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GLCM and LSTM Recurrent Neural Networks Integrated with Machine Learning Techniques to Identify Plant Disease

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***Abstract:** Plant diseases are very impactful towards the overall effectiveness and quality management of the agricultural sector. In recent years, deep learning methods have been used as a way to identify these diseases, based on neural networks. The study presents GLCM and LSTM Recurrent Neural Networks Integrated with Machine Learning towards the identification of plant diseases. It has been found that the process is very accurate and can assess diverse plants disease characteristics dataset as well.*

***Keywords:** GLCM and LSTM System, Deep Learning, RNN, Plant Disease Identification*

I. INTRODUCTION

Plant diseases are a major threat for the entire agriculture segment, as it can impact the quality of crops and cause health complications. Furthermore, plant diseases impact the overall revenue coming from the plants, resulting in severe complications for the process. As a common method of identifying the plant diseases, plant pathologists use different forms of ecological or molecular methods, resulting in an identification of different parameters. As mentioned by [1], factors such as transpiration rate changes, morphological changes and volatile organic compound changes can provide an idea of the plant disease spread rate. On the other hand, it is considered as a costly and time consuming process, and gathering expert evaluation is often difficult. In recent years, deep learning has gathered enough success in classifying the various plant diseases. In this study, the implementation of GLCM and LSTM neural network, along with machine learning techniques. The study aims to assess a deeper evaluation of these systems, towards the plant science applications segment. Over 10% of the global food production is affected because of plant diseases. The rationale of the paper is to support the segment, with the help of proper detection strategies.

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II. RELATED WORK

The paper provides a technique for plant leaf disease detection, paired with deep learning and GLCM and LSTM techniques. Using a digital image based processing model, the overall costs associated with the process can be decreased a lot. Furthermore, a huge set of image based diagnosis methods has resulted in a proper and effective practical detailing process, and the costs are also reduced [2]. On the other hand, the information stream is heavily condensed in these images, resulting in difficulties to process the images properly.

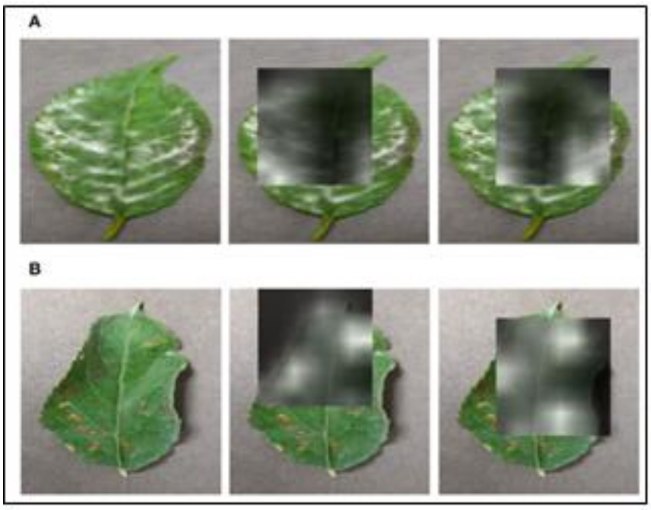

Figure 1: Attention Maps using Deep Learning

(Source: [3])

In these types of situations, the deep learning process is used as a way to learn the plant disease based diagnosis in an automated manner. Models with a proper deep learning algorithm have the potential to deliver up to 99% accurate results. Since then, multiple applications of deep learning based plant disease identification have been observed. Convolution neural networks or CNNs are some of the most widely used networks used for the purpose of image recognition. As mentioned by [3], the large scale CNNs became trainable over the years, exceeding the qualities of the traditional machine learning approaches. In both the GLCM and LSTM networks, convolution layers can be observed. These are the sets of image filters that are convoluted with the other feature maps and images. Therefore, specific training datasets can also be used towards the process, as a way to classify the different plant based diseases.

The CNNs are mostly very effective towards the machine learning implementation process, but there are also chances of the machine learning irrelevant disease characteristics [4]. These mostly originate from neuron activations, resulting in background noise caught by the system. These types of factors can impact the overall success of the process.

III. PROPOSED METHOD

A recurrent neural network can be presented as a form of neural networks that aims to get node connections using a sequence of variables. With the help of these recurrent connections, a Marko chain like structure can be presented. This is why a RNN based approach is selected here as the most applicable process. An improved RNN model based on the LSTMs and GLCM is presented here. The model will enable training long sequences, mitigating the challenges such as vanishing gradients. Therefore, an RNN architecture based on the GRU will be an effective option to produce different images of plant observations. Along with that, LSTM can also be used to fine grain classified images.

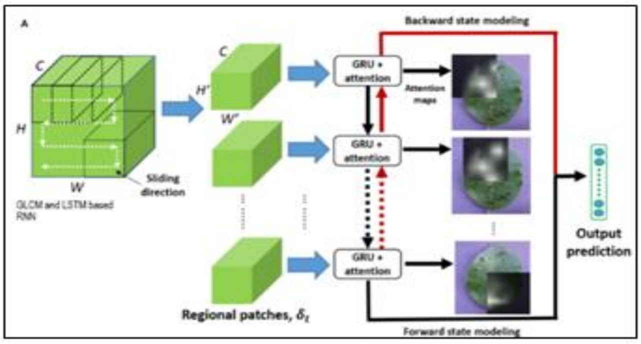

Figure 2: Proposed model

(Source: Self developed)

The attention mechanism mentioned earlier is used to focus on the spatial structures that are absorbed within the images, resulting in detailed instance segmentation. In the proposed model, the RNN is combined with a specific attention mechanism. Common disease characteristics, such as the silent path disease characteristics are used to enhance the overall quality of the model. All forms of activations are captured in the form of smaller images that are also used as a new convolution layer. As an outcome of the process, specific disease characteristics can be identified easily.

IV. ARCHITECTURE OF THE SYSTEM

A specific plant disease image is fed to the system, and it is termed as I. Along with that, the corresponding feature maps are extracted using the CNN convolution layers and is presented as $s\ \delta\ \varepsilon\ R^{H\times W\times C}$, where H denotes height, W denotes weight and C denotes the total number of channels present in the selected feature maps. The model is trained at an early stage of the process and the entire optimization is done on the basis of targeted plant disease classes. The global feature is sliced and rendered, providing us with T regional feature maps, namely $\{\delta 1, \delta 2, \cdot\ \cdot, \delta T\}$. The resulting set of sequence maps are used towards the proposed deep learning model. This also provides the model with an adaptation optimization factor, and can be used for detecting various types of plant diseases. Furthermore, the model will easily learn the various visual patterns that are present in the process, and the overall spatial process observed within it. This model will specifically focus on the relative contribution that has been observed across the different pixels.

V. RESULTS

Table 1: Comparison of accuracy using model

Method	PV-SC	PV-UCB	IPM-SC	Bing-SC
CNN InceptionV3 of Brahimi et al. (2018)	98.05	29.63	29.06	28.57
Our CNN (GoogleNet)	**99.17**	18.98	37.61	36.51
Our new model Seq-RNN	98.17	**58.80**	**40.17**	**39.68**

(Source: Self developed)

The experimental results observed within the table above indicate the PV, IPM and Bing values from the model. The model is tested using only the scene crop images, and the critique is on the basis of Inception V3 model [5]. It is considered as one of the best approaches towards plant disease identification using a specific dataset. In this regard, 21 target classes have been included in the training set. The process starts from evaluating the accuracy of the PV-SC test set model. It has been observed that deep learning based models have been able to record high accuracy values. The images of this test set were acquired in similar conditions of the test segment, resulting in an overall process efficiency. Mainly for the Bing and IPM based test sets, low accuracy values have been observed. This is mainly because of the changes that are observed in the data distributions segments, due to their collection in different conditions. It is necessary to make some changes in the dataset, as a way to handle the difficult datasets. These models are resulting in difficulties in generalizing the images that are acquired from a different domain. The overall comparison of the models indicate that GLCM and LSTM based networks are far more accurate, then the conventional deep learning networks. This is mainly because of the presence of the varying and adaptive parameters that can be used as a way to address the variations in the datasets. Further comparison of the generalization ability of the model indicates that the strong neuron activation networks do not contribute towards the visual pattern characteristics. In some cases, the activation spots match the disease spots that can cause complications. These types of similar visualizations need to be addressed in an effective manner, focusing on specific spots in the images.

VI. CONCLUSION

The findings of the paper clearly indicate that integration of the proposed GLCM and LSTM based recurrent neural network and machine learning techniques. Designing the deep learning architectures through this process, results in a better classification performance of the system. Along with that, both global and local representation and the activation spots can be identified easily. All these factors are observed within the deep end-to-end network that provides better visual representations.

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Alongside that, any type of complementary RNN approaches should be conducted on the basis of field agricultural actors.

FUTURE WORK

The study can be used as a viable tool to gather new perspectives related to automated classification processes and plant disease identification. Furthermore, the future work should focus on establishing a diversified visual dataset, containing all the symptoms observed on a global scale. It will also provide better insights regarding actual information detection through the machine learning approach. Integration of the proposed architecture towards the proposed model is more likely to provide better classification performance, along with better recognition of the plant diseases. Future studies should aim to conduct complex statistical analysis related to the de facto paradigm observed within the study.

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