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A CNN-LBP IMAGE MODELING AND CLASSIFICATION SCHEME FOR MANGO LEAF DISEASE DETECTION

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Abstract: - One of the major threats to the global economy of food is caused by various diseases in plants. These diseases affect the quality as well as the quantity of the fruits, vegetables and so on that has a direct influence on efficiency which in turn is reflected by huge prices. There is a need of recognizing these diseases at early stages so that the productivity and quality of the fruits, vegetables etc. are not degraded. From the literature survey conducted, it is analyzed that the various methods such as ANN, SVM, CNN etc. were already proposed in order to detect the plant disease at early stages. However, most of the techniques are facing issue for only focusing on the contrast enhancement and not improving the content quality which in turn affects the performance of feature extraction models that do not retrieve enough features from the images. Thus, to overcome the limitations of the traditional methods, a novel approach is proposed that utilize Kuwahara filter for edge enhancement with histogram equalization to improve the quality and contrast of the image. Furthermore, to extract important features LBP feature extraction technique is implemented to get pattered information for MCNN classifier to get trained and provide accurate results. The simulation of the proposed work is performed in MATLAB environment and the results are achieved for accuracy, missing report rate and false report rate. The simulation outcomes demonstrate the high efficiency of the proposed model in terms of the accuracy, missing report rate and false report rate.

Keywords: - Agriculture application, plant disease detection, artificial intelligence, computer vision, segmentation, etc.

1. INTRODUCTION

The agricultural industry is one of the influential sectors, with sales and escalation measured on the basis of the agricultural industry in different countries. With the increasing demands of the farming industry, better structures should be implemented to ensure higher production efficiency [1]. In the lower output of agricultural industries, the most impactful element was seed and plant malfunctions and deprivations, which contributed to a rise in total losses [2]. The increased occurrence of virus, fugal mosquitoes, microbes, and pathogens has contributed to increased diseases in plants [3]. Other causes, such as climate change and temperature variation, also influence and contribute to plant disease escalation. When plant infection has been identified, it affects different plant segments and reduces growth of vegetables and fruit [4].

Plant Disease

A plant disease influences the function and appearance of the plants. It influences the role or function of the whole plant of a specific plant segment. The quality and development of plants is also influenced by plant diseases. Any condition affecting some parameter of the work of the plant, such as growth, quality and economic value, is called a plant disease. The symptoms of these diseases are taken as every original, observable parameter of diseases. Any alteration in the form, colors or functional development of any disease-causing agents in the parameter is known to be the symptom of that cause. These signs help to classify the disease of the plant. Any plant disease sign specifically shows the existence of pathogens.

Different plant diseases:

Plant diseases are often caused by abiotic environmental factors such as deforestation, food shortages and environmental toxicity or biotic factors such as virus, fungus and bacteria. The view of the plant provides an influential suspicion and descriptions of the disease-causing pathogens. Some of the major plant diseases are described below:

Fungal Diseases: The primary risk of fungal-related diseases in the plant is largely due to fungal infections. There may be single or several cells of fungi that increase the tissues and draw nutrients out of plants to induce the infection. The most prevalent pathogens found in plants are fungal-based diseases.

Symptoms of Fungal disease:

- Birds-eye spot on berries (anthracnose)
- Damping off of seedlings (phytophthora)
- Brown spots on the Leaves
- Yellowish leaves

Bacterial Diseases: The infection caused by bacteria is most frequently found on fruits and leaves. The spots are mostly located in the leaf veins and on all the leaves, such as fungal ones [5].

Symptoms of diseases caused due to bacteria:

- Spots on Leaves

- Wrinkled leaves
- Spots on Fruits
- Crooks on the Woody plants

Viral Diseases: Viruses are infectious small particles and not microscopically easy to detect. They enter the host cells and hijack the mechanism with vast amounts of repeat particles.

Symptoms of Viral Disease
- Mosaic Pattern observed on leaf
- Wrinkle on leaves
- Yellow spots on leaves
- Plant stunting

Anthracnose in mango leaves
In complimentary climate conditions extreme loss of shoots, fruit and flowers can occur. Because of this disorder different signs are found such as blight flora, leaf spots and fruit rots. These ailments dramatically influence the bidding of the new divisions and rot. It also infects the old divisions that can die under the worst circumstances. In certain cases, the entire inflorescence dies due to the infection which leads to poor conditions for fruit development. The fruit that is infected early in the process falls out of the branches after the creation of black spots in the fruit. In later stages, the infected fruit was transported to storage by the infection which further leads to high probabilities of infection in the storage facility and greater loss in stockpiling and storage. The Anthracnose disease in mango leaves is usually caused by frequent rains that increases the chances of development of the fungal diseases and can easily grow in normal temperature range of 24-32 degrees. Fig.1. shows the mango leaves infected with the Anthracnose diseases [6].

Fig.1 Anthracnose Disease on mango leaves

Disease symptoms
- Due to the disease, huge losses are faced related to young shoots, fruits, and flowers and also cause problem in the fruit storage.
- Fragile and new shoots are highly in risk that cans even leads to the death of the new branches. Whereas the old shoots face the risk through different wounds.
- These diseases highly affect the tender shoots and decay the new branches. It also infects the old twigs which may die in worst conditions.

Control
The tainted trees and the leaves must be charred. Carbendazirn spray (Bavistin 0.1%) was sufficient to manage infection in a span of fifteen days. In addition, spray of copper (0.3 percent) was also advised to contain the foliar infection. In order to overcome these diseases in plants, various techniques were proposed by a number of researchers which are described in the literature survey section.

2. LITERATURE SURVEY

A lot of researches have been done to detect the disease in plant leaves, vegetables or fruits using digital imaging technology. Among them, some of the works are analyzed here; Mia, et al. [7], presented an ensemble of neural networks (NNE) for the detection of mango leaf diseases, helping to identify diseases better than typical systems easily and accurately. This study sought to classify the diseases of mango leaves using a master learning method which controls various leaf symptoms. UdayPratap Singh, et al. [8], suggested a Multi-layer convolutionary neural network (MCNN) for the classification of mango leaves afflicted with Anthracnose fungal disease. K. Golhani, et al. [9], proposed an advanced strategy for the analysis of hyper-spectral data were explored in the neural network (NN) with special focus on plant disease identification. AnandSwaroop, et al. [10], outlined and illustrated the numerous benefits of mangiferin and mango leaf extract for human health and disease prevention. S. Arivazhagan and S.VinethLigi [11], proposed a deep learning approach to automating the identification of leaf diseases in mango plants. Five separate leaf disorders such as the leaves of Anthracnose, Alternaria, Leaf Gall, Leaf Webber and Leaf Mango Burn were found in a data series. Vijai Singh and A.K.Misr [12], provides an algorithm for image segmentation strategies for the automated recognition and classification of plant leaf conditions. It also contains surveys of various disease recognition methods that may be used for the identification of plant leaves. The separation of images is rendered through the use of genetic algorithms, a major factor in plant disease detection. Srunitha K. and Bharathi D. [13], proposed the unhealthy area of the mango blades is defined and measured. Multiclass SVM is used in the proposed analysis to identify and segment diseases by k-means. Adl, Ammar &Elaraby,Mohamed [14], investigated the detection mechanism through machine learning and in-depth learning by using Linear SVC, Conv Net. To observe mango conditions, including Algal Leaf Blot, Powderous Mildew, Sooty Mold, and Anthracnose. Sethupathy, Jayaprakash&Veni, S. [15], classify and recognize diseases of mango leaves for Indian agriculture. A k-means algorithm was selected and an SVM grouping and distinguishing illnesses was made for the segmentation of the disease. Bed Prakash1Amit Yarded [16], proposed a scheme using K-mean classification techniques and a Back Propagation Neural Network Mango Leaf Classification (MPCN) technique (BPNN). Jagadeesh et al. [17], presented a technology and Classification Segmentation Methodology to classify a stable and anthracnose mango, grape and pomegranate disease. If the fruit and the proportion of anthracic disease areas affected are determined, clustering techniques for the separation of anthracic diseases are used for a threshold, rising area and k-means.

From the literature survey it is analyzed that a number of deep learning methods were proposed by various researchers in order to develop automated models that empower accurate and timely identification of the plant leaves disease. Among these, CNN is one of the most popularly deployed deep learning models but the problem with the conventional CNN methods is its inefficiency. Other than this few researches were on basis of the enhancement of the images in preprocessing phases, but such approaches also face few drawbacks as it only enhanced the contrast of the image and not its quality. Furthermore, from study conducted, it is observed that in some approaches no feature extraction technique has been applied while performing analysis of complex data. As, analysis with a large number of variables generally requires a large amount of memory and computation power; that may cause a classification algorithm to overfit to training samples and generalize poorly to new samples. Inspired from these findings an efficient model is proposed in this paper that will overcome the problems related to the feature extraction techniques as well as provide a system that will resolve all the concerns related to the traditional models. The detailed description of the proposed scheme is given in the next section.

3. PROPOSED WORK

In order to overcome the drawbacks of conventional approaches, this paper proposes an efficient model that enhances the quality as well as the contrast in the image. For this purpose, Edge enhancement image processing filter namely Kuwahara filter along with the contrast enhancement technique is used that not only enhanced the contrast of an image but also improve its acutance and quality. The edge enhancement filter enhances the local discontinuities at the boundaries of different objects (edges) in the image. In addition to this, LBP feature extraction algorithm is used in the proposed approach to make the system more accurate as it provides efficient storage, communication and retrieval. Finally, an advanced variant of conventional neural networks that is Multilayer CNN is used for the classification purpose. The flow chart of the proposed model is shown below in fig.2.

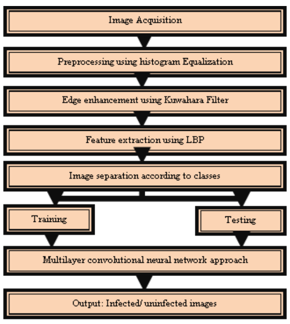

Fig.2 Flowchart of the proposed Model

The first and the far most step-in proposed system is image acquisition in which images of the leaves are selected and captured from the dataset. After the images are obtained, preprocessing starts which is done by Histogram equalization. In the next phase, edge enhancement technique using Kuwahara filter is applied to enhance the contrast and quality of the image. Furthermore, a feature extraction technique namely Local Binary pattern (LBP) is used to analyze and extract features from the processed images. The images are then categorized into two categories for training and testing purpose. The data is given to the MCNN for training purpose then the model is tested and an output is obtained. Fig.3 shows the leaf images at different stages in the proposed system.

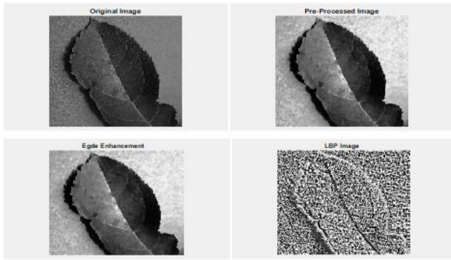

Fig.3 leaf images at different stages in the proposed MCNN method

In fig.3, the first image represents the original leaf image which is later on processed using Histogram equalization. The next image depicts the image of leave when edge enhancement using Kuwahara filter is applied and finally the LBP technique is used to extract the features from the images as shown in the figure. The performance of the proposed advanced variant MCNN is then analyzed and compared to the previously proposed models in terms of accuracy and missing report rate which are discussed in the next section.

4. RESULTS AND DISCUSSIONS

The proposed advanced Multi-layer model was tested and analyzed in the MATLAB software in terms of accuracy and the missing report rate. The simulation results obtained are then analyzed and compared with the traditional methods and are discussed in this chapter.

Performance evaluation

The performance of the proposed improved MCNN was analyzed in terms of accuracy. Fig.4 shows the comparative analysis of the proposed system with the traditional PSO, SVM and RBFN systems.

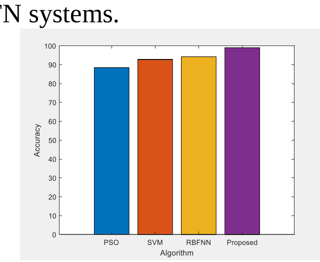

Fig.4 Comparison of the proposed and traditional models in terms of Accuracy

The blue bar represents the performance analysis of PSO model, while as the orange and yellow bars represent the performance of SVM and RBFNN traditional models in terms of accuracy. The performance of the proposed model is depicted by the purple bar as shown in Fig.4. After analyzing the graph, it is observed that the accuracy of the proposed model more i.e. around 99%, thus proving the efficiency of the proposed model.

In addition to this the proposed model was also analyzed and compared to the previously proposed models such as PSO, SVM etc. in terms of missing report rate. The simulation results are shown in fig.5.

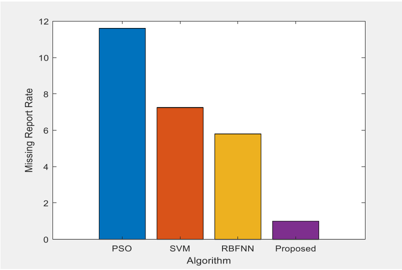

Fig.5 Missing report rate of proposed and traditional models

The missing in any model should be as less as possible, as the missing rate of missing reports is inversely proportional to the efficiency of the model that means if the missing report rate is lesser, higher will be the efficacy of the model and vice-versa. After analyzing the simulation results, it is observed that the missing report rate in the proposed model is very less i.e. around 1 while as the missing report rate in previous models such as PSO, SVM and RBFNN is around 11.8, 7 and 5.8 respectively. Thus, the proposed model is highly efficient as compare to previous methods. Fig.6 represents the overall performance of the proposed system and the traditional systems in terms of various parameters such as accuracy, missing report rate and false report rates. The blue bars in the given graph represent the performance of the models in terms of accuracy while as the missing report rate and false report rates are depicted through the orange and yellow bars respectively.

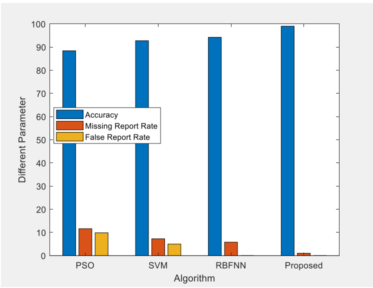

Fig.6 Overall comparison of all the parameters

From the figure, it is observed that the proposed advanced MCNN model outperforms the traditional PSO, SVM and RBFNN models in terms of all the three parameters (accuracy, missing report rate and false report rate). The accuracy in the proposed system is high while as the missing report rate and the false report rate is almost negligible. The simulation results prove that the proposed model is highly efficient, stable and reliable.

5. CONCLUSION

A number of diseases can affect the plant which reduces the production as well as the quality of the fruits, vegetables etc. In order to detect and analyze these diseases at early stages various image processing methods were already proposed by various researchers. The problem with the existing methods was poor visibility of sharp-edged pictures, retention of enhanced pictures etc. As image enhancement is very important component in the image processing to determine the diseases at early stages. This paper presented a novel technique that is based on histogram equalization and Kuwahara filter to enhance the contrast and the edges of the images that might get blurred due to noise or other reasons. Along with this, LBP feature extraction technique is applied for extraction of important features. The proposed MCNN model is simulated and tested in the MATLAB software in terms of three important parameters (accuracy, missing report rate and false report rate). The simulation results demonstrate that the proposed model is capable of detecting the mango leaves diseases with high accuracy and low false report rate and missing report rate. Thus, it is observed from output that proposed model gives 99% accurate results that in turn outperformed the traditional methods.

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