determined and presented on a single graph for easy evaluation of the proposed model. The graph is displayed in Figure 6 that demonstrates that each model has given better results as per the techniques used; however, the efficiency of every approach is different from each other. The close examination of the figure reveals that the proposed model (P-MCNN) is capable of achieving highest accuracy (99.5 %) and minimum MRR (0.5 %) and FRR (0) amongst all existing techniques. The corresponding values of other techniques are recorded in Table 2 and can be validated that the efficacy of the purposed model is batter and reliable.

Figure 4: Comparison of Accuracy with Existing Models.

Figure 5: Comparison of MRR with Existing Models.

Figure 6: Comparison of Different Parameters with Existing Models.

Table 2: Comparative Analysis of Proposed and Existing Approaches

Technique	Accuracy	Missing Report Rate	False Report Rate
PSO	88.39	11.61	9.83
SVM	92.75	7.25	4.98
RBFNN	94.2	5.8	0
MCNN	97.25	2.75	0
P-MCNN	99.5	0.5	0

5. CONCLUSIONS

Image processing is one of the most preferred techniques to be used in the medical field. Plant diseases are the main concerns of reduced agricultural production. Mango leaves suffer from a fungal disease that affects its production. This paper discussed the different techniques designed to this end and observed the limitation of those techniques. Thus, a novel method using MMBEB histogram equalization technique and the image processing approach, the infected mango leaves are detected through their images. Region of interest is extracted that assists in detecting the disease effectively. The results showed that the proposed P-MCNN model is capable of minimizing MRR and FRR. The proposed model outperformed the existing techniques by achieving highest accuracy in detecting the plant leaves diseases.

However, In future, the enhancements can be made in determining the mango leaves diseased by classifying the different types of the fruit and the diseases such as fungal, bacterial or viral diseases. This would enhance the system performance and efficaciousness.

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