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Mulberry Leaf Disease Detection using Deep Learning

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Abstract: ***Disease diagnosis and classification in a mulberry plant using deep learning is an interesting technique which can be useful for farmers and researchers to identify and classify diseases. It helps to manage plant pathogens within fields effectively and automatically at a minimal cost. Major mulberry diseases usually express their symptoms on leaf area at the early stage of infection. Infections can be analysed and classified by processing the image using a computer or machine using different algorithms to interpret the information. This paper gives us a brief knowledge of mulberry leaf diseases which is used for automatic detection of disease. It presents in detail that the algorithm and techniques which are involved in classification based on different criteria for image segmentation. Our goal is to develop a more suitable deep algorithm for our task. These convolutional layers are mostly used for image processing. The system identifies and classify mulberry leaf diseases effectively with complex scenarios from the affected areas using CNN.***

Keywords: ***Mulberry diseases, Convolutional neural network, Leaf Spots, Powdery Mildew.***

I. INTRODUCTION

Agriculture is more than a feeding source in today's world. Indian economy highly depends on productivity. The use of pesticides and chemicals to increase productivity has very harmful effects on the soil, water and air. The plants such as mulberry involve a high risk of crop failure. These are very expensive for production, so needs to be taken care of very well. The right amount of fertilizers and pesticides should be added to prevent harmful effects. It is generally cultivated in the Middle Eastern part of the world, Southern parts of Europe and the Indian subcontinent. Silkworm feeds only on mulberry leaves. Only fresh mulberry leaves should be fed as silkworms do not drink water, so all moisture is provided to them by leaves. The early detection is necessary to prevent more infection, also bad will leaves will cause plant disease and the fruit production will be affected. Organic farming is the solution for these problems which involves pest control as well as disease control [1,14]. The classical approach for disease detection is through naked eye observation of the mulberry plants.

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It involves expert observation and continuous monitoring. On large scale, team of experts are required, which costs very high for us. In many countries, farmers do not have proper facilities, also they do not even have idea to contact the experts. Automatic detection of diseases by identifying their symptoms of the plant leaves is easier and cheaper. Machine vison and detection provides more accuracy compared traditional system. Deep learning is modern technique used for data analysis, image segmentation and image processing technique in recent times. It can be applied in various domain and now being used in agriculture as well. Convolutional Neural Network (CNN) is used for image processing. The early detection could help silk producers and farmers to detect the disease which could be valuable for plant growth as only fresh leaves are consumed by silkworms [2,8]. The project done is to classify the type of disease caused in the mulberry plan leaves. This would help the farmer to take prerequisite measures steps for the prevention of the disease from spreading more in the plant. Mulberry leaf is very essential as it provides various products like silk, tea(very good for health). The leaf of the mulberry plant is also used in the production of various types of cosmetic products for both men and women. Though mulberry cultivation is practiced in diverse climates and weather conditions, the major region of cultivation falls in the tropical zone of India covering the states of Andhra Pradesh, Karnataka and Tamil Nadu, which ranges to about 90% of the total growth. The states lying in sub topical region of India such as West Bengal, Himachal Pradesh and some states of the north-east have major regions spared for mulberry cultivation. This proves many people (farmers) are dependent on the production of cultivation of the mulberry plants. I hope our project if ever implemented in real life will help the farmers to prevent their losses. Using the CNN algorithm, we have performed the layer classification of the disease-induced leaf.

II. MULBERRY LEAF DISEASE

"Leaf Spots" (fungi – "Cercospora moricola", "C. missouriensis" and "Cercosporella spp"):

1)In the rainy season the leaf of the mulberry plants are generally effected by fungi which can lead to defoliation of the older trees.

2)Pre-treatment of the specimen should be done using antifungal pesticide.

Symptoms:

1)Formation of Irregular leaf spots or brown circular rings are formed in the initial stage followed by spot enlargement, coalesce and formation of shot hole in the later stage.

2)Extremely affected leaves become pale yellow in

colour and fall off prematurely.

Fig 1: Leaf Spot

"Powdery mildew" :(fungi – "Phyllactinia corylea" and "Uncinula geniculate"):

1)White patches occur on the leaf and which gradually gets increased as it gets affected by Phyllactinia corylea.

Symptoms:

1)Initially, white powdered patches are observed on the lower surface of leaves which eventually spread over the entire leaf surface.

2)Later turn black to brown in color.

3)Infected leaves turn yellow and fall off.

Fig 2: Powdery Mildew

III. RELATED WORKS

Some of the already present ideas on image processing and leaf disease detection are taken for the reference purpose.

Vijay Singh/AK Mishra [1] presents generic algorithm for Image segmentation using soft computing techniques. The image of the leaf is taken and then converted into greyscale image. Using texture feature including contrast, local homogeneity, cluster shades are also used. For image classification, SVM classifier and minimum distance criterion is used.

Paper [2] presents disease classification using RCNN and R-FCN methods. The data collection is done by taking pictures and then image is preprocessed using image annotation and augmentation. Image analysis is done using multiple extractor. For experimentation dataset is divided into testing, training and validation sets. System can classify the diseases using algorithm.

Paper [3] presents the image segmentation including all existing factors using the HSI color system, here H component is used to segment spots and to reduce illumination. The regions with disease spot segmented using Sobel operator. Disease is finally graded by the calculation of leaf spots.

Sanjay B. Patil et al. [4] presents thresholding methods. The triangle and simple threshold techniques are used to segregate the affected region and leaf segment area respectively. In the final step, the disease is classified using quotient calculation of leaf and lesion area. According to this research, this method is fast and calculation of leaf disease severity is accurate, here leaf area is calculated by using threshold segmentation.

Author [5] presents PNN algorithm to classify the diseases using radial basis layer and competitive layer. The leaf image is pre-processed, and greyscale conversion is done. Network training is done using large number of datasets to improve the results. The pieces of leaves are tested, some sample got low accuracy. The system can recognise different types of leaves.

In paper [6], author presents disease detection technique in apple (Malus domestica) using k-mean clustering and Bayes classifier. Texture segmentation is done by using co-occurrence matrix and k-mean clustering. PCA analysis is done and by using Bayes classifier system can detect disease.

Paper [7] presents disease detection using k-means clustering and multi SVM algorithm. Feature extraction and statistical features by GLCM formula. Different statistical features energy, sum entropy, covariance, information measure, entropy contrast. The system can detect the disease with less accuracy.

Author [8] describes about the fungus Myrothecium verrucaria and its effects on mulberry leaves. Fugus grew normally between 5°C and 35°C. The colony diameter was found to be 50mm at optimum temperature after 6 days. The author gives methods to protect leaves from infection.

Author [9] presents image thresholding techniques and its performance evaluation. Point dependent thresholding

techniques includes p-tile method,
mode method, Otsu method, Histogram concavity analysis, entropic method and minimum error method. Region dependent techniques Include histogram transformation, secondary level grey scale statistics, Deravi and pal method, local thresholding, multi thresholding methods has been analysed. Ostu, Johannsen & Bille and moment-are better threshold selection methods region uniformity and shape measure. Otsu method is better than other methods.
Paper [10] presents disease classification using plant texture features. First, colour transformation for RGB input image is generated. Then green pixel masking and removal is done using threshold value, finally classification is done using SVM classifier.
The author [11] presents image segmentation techniques to do a comparative study between Edgebased, thresholding k-means clustering and regionbased extraction. after image enhancement, the extracted objects are compared with the mean weighted distance of the object with the original image. Correlation between objects are matched in two images, it is done to measure the similarity between the objects. PCA algorithm is used and the objects are aligned to take account of different orientations. The paper shows us that k-mean clustering is better than other approaches.
The paper [12] presents fruit disease detection using color and texture by using artificial neural networks. The author presents a system to detect and classify diseases using k-means clustering. Multiple samples were taken and using an algorithm, the system classifies the fruit and diseases. First, image acquisition is done to remove the consequence of hardware which was used to fabricate, image is segmented. Finally, feature extraction is done and then the image is matched with the training dataset for pattern classification.
The author [13] presents disease detection in groundnut using Back Propagation Algorithm. Colour renovation is done an RGB image is formed for colour generation and description. RGB image is converted into HSV. Feature extraction is done and then using algorithm disease detection is done.
The author in [14] reference uses the process of converting the carbon copy of the leaf mage into a negative image .Then fragmenting the analysed carbon copy and then removal of the components in the fragments.
All the above-mentioned papers have been thoroughly studied. These papers gave a lot of description about the chosen topic and the basic foundation concept for this paper stands on the bits of references we observed.

IV. PROPOSED SYSTEM

The invention of the CNN in 1994 by Yann LeCun is what propelled the field of Artificial Intelligence and Deep learning to its former glory. The first neural network named LeNet5 had a very less validation accuracy of 42% since then we have come a long way in this field. Nowadays almost every giant technology firms rely on CNN for more efficient performance.
The idea to detect diseases in mulberry leaf incorporates the use of CNN before we dive into the "functionality and working of CNN" concept, we must have a basic idea on how the human brain recognizes an object in spite of its varying attributes from one another. Our brain has a complex layer of neurons ,each layer holds some information about the object and all the features of the object are extracted by the neurons and stored in our memory, next time when we see the same object the brain matches the stored features to recognize the object, but one can easily mistake it as a simple "IF-THEN" function, yes it is to some extent but it has an extra feature that gives it an edge over other algorithms that is Self-Learning, although it cannot match a human brain but still it can give it a tough competition .
Image is processed using the Basic CNN to detect the diseases in leaves. The data training in our CNN model has to satisfy following constraints:
1) There should be no missing values in our dataset.
2) The dataset must distinctly be divided into training and testing sets, either the training or the testing set shouldn't contain any irrelevant data out of our model domain in case of an image dataset all the images must be of the same size, one uneven distribution of image size in our dataset can decrease the efficiency of our neural network.
3) The images should be converted into black and white format before feeding it into the convolution layer because reading images in RGB would involve a 3-D numPy matrix which will reduce the execution time of our model by a considerable amount.
4) Any kind of corrupted or blurred images should also be trimmed from the database before feeding it into the neural network .
Now we have learned the data pre-processing rules, let us dive right into the working of the convolutional neural network.

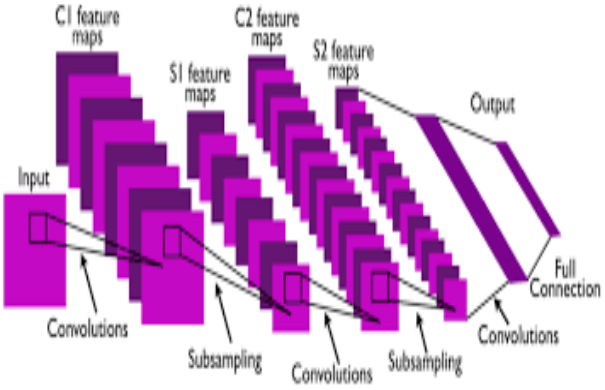

Fig 3: CNN layers

A. Convolution layer

This layer involves scanning the whole image for patterns and formulating it in the form of a 3x3 matrix. This convolved feature matrix of the image is known as **Kernel.** Each value in the kernel is known as weight vector.

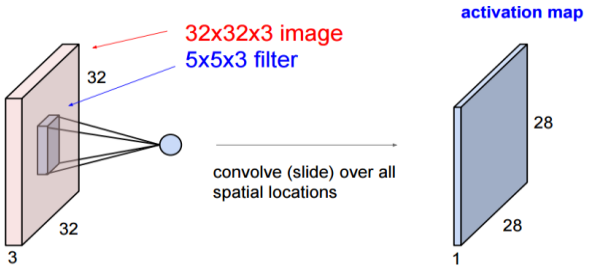

Fig 4: Convolution layer

B. Pooling layer

After the convolution comes to the pooling here the image matrix is broken down into the sets of 4 rectangular segments which are non-overlapping. There are two types of pooling, Max pooling and average pooling. Max pooling gives the maximum value in the relative matrix region which is taken. Average pooling gives the average value in the relative matrix region. The main advantage of the pooling layer is that it increases computer performance and decreases over-fitting chances.

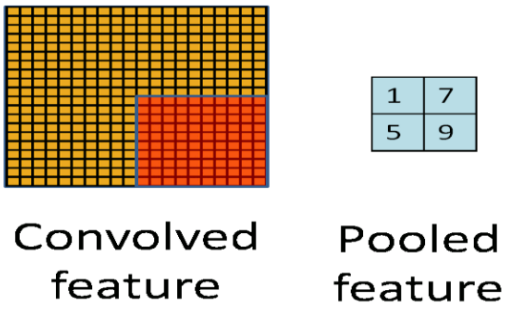

Fig 5: Pooling layer

C. Activation layer

It the part of the Convolutional Neural Networks where the values are Normalized that is, they are fitted in a certain range. The used convolutional function is ReLU which allows only the positive values and then rejects the negative values. It is the function of low computational cost.

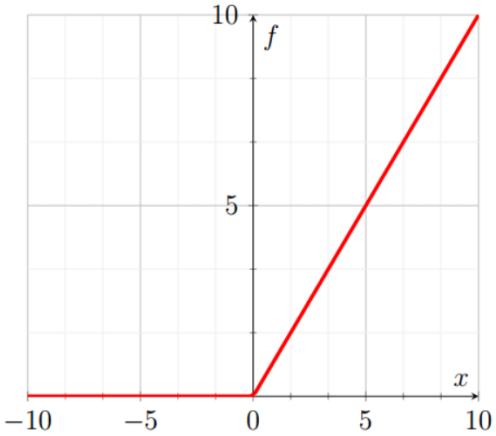

Fig 6: ReLU function

D. Fully connected layer

Here the features are compared with the features of the test image and associate similar features with the specified label. Generally, labels are encoded in the form of numbers for the computational ease, they will be later converted into their respective strings.

V. SYSTEM ARCHITECTURE

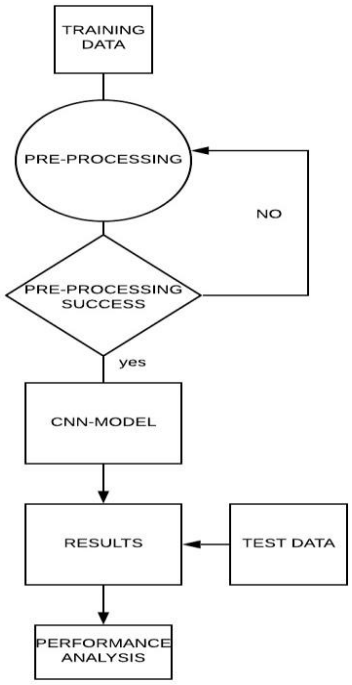

Fig 7: Proposed System Architecture

VI. GRAPHICAL OUTPUT

Fig 8: Performance analysis 1

Fig 9: Performance analysis 2

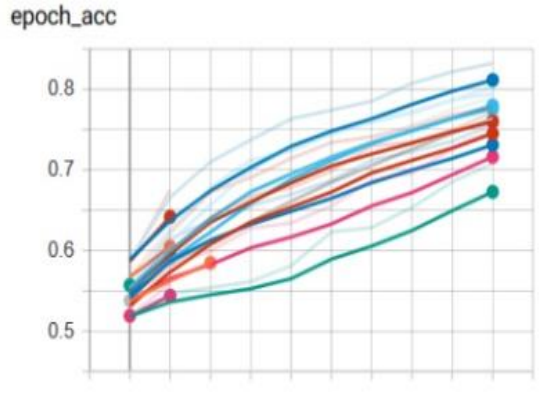

Fig 10: Performance analysis 3

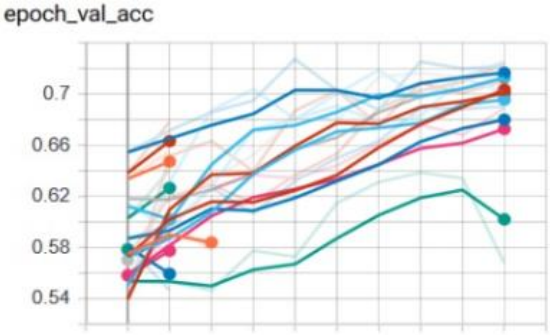

Fig 11: Performance analysis 4

VII. CONCLUSION

The project done is to classify the type of disease caused by the mulberry plant. This would help the farmer to take prior steps for the prevention of the disease from spreading more in the plant. Mulberry leaf is very essential as it provides various products like silk, tea (very good for health). The leaf of the mulberry plant is also used in the production of various types of cosmetic products for both men and women Though mulberry cultivation is practiced in diverse climates and weather conditions, the major region of cultivation falls in the tropical zone of India covering the states of Andhra Pradesh, Karnataka and Tamil Nadu, which ranges to about 90% of the total growth. The states lying in sub topical region of India such as West Bengal, Himachal Pradesh and some states of the north-east have major regions spared for mulberry cultivation. This proves many people (farmers) are dependent on the production of cultivation of the mulberry plants. I hope our project if ever implemented in real life will help the farmers to prevent their losses. Using the CNN algorithm, we have performed the layer classification of the disease-induced leaf.

VIII. FUTURE WORK

The convolutional neural network is a category of deep learning strategies that have become dominant in various computer vision tasks in recent times and is attracting interest across a widespread diversity of domains, including crop cultivation agriculture. Looking at its current growth and its widespread uses it can be deduced that soon enough to find neural networks controlling some major aspects of our day to day life. There are many countries in the word like Guinea-Bissau, Central African Republic where more than 60 percent of the GDP is dependent on Agriculture. In some countries, the production of silk contributes to about 20% of the overall GDP. Now the only food that the silkworm can feed on is the mulberry leaves, they don't have any kind of other diets. In these countries, any outbreak of disease among the crops can be catastrophic and will result in a heavy loss of lives and capital. Here the Convolutional Neural Network System predicts the disease by analysing the first appearing symptoms, it spares the farmers from a lot of effort. CNN can also be used to predict the Cure of the Disease and The proportion of the Fertilizers required for the Cure by combining some logistic regression techniques with it, It can also inform the farmers nearest locations where he/she could get the required fertilizers/pesticides and also their Authentic prices so that they cannot be tricked by the some greedy shopkeepers. Using Algorithm across various platforms including mobile apps can help it spread easily to the masses, Agriculture experts can also issue a question forum where the farmers can post their issues which will be later resolved by the agricultural experts.

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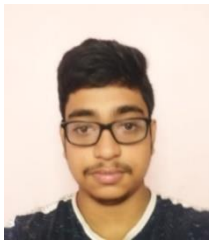

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