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Plant Leaf Perception Using Convolutional Neural Network

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Abstract--- *Automatic plant leaf disease prediction is a complex and essential research topic-The main aim of plant leaf perception using CNN is to detect diseases that occur on different plant leaves, the proposed system used deep learning methods to detect the various diseases on the leaves of such plants. Deep learning architecture selection was the key issue for the implementation. In earlier stages disease in plants was predicted by using some classic image processing techniques like threshold, contrast enhancement and morphological contour operations, then to make disease detection in advance level they have used data mining applications such as classification and clustering approaches for predicting infected leaf diseases. But in both the above mentioned works there are some impacts in processing the images, it requires manual disease prediction, then time complexity of work was high and the image with high qualities will have different accuracies and low quality image can't be accessed for processing. Considering all these limitations, the proposed work is implemented, we have used Convolutional Neural Network (CNN) algorithm for automatic prediction of plant leaf disease. Here, the proposed work has divided into four stages, such as data collecting, data wrangling (preprocessing the collected data) i.e, unwanted data will be removed. After analyzing the dataset training and testing the model by using collected data will be done. Finally, the CNN algorithm to classify the plant leaf image and identify the disease information is applied. Thus, this project results with high accuracy of 93% (approximately) and effective prediction of plant disease with minimum time.*

Keywords--- *Convolutional Neural Network (CNN), Deep learning, Maxpooling, Flattening, Hidden layers, Prediction, Training and Validation.*

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 right amount of fertilizers and pesticides should be added to prevent harmful effects. Farmers have wide range of diversity to select suitable crops for their farm. However, the cultivation of quality crops is highly difficult. This can be improved with the aid of technological support. The management of crops requires regular monitoring, especially for the management of diseases that can affect production. Early detection on crop health and disease detection can facilitate the controls of disease. The early detection is necessary to prevent more infection, also bad leaves will cause plant disease and the fruit production will be affected. Automatic detection of diseases by identifying their symptoms of the plant leaves is easier and cheaper. Machine vision and detection provides more accuracy compared

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traditional system. Deep learning is a modern technique used for data analysis, image segmentation and image processing technique in recent times. It can be applied in various domains and now being used in agriculture as well. The already existing works are,

- The naked eye observation of experts is the first and foremost approach in practice for detection and identification of plant disease. But, it needs regular interval of monitoring by experts which is a difficult task and requires high maintenance charge for large farms. Further, in some developing nations, farmers may need to go long distances to contact specialists, this makes things counseling excessively costly and tedious and in addition farmers are unaware of non-local diseases.
- Automatic detection of plant diseases in a very important analysis topic because it might prove advantages in observance in large fields of crops, and therefore automatically noticing the diseases from the symptoms that are sensed on the plant leaves. This allows machine vision that is to apply image based automatic examination, method management and automation process.

A superior other option, quick and precise recognition by utilizing picture handling strategies which can be more solid than some other old techniques. This paper gives a philosophy for the investigation and recognition of plant disease analysis using digital image processing techniques[1]. The automatic disease recognition strategy is an advantageous process at the initial stage for disease prediction. If automatic disease sensing technique is used, then it'll take less effort, less time and conjointly gives a high accurate output. Disease detection system involves the steps like image acquisition, image pre-handling, image divisions, feature extraction and classification[2]. The image processing is employed in the discovering plant that is affected by diseases. Plant disease detection involves the steps like image acquisition, image pre-handling, image segmentation, highlights extraction and classification. This work mentions the strategies used for the detection of plant diseases, exploitation their leaves [3]. This paper is a software solution for automatic detection and characterization of plant leaf infections. The created to prepare plan comprises of four primary advances, initially a color transformation structure for the input RGB image is created, then the green pixels are masked and expelled utilizing specific threshold value, followed by division process, the surface measurements are computed for the useful segments, finally the extracted features are passed through the classifier. The algorithm's efficiency can effectively recognize and classify the trained diseases with an accuracy of 94%. Experimental outcomes on a database of around 500 plant leaves confirm the robustness of this approach[4]. Detection of disease through some automatic methods is useful because it reduces an oversized work of observance in huge farms of crops, and at terribly early stage itself, it detects the symptom of diseases that is once seen on plant leaves. This paper has used some segmentation algorithms on images that are employed for automatic detection and classification of plant leaf diseases. It additionally covers survey on completely different diseases classification technique used for disease detection. Image segmentation is a vital side for disease detection in plant leaf, is completed by victimization of some basic genetic algorithm[5]. This paper present study of various arrangement methods that can be utilized for plant leaf ailment order. A characterization strategy, manage to arrange each example in one of the unmistakable classes. A characterization is where leaf is arranged dependent on its distinctive morphological highlights. Choosing an arrangement technique is constantly a troublesome undertaking on the grounds that the nature of the result can change for various information. Plant leaf disease characterizations have

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wide applications in different fields for example, in natural research, in Agriculture and so on. This paper gives an outline of various characterization procedures utilized for plant leaf disease [6].

This proposed model can be used to overcome the limitations in the above mentioned papers with higher accuracy. The proposed model used Convolutional Neural Network (CNN) for leaf disease detection. The early detection could help farmers as well as people having Potager(Vegetable Gardner) in their lawns to detect disease which could be valuable for plant growth. This project is to classify the type of disease caused in the plant leaves. This would help the farmer to take measures for the prevention of disease before it gets spread to the nearby plants in the farm. This proves many people (farmers) are dependent on the production of cultivation of the plants. If this proposed model is implemented in real life it will help the farmers to prevent their loss.

II. PROPOSED METHOD

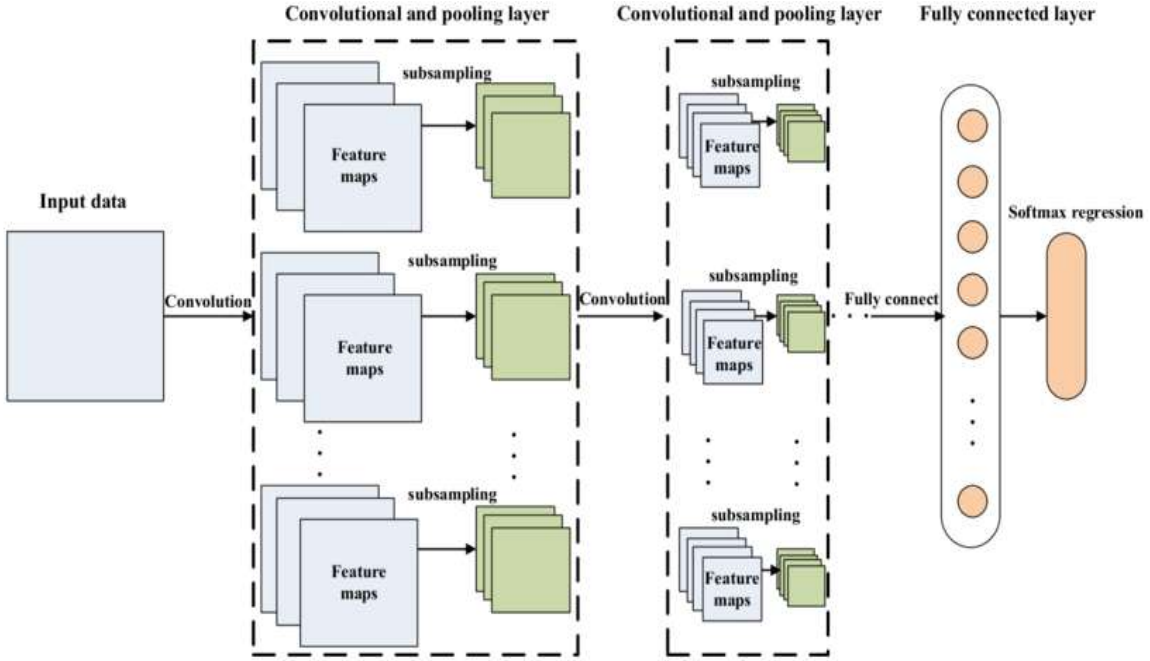

Fig. 2.1: CNN Model of Proposed Method

2.1 Process Involved in Designing

Steps involved in designing the CNN for the proposed model are:

1. Importing Libraries-Initially, libraries like Sequential, Dense, Convo2D, MaxPooling and Flatten from keras. models and keras. layers packages are imported to initialize the model and for having hidden layers.
2. Initializing the model-Initialize the model, by calling the constructor – Sequential.
3. Convolutional layer-To add convolution layer to the Neural Network "add" function is used along with 'Convo2D'.

cnn_model.add(Conv2D(32,3,3,input_shape=(64,64,3)))

- 32 denotes the number of feature detectors to be applied to every single image.

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- 3,3 is the shape of the feature detector
- Input_shape defines the size of the image and number of channels (colour images-3,grey scale images-1). As this is the first layer, we used input_shape parameter. If more than one convolution layer is required then this parameter is not necessary for the second cycle.

4. *MaxPooling*-The next layer is maxpooling by using "add" function along with MaxPooling2D the pooling layers can be added to the model.
   - (2,2) represents the pool size of the filter used in the convoluted image.
5. *Increasing efficiency*-The efficiency of the model can be increased by adding four convolution and maxpooling layers to get high accuracy and to analyze the images more in detail.
6. *Flattening*-After MaxPooling, flatten layer is used to change the shape of the image into a single dimension/array. The output from the flatten function is given as the input to the Artificial Neural Network(ANN).Flattening is an important layer to the model because the ANN will accepts input only in single dimension.
7. *Full connection*-The output from the flatten layer is given as an input to the ANN for further works
8. *Artificial Neural Network*-Artificial neural networks are a nonlinear statistical data modeling tool used to find relationship between input and output models and patterns. It is similar to biological nervous system, such as human brains. Such system "learns" to perform task by considering examples, it has any number of hidden layers connected to the output layer, and hence this process is generated without being programmed with specific rules. The process that takes place in ANN are,
   a. *Adding hidden layers*-To establish full connection, the output from the flatten layer(Input) which is from the convolution network is given to the hidden layer for processing the input by the hidden neurons layers. Thus by increasing the hidden layers the accuracy of the output can be increased. In this model, there is only one hidden layer is used by the Dense library.
   b. *Final output layer*-After hidden layer, the output from the hidden layer is given to the final output layer. The activation function used is 'softmax' which is for categorical data as the output consists of more than two classes (output dimension = 7). 'Sigmoid' activation function is used if our output is binary (consisting of two classes only).
9. *Compiling the model*-After adding all layers, compile the model.
   - *Optimizer* - adam which is one of the weight optimization strategy
   - *Loss*- categorical_crossentropy to calculate the error
   - *Metrics* – accuracy to calculate the model performance.
10. *Image transformation*-In order to avoid over fitting of various images, transformation of image is needed. So, use ImageDataGenerator to apply pre-processing steps to the images. For both training and testing dataset, the pre-processing features are
    - Rescaling – 1. /255 is used to apply feature scaling to get values in range 0 to 1
    - Shear_range – 0.2 performs geometrical operation to move images in some particular angle, then Zoom range and horizontal flip are used.

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By using all these pre-processing features, different images with variations can be obtained and hence over fitting can be avoided.

2.2 Dataset

Datasets are a collection of images or data which is an important tool to train and test the model. In this the dataset (images)of around 19736 images for training purpose and 5565 images for testing purposes belonging to 7 classes namely, Bacterial spot, Black rot, Early blight, Late blight, Powdery mildew, Healthy, Leaf spot sptoria are used.

The model is run with 50 epochs.

Fig. 2.2: Powdery mildew; Fig. 2.3: Leaf spot

Fig. 2.4: Late Blight; Fig. 2.5: Healthy

Fig. 2.6: Early Blight; Fig. 2.7: Black ROT

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Fig. 2.8: Bacterial Spot

A. Powdery Mildew

Unlike many other fungal diseases, powdery mildew thrives in warm, dry climates, though it does require fairly high relative humidity (i.e., humidity around the plant) to spread. In cooler, rainy areas, it does not spread as well. Powdery mildew can slow down the growth of the plant. In some cases, if the infection is severe enough, powdery mildew can kill the plants.

B. Leaf Spot

Leaf spots are round blemishes caused by the parasitic fungi or bacteria which are found on the leaves of many species of plants. A typical spot is called "zonal", which means a definite edge and a darker border is present. If the spot is round in shape or in free-form, then it is called fungal spots.

C. Late Blight

Late blight is mostly called as potato blight, infection of potato and tomato plants that is brought about by the water shape Phytophthora infestans. The disease occurs in humid areas with temperatures extending somewhere in the range of 4 and 29 °C (40 and 80 °F).

D. Early Blight

Early blight is caused by a fungus called Alternaria Solani, early blight is a plant disease that specifically targets the plant stem, foliage, and, in some cases, fruits. Early blight affects every plant differently, but in most cases, the leaves tend to drop first, which exposes the fruits to direct sunlight. Affected plants also under-produce or completely stop producing flowers and fruits.

E. Black Rot

Black rot is a one kind disease in leaf caused by fungus Guignardia Bidwellii. This disease is mostly seen in plants during warm and wet seasons. It attacks almost entire plants from leaves to fruit. This will affect the fruit production of the plant.

F. Bacterial Spot

The Bacterial spot is caused by Xanthomonas, it causes leaf and fruit spots, which leads to defoliation, sun-scalded fruit, and reduce production of fruits. Thus, it is due to the diversity of bacterial spot pathogens, it can occur at different temperatures of 75 to 86 °F and high precipitation, and sometimes it highly dependent on cool and wet conditions for infection and disease development.

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III. RESULT AND DISCUSSION

The concepts involved in this model are:

1. *Computer Vision* – to extract features from images
2. *Machine Learning* – Supervised learning is needed for the model in order to classify the leaf diseases.
3. *Deep Learning* – This provides the cognitive skill of analyzing the diseases detected to a particular class and hence produce the appropriate output, just like how human analyses and this can be achieved with the help of CNN.

The most important packages needed to drive the code are OpenCV and Keras where this both will help in the processing of the data acquired involving all the above concepts in the back-end. The tools used in the proposed model are personal computer, anaconda navigator. The personal computer (PC) used for this project has a processor of intel(R) Core(TM) i3-5005U CPU @2.00GHz 2.00GHz, it has a RAM of 4 GB, then the system type is 64 bit Operating System, x64 based processor. Anaconda Navigator is a desktop graphical user interface (GUI) which is a "Data Science Tools", which allows to launch applications and easily manage conda packages like keras, tensorflow and channels without using command-line. Anaconda is an open-source platform for using Python and R programming languages for computing (data science models, machine learning and deep learning applications, large-scale data processing, predictive analytics, etc.), thus the main aim is to simplify the package uses and deployment processes and it is a free source to use. In this Jupyter notebook is used to build the proposed model, the version of Jupyter notebook is 1.0.0,the language used is python(py37_7). Anotherconda packages is like Keras which is also installed in it by using Anaconda prompt with a version of 2.3.1(pypi_0),keras preprocessing 1.1.0(pypi_0).

3.1 Computation Time

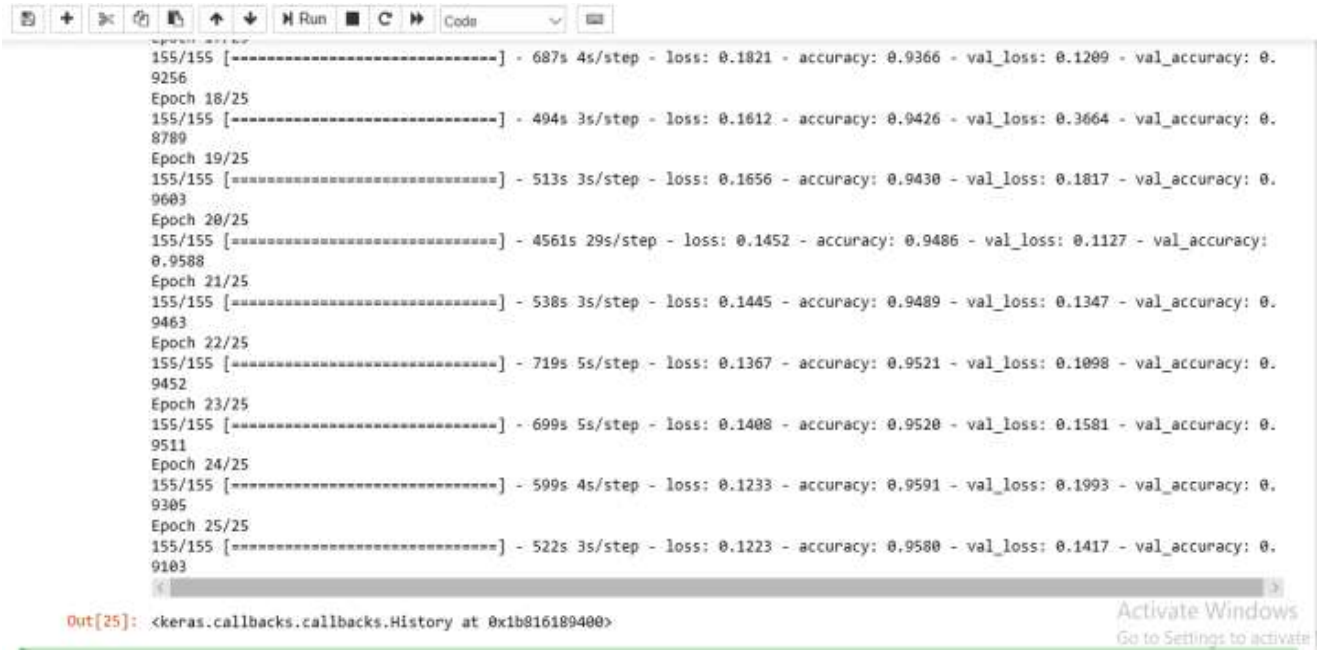

Fig. 3.1: Running Model

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In this proposed model, the overall time taken to run a single step per epoch is 20 seconds(approximately), the total time taken to complete one full epoch is 600 seconds(approximately). Training loss is around 0.15, accuracy is 0.95. Then validation loss is 0.2, validation accuracy is 0.93.

After running the proposed model completely, an accuracy of 93 percentage is obtained. If an image of leaf is given as an input to the model(driver code), the proposed model will predict what kind of disease the plant is affected. For example if an image of a leaf affected by some bacterial spot is given as an input to the model, then the output will be zero(0), likewise for other diseases also it will provide output from 0 to 6 i.e.,

Table 3.1: Output Classification

Bacterial spot -0	Late blight-3	Leaf spot sptoria-6
Black rot-1	Powdery mildew-4	
Early blight-2	Healthy-5	

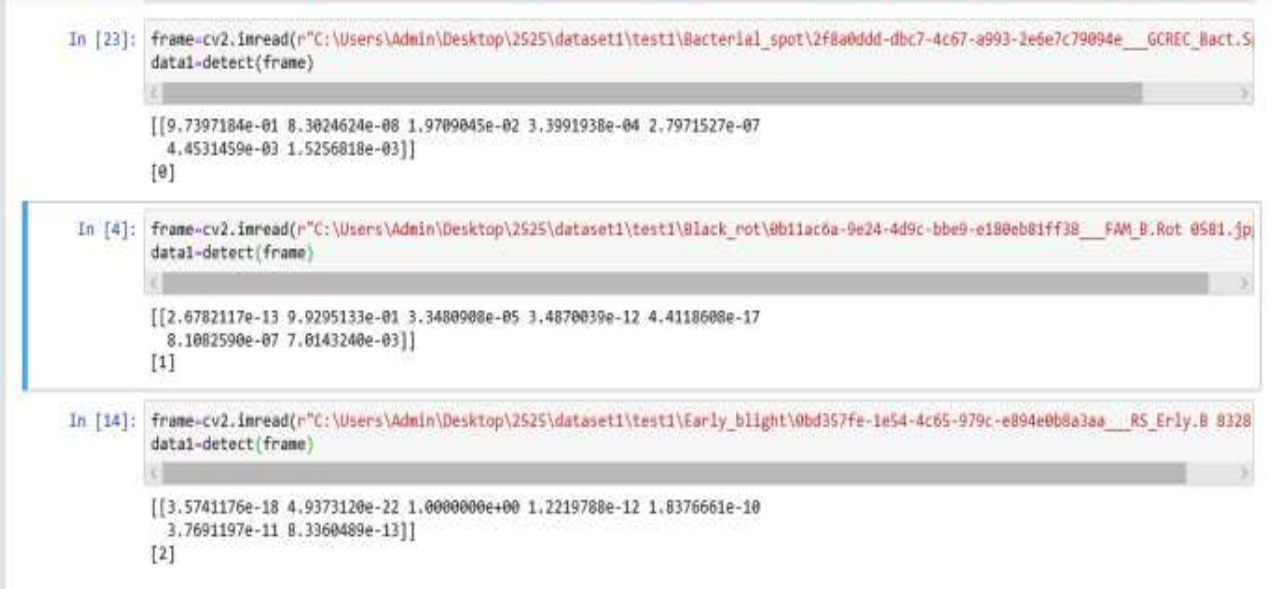

Fig. 3.2: Output

IV. CONCLUSION

The project is done to sense the diseases that occur on various plant leaves. The type of diseases occurs in the plant leaves are classified based on the pathogenic agents which affects the plant leaves such as bacteria, virus and so on. A deep learning technique in which Convolution Neural Network (CNN) Algorithm is used to detect the various diseases on the leaves of such plants. Early detection on crop health and disease detection can facilitate the controls of disease. This would help the farmer to take prior steps for the prevention of the disease from spreading more in the plant. Thus, if the model ever implemented in real life, the proposed model will help the farmers to prevent their losses.

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REFERENCES

[1] Ghaiwat Savita N, Arora Parul. Detection and classification of plant leaf diseases using image processing techniques: a review. *Int J Recent Adv Eng Technol* 2014;2(3):2347–812. ISSN (Online).

[2] Mrunalini R Badnakhe, Deshmukh Prashant R. An application of K-means clustering and artificial intelligence in pattern recognition for crop diseases. *Int Conf Adv Inf Technol* 2011;20. 2011 IPCSIT.

[3] Arivazhagan S, NewlinShebiah R, Ananthi S, Vishnu Varthini S. Detection of unhealthy region of plant leaves and classification of plant leaf diseases using texture features. *Agric Eng Int* CIGR 2013;15(1):211–7.

[4] Dhaygude Sanjay B, Kumbhar Nitin P. Agricultural plant leaf disease detection using image processing. *Int J Adv Res Electr Electron Instrum Eng* 2013;2(1).

[5] Kulkarni Anand H, Ashwin Patil RK. Applying image processing technique to detect plant diseases. *Int J Mod Eng Res* 2012; 2(5):3661–4.

[6] Naikwadi Smita, Amoda Niket. Advances in image processing for detection of plant diseases. *Int J ApplInnov Eng Manage* 2013; 2(11).

[7] Bashir Sabah, Sharma Navdeep. Remote area plant disease detection using image processing. *IOSR J Electron Commun Eng* 2012; 2(6):31–4.

[8] RathodArti N, Tanawal Bhavesh, Shah Vatsal. Image processing techniques for detection of leaf disease. *Int J Adv Res Comput Sci Softw Eng* 2013;3(11).

[9] Chaudhary Piyush et al. Color transform based approach for disease spot detection on plant leaf. *Int Comput Sci Telecommun* 2012;3(6).

[10] Beucher S, Meyer F. The morphological approach to segmentation: the watershed transforms. *In: Dougherty ER, editor. Mathematical morphology image processing, vol. 12. New York: Marcel Dekker;* 1993. p. 433–81.

[11] Rathod Arti N, Tanawal Bhavesh, Shah Vatsal. Image processing techniques for detection of leaf disease. *Int J Adv Res Comput Sci Softw Eng* 2013; 3(11).

[12] Vijayaraghavan Venkatesh, Garg Akhil, Wong Chee How, Tail Kang, Bhalerao Yogesh. Predicting the mechanical characteristics of hydrogen functionalized graphene sheets using artificial neural network approach. *J Nanostruct Chem* 2013; 3: 83.

[13] Bhanu B, Lee S, Ming J. Adaptive image segmentation using a genetic algorithm. *IEEE Trans Syst Man Cybern* Dec 1995; 25: 1543–67.

[14] Woods Keri. Genetic algorithms: colour image segmentation literature review, 2007.

[15] Bhanu B, Peng J. Adaptive integrated image segmentation and object recognition. *IEEE Trans Syst Man Cybern Part* C 2000; 30: 427–41.

[16] A. M. Mutka, R. S. Bart, "Image-Based Phenotyping of Plant Disease Symptoms", *Frontiers in Plant Science*, vol. 5, pp. 1-8, 2015.

[17] I.S. Jacobs, C.P. Bean, G.T. Rado, H. Suhl, "Fine particles thin films and exchange anisotropy" *in Magnetism, New York: Academic*, vol. III, pp. 271-350.

[18] Krizhevsky, I. Sutskever, G. H. E. Hinton, "ImageNet Classification with Deep Convolutional Neural Networks", *Advances in Neural Information Processing Systems*, 2012.

[19] S. P. Mohanty, D. Hughes, M. Salathe, Using Deep Learning for Image-Based plant Disease Detection, 2016.

[20] Rao, VM. Inclusive growth in India – "Agriculture, poverty and human development. *Indian Journal of Agricultural Economics"*.Vol.63, Iss. 2, (Apr-Jun 2008), 276-279.

[21] Jayamala K. Patil, Raj Kumar "Advances in Image Processing for Detection of Plant Disease" *Journal of Advanced Bioinformatics Applications and Research* ISSN 0976-2604 Vol. 2, Issue 2, June2011, pp 135-141.

[22] S. Arivazhagan, R. Newlin Shebiah*, S. Ananthi, S. Vishnu Varthini. "Detection of unhealthy region of plant leaves and classification of plant leaf diseases using texture features". *CGIR* 2015 vol.15.

[23] Huang, K. Y. (2007). Application of artificial neural network for detecting phalaenopsis seedling diseases using color and texture features. *Comput. Electron. Agric.* 57, 3–11.

[24] Dalal, N., and Triggs, B. (2005). "Histograms of oriented gradients for human detection," in *Computer Vision and Pattern Recognition, 2005. CVPR 2005. IEEE Computer Society Conference on. (IEEE)* (Washington, DC).

[25] Schmidhuber, J. (2015). Deep learning in neural networks: an overview. *Neural Netw.* 61, 85–117. doi: 10.1016/j.neunet.2014.09.003.

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[26] Singh, A., Ganapathysubramanian, B., Singh, A. K., and Sarkar, S. (2015). Machine learning for highthroughput stress phenotyping in plants. *Trends Plant Sci.* 21, 110–124.

[27] Simonyan, K., and Zisserman, A. (2014). Very deep convolutional networks for large-scale image recognition.arXiv:1409.1556.

[28] Russakovsky, O., Deng, J., Su, H., Krause, J., Satheesh, S., Ma, S., et al. (2015). ImageNet large scale visual recognition challenge. *Int. J. Comput. Vis.* 115, 211–252.

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