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Disease Discovery in Plants using Artificial Intelligence Techniques

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Abstract: *Agricultural productivity is a key component of Indian economy. Therefore, the contribution of food crops and cash crops is highly important for both the environment and human beings. Every year crops succumb to several diseases. Due to inadequate diagnosis of such diseases and not knowing symptoms of the disease and its treatment many plants die. This study provides insights into an overview of the plant disease detection using different algorithms. A CNN based method for plant disease detection has been proposed here. Simulation study and analysis is done on sample images in terms of time complexity and the area of the infected region. It is done by image processing technique. A total of 15 cases havebeen fed to the model, out of which 12 cases are of diseased plant leaves namely, Bell Paper Bacterial Spot, Potato Early Blight, Potato Late Blight, Tomato Target Spot, Tomato Mosaic Virus, Tomato Yellow Leaf Curl Virus, Tomato Bacterial Spot, Tomato Early Blight, Tomato Late Blight, Tomato Leaf Mold, Tomato Septoria Leaf Spot and Tomato Spider Mites and 3 cases of healthy leaves namely, Bell Paper Healthy, Potato Healthy and Tomato Healthy. Test accuracy is obtained as 88.80%. Different performance matrices are derived for the same.*

Keyword: CNN, image processing, training set, test set

1. INTRODUCTION

India is a country with a population of approximately 1.38 billion as of April 2020. Estimates put the total number of farmers in India somewhere between 95.8 million. It must be noted that 18% of India's GDP is produced from the agricultural sector. It would, thus, be safe to infer that if agriculture was revolutionized, it'd benefit the country greatly and also apart from alleviating the conditions of local farmers, it'd also create a lot of employment and expansion opportunities in the agricultural sectors [1]. Research and development on pesticides, fungicides, and herbicides have progressed very well in India. But, every year, due to natural reasons, crops succumb to various known diseases and tonnes of produced corps are lost and this can be dealt with quick detection of plant diseases in proper time. It will help to get over the dire economic conditions faced by the country's farmers [2]. Nowadays technology has changed lives for the better. Due to the internet, almost everything is within reach. With the help ofa normal camera, one can easily click photos of affected parts and upload it to the system which detects the particular disease and provides the exact treatment as well as a pesticide if required. Most of the plants are infected by various fungal and bacterial diseases. The exponential increase of population, the climatic conditions also cause plant diseases. The leaves require close monitoring to detect the disease. There are several techniques are reported by many researchers for plant disease detection and monitoring. Usama Mokhtar presented Gabor wavelet transform techniques to extract tomato leaf features. They used SVM to detect leaf diseases. For experiments real sample images of tomato leaf have been considered and two types of disease in tomato leaves including early blight and powdery mildew have been observed. In preprocessing, phase images are resized to 512*512 resolutions to deduce the computational time. Background subtraction method has been applied to remove the background of the image. In the classification, using kernel function the SVM was trained and tested [3]. Ganesan proposed a fuzzy-based segmentation method with computer vision for the early identification of plant leaf diseases. Image segmentation is also applied to extract the diseased part of the plant leaf from the input image. Color space segmentation is also applied to identify the color of the fruit or disease affected area [4]. Arthit Srikaew, Kitti Attakitmongcol, and Prayoth Kumsawat proposed a leaf disease diagnosis method using neural networks. An unsupervised method is implemented using color imagery. Color and texture, both the features of the image are processed. The proposed system consists of two parts. One is extraction of disease feature and the other one is classification of the same. Former one emphasizes on feature appearance based on a co-occurrence matrix depend on gray level along with texture feature equations. Later one deploys the fuzzy ARTMAP neural network which is basically an unsupervised method to categorize different types of diseases. Healthy plant with no disease, rust, scab, downy and mildew are the five classes that are considered in this work. With this variation of grape leaf diseased images, the proposed system's classification performance is examined in

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terms of accuracy and a desirable score of 90% is obtained for the same [5]. The study is presented by H. Sabrol and K. Satish where five kinds of tomato diseases is considered for classification for example tomato late blight, bacterial spot, Septoria spot, bacterial canker, tomato leaf curl. The classification is carried out by Attakitmongcol, and Prayoth Kumsawat proposed a leaf disease diagnosis method using neural networks. An unsupervised method is implemented using color imagery. Color and texture, both the features of the image are processed. The proposed system consists of two parts. One is extraction of disease feature and the other one is classification of the same. Former one emphasizes on feature appearance based on a co-occurrence matrix depend on gray level along with texture feature equations. Later one deploys the fuzzy ARTMAP neural network which is basically an unsupervised method to categorize different types of diseases. Healthy plant with no disease, rust, scab, downy and mildew are the five classes that are considered in this work. With this variation of grape leaf diseased images, the proposed system's classification performance is examined in terms of accuracy and a desirable score of 90% is obtained for the same [5].

2. LITERATURE SURVEY

In the paper —Deep learning for Image-Based Plant detection" [1] the authors Prasanna Mohanty et al., has proposed an approach to detect disease in plants by training a convolutional neural network. The CNN model is trained to identify healthy and diseased plants of 14 species. The model achieved an accuracy of 99.35% on test set data. When using the model on images procured from trusted online sources, the model achieves an accuracy of 31.4%, while this is better than a simple model of random selection, a more diverse set of training data can aid to increase the accuracy. Also some other variations of model or neural network training may yield higher accuracy, thus paving path for making plant disease detection easily available to everyone. Malvika Ranjan et al. in the paper —Detection and Classification of leaf disease using Artificial Neural Network proposed an approach to detect diseases in plant utilizing the captured image of the diseased leaf. Artificial Neural Network (ANN) is trained by properly choosing feature values to distinguish diseased plants and healthy samples. The ANN model achieves an accuracy of 80%. According to paper —Detection of unhealthy region of plant leaves and classification of plant leaf diseases using texture features" [3] by S. Arivazhagan, disease identification process includes four main steps as follows: first, a color transformation structure is taken for the input RGB image, and then by means of a specific threshold value, the green pixels are detected and uninvolved, which is followed by segmentation process, and for obtaining beneficial segments the texture statistics are computed. At last, classifier is used for the features that are extracted to classify the disease..Kulkarni et al. in the paper —Applying image processing technique to detect plant diseases [4], a methodology for early and accurately plant diseases detection, using artificial neural network (ANN) and diverse image processing techniques. As the proposed approach is based on ANN classifier for classification and Gabor filter for feature extraction, it gives better results with a recognition rate of up to 91%.

3. METHODOLOGY

The proposed plant disease prediction method takes input from the plant's leaves images. Fig-1 represents the block diagram of the proposed method.

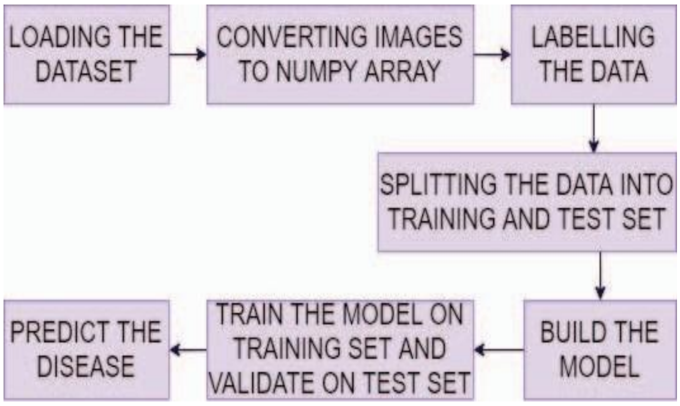

Fig-1: Block diagram of Proposed Methodology

Firstly, the data is preprocessed by resizing the input images and further a NumPy array is created for the same. Next the dataset and label of all the images are segregated. The model has been trained on a specific data set consisting of images of the different diseased plant leaves which are considered for this study. The labeled data is now stored in pickle files which are again extracted during the training period of the model. For the model, the convolution layers are declared followed by max-pooling layers. After that, 25% of the whole data is dropped out. The output is flattened to feed the dense network. The last layer has a softmax activation to predict the disease of the given leaf. To reduce the loss function Adam optimizer is utilized. The framework consequently distinguishes the picture of leaf given and pre-processes the picture further for prediction. The model will produce 15 distinctive probability values for 15 labels respectively among which the probability value with highest score to the relating name will be the anticipated disease or result for that particular image.

3.1.CNN

In machine learning, CNN takes a varied approach towards regularization. It is less complicated than conventional models of regularization. The layers are described below.

3.1.1. Input Layer

In this layer input is fed to the model. At this beginning stage of the neural network, the no of neurons and number of features are equal. Considering an image, the number of pixels in it is equivalent to the total number of features. The input data is divided into two parts which are used for training and testing the model. The major part of data is used for training and the minor part of it is used for testing. Fig. 2 shows two different image of tomato leaves.

Fig-2:Two different image of tomato leaves.

3.1.2. Hidden Layer

This layer receives the output from the input layer. It is dependent upon both the model and size of data as well. Number of neurons may vary in each of the hidden layer.

3.1.3. Output Layer

A logistic function receives the data from hidden layer as input. The probability score is obtained for each class by converting the output of each class by a logistic function. It coverts each class output into an equivalent probability score for the same.

3.2. CNN Layers

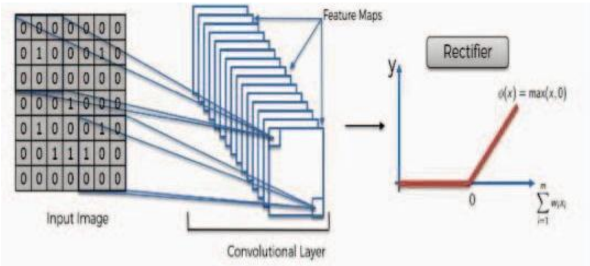

Fig-3: CNN Layers

3.2.1. Convolution Layer

It is the first layer for dimensions extraction from any input image. Convolution layer consists of filters which help extract particular characteristics, which results into a feature map of the input images. This is a mathematical operation which receives two inputs. Input and output information is provided below for this layer.

Inputs:

An image matrix (volume) of dimension (h*w*d).

A filter (fh*fw*d).

Output:

Output volume dimension (h-fh+1) *(w-fw+1)

3.2.2. Pooling Layer

The pooling layer functions such a way that a 2D filter slides over every channel of the feature map and conveys the features lying within the area enveloped by the filter. Given a specified dimension of any feature map the pooling layer output dimension is expressed as follow

$$(n-f-1)*(n-f-1)$$

$$\frac{h}{s}*\frac{w}{s}*s$$

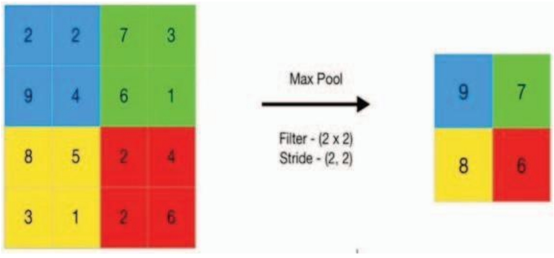

Fig-4: Maximum Pooling Layer

3.2.3. Max Pooling Layer

It is that feature map region from where maximum numbers of elements are selected and hidden by the filter. Thus, the max-pooling layer output is a feature map which contains the most prominent features of the preceding feature map. Fig 4 shows maximum pooling layer.

3.2.4. Fully Connected Layer

The fully connected (FC) layer in the CNN represents the feature vector for the input. It contains crucial information about the input. During the training of the network, this feature vector is further used for classification, regression etc. It is also being used as an encoded vector. During training, this is used to determine the loss and helps the network to get trained. The convolution layers before the FC layers hold vital information about local features in the input image such as edges, blobs, shapes, etc. Each convolution layer holds multiple filters that represent one of the local features. The FC layer detains composite and collectively compiled information from all the convolution layers that matters the most.

Table-1: Model Summary

Layer	Output	Parameter
Conv2d_1	(256,256,32)	896
Activation_1	(256,256,32)	0
Batch_Normalization_1	(256,256,32)	128
Max_Pooling2d_1	(85,85,32)	0
Dropout_1	(85,85,32)	0
Conv2d_2	(85,85,64)	18496
Activation_2	(85,85,64)	0
Batch_Normalisation_2	(85,85,64)	256
Conv2d_3	(85,85,64)	36928
Activation_3	(85,85,64)	0

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Batch_Normalisation_3	(85,85,64)	256
Max_Pooling2d_2	(42,42,64)	0
Dropout_2	(42,42,64)	0
Conv2d_4	(42,42,128)	73856
Activation_4	(42,42,128)	0
Batch_Normalization_4	(42,42,128)	512
Conv2d_5	(42,42,128)	147584
Activation_5	(42,42,128)	0
Batch_Normalization_5	(42,42,128)	512
Max_Pooling2d_3	(21,21,128)	0
Dropout_3	(21,21,128)	0

3.3. Filters and Feature Maps:

Filters are not predefined in CNN, rather self-learned by the model itself. In a convolutional layer filters, learn to detect abstract concepts like the boundary of a face or the eyes of a person. Several convolution layers together can extract in-depth information from an image. It is like a membrane that only allows desired characteristics to pass from it. Feature maps are the outputs of filters in the convolution layer.

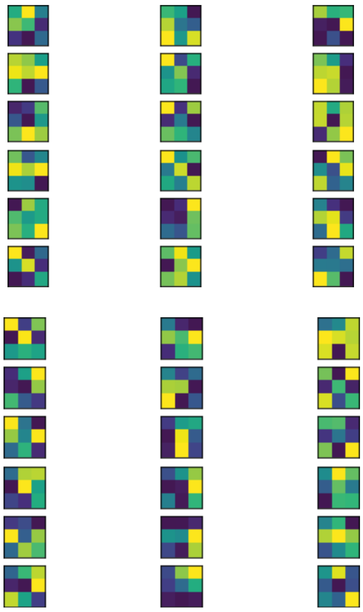

Fig-5: Visualization of filter for 1st convolution layer

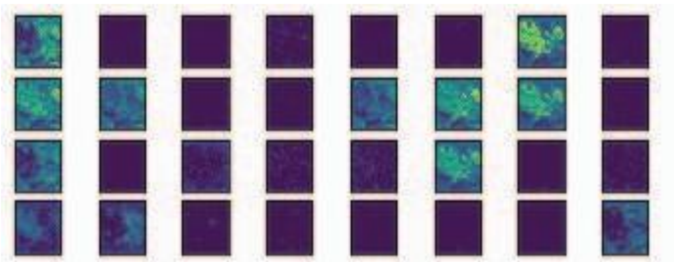

Fig-6: Visualization of filter for 2nd convolution lay

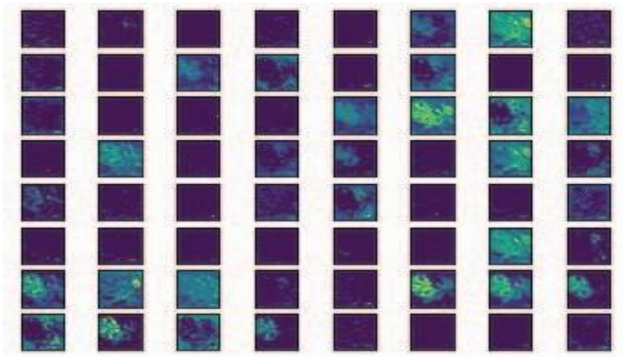

Fig-7: Visualization of feature map for 1st convolution layer

4. RESULT

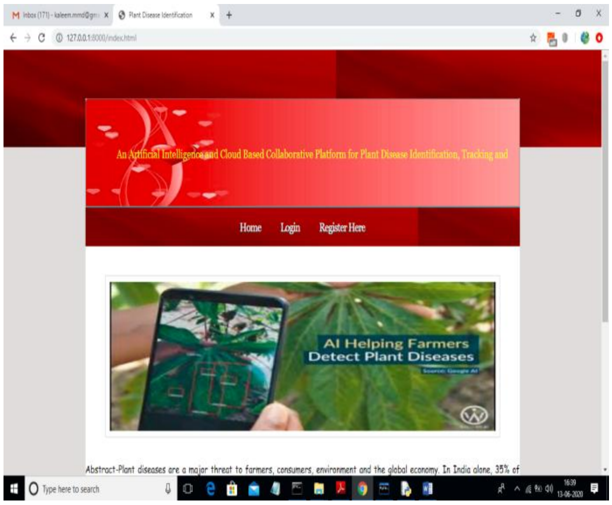

Fig-8: Registration of New Leaves

In Fig-8, it shows that register the new user

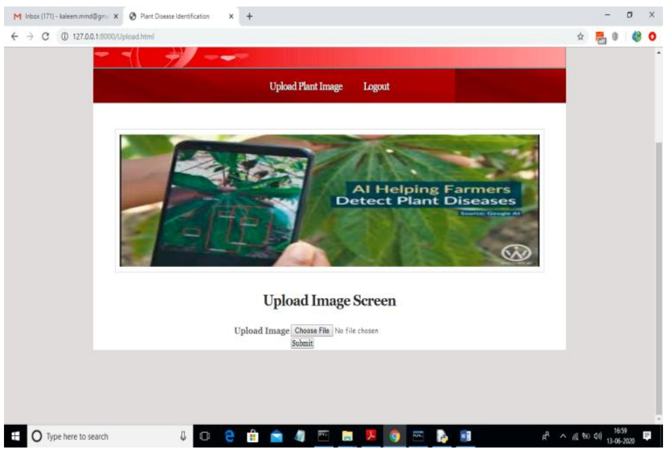

Fig-9: upload crop image

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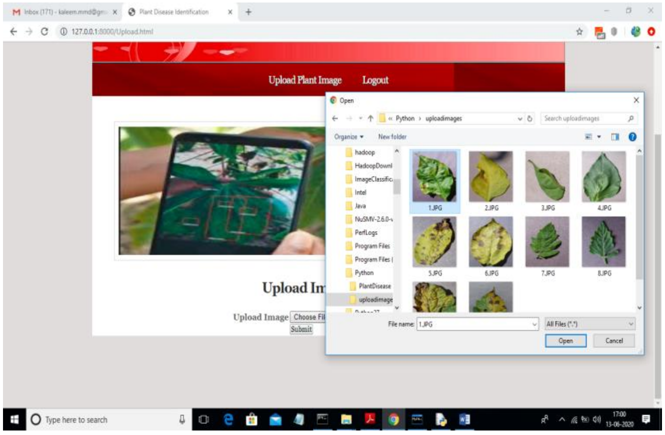
In above figure-9 user can upload image of his crop to predict disease using CNN



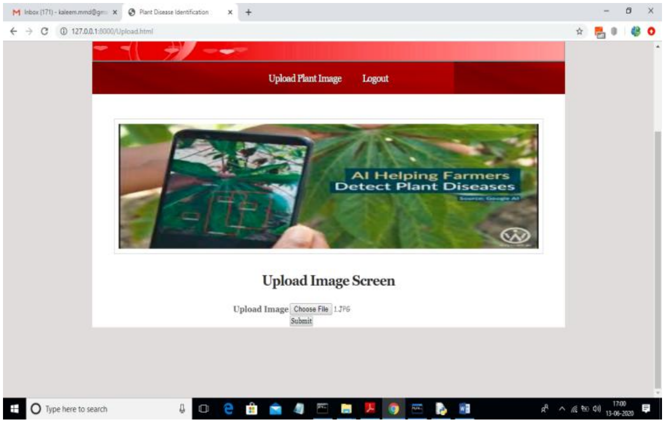
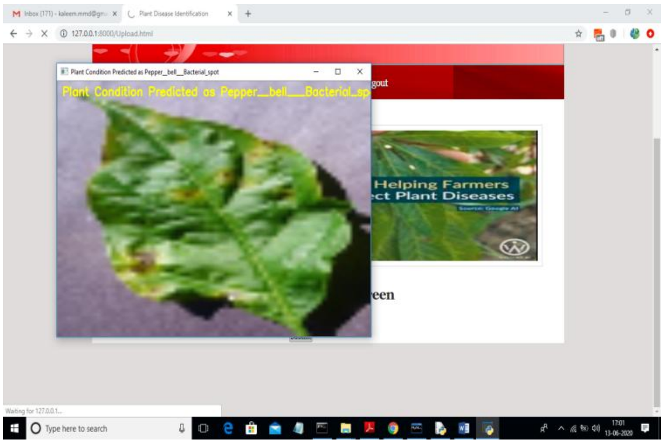


Fig-11: Fig-10: Predict disease using CNN

In above screen click on 'Submit' button to predict disease



-11: Fig-10: Predict disease using CNN

In above screen we will get image with predicted disease name printed on image and now close that image to get locations in map.

5. CONCLUSION

The proposed algorithm is implemented successfully to train the system. The accuracy percentage on the test set is 88.80% with no overfitting There is still room for improvement as the remaining 12.20% is covered. This present work can contribute to agricultural domain and can be used to help people for tracking their house plants and also enables the farmers to keep a track of the harvest. This work can be expanded into further to develop an app through which one would also know the remedy to a plant disease.

REFERENCES

[1] U. Mokhtar, M.A.S. Ali, A.E. Hassenian, H. Hefny, "Tomato leaves disease detection approach based on support vector machines", 11th international computer engineering conference (ICENCO), Cairo, Egypt, 29-30 Dec.2015, pp. 246-250.

[2] Ganesan, S. Sajiv, L. Megalanleo Leo, "CIELuv Color Space for Identification and Segmentation of Disease Affected Plant Leaves Using Fuzzy based Approach", 3rd International Conference on Science Technology Engineering & Management (ICONSTEM), Chennai India, 23-24 March 2017, pp. 889-894.

[3] M. Sardogan, A. Tuncer, Y. Ozen, "Plant Leaf Disease Detection and Classification based on CNN with LVQ Algorithm", 3rd International Conference on Computer Science and Engineering (UBMK), Sarajevo, 20-23 Sept. 2018, pp. 382-385.

[4] A. Sehgal, S. Mathur, "Plant Disease Classification Using SOFT COMPUTING Supervised Machine Learning", 3rd International Conference on Electronics, Communication, and Aerospace Technology (ICECA), Coimbatore, India, 12-14June 2019, pp.75-80.

[5] C. Khitthuk, A. Srikaew, K. Attakitmongcol, P. Kumsawat "Plant Leaf Disease Diagnosis from Color Imagery Using Co-Occurrence Matrix and Artificial Intelligence System", International Electrical Engineering Congress(iEECON), Krabi, Thailand, 7-9 March 2018.

[6] H. Sabrol, K. Satish, "Tomato Plant Disease Classification in Digital Images using Classification Tree", International Conference on Communication and Signal Processing (ICCSP), Melmaruvathur, India, 6-8 April 2016, pp. 1242-1246.

[7] N. Petrillis, "Plant Disease Diagnosis With colour Normalization", 8th International Conference on Modern Circuits and Systems Technologies (MOCAST), Thessaloniki, Greece,13-15 May 2019.

[8] N. Petrellis, "A Smart Phone Image Processing Application for Plant Disease Diagnosis", 6th International Conference on Modern Circuits and Systems Technologies (MOCAST), Thessaloniki, Greece, 4-6May2016.

[9] M. Islam, AnhDinh, K. Wahid, P. Bhowmik, "Detection of Potato Diseases Using Image Segmentation and Multiclass Support Vector Machine", IEEE 30th Canadian Conference on Electrical and Computer Engineering (CCECE), Windsor, Canada, 30 April- 3 May 2017.

[10] H. Wang, G. Li, Z. Ma, X. Li, "Application of Neural Networks to Image Recognition of Plant Diseases", International Conference on Systems and Informatics (ICSAI2012), Yantai, China, 19-20 May 2012, pp. 2159-2164.

[11] K.K. Singh, "An Artificial Intelligence and Cloud-

Based Collaborative Platform for Plant Disease Identification, Tracking and Forecasting for Farmers", IEEE International Conference on Cloud Computing in Emerging Markets (CCEM), Bangalore, India, 23-24 Nov 2018, pp. 49-56.

[12] E. Agustina, I. Pratomo, A.D. Wibawa, S. Rahayu, "Expert System for Diagnosis Pests and Diseases of The Rice Plant using Forward Chaining and Certainty Factor Method", International Seminar on Intelligent Technology and Its Applications (ISITIA), Surabaya, Indonesia, 28-29 Aug 2017, pp. 266-270.

[13] A. Louise P.de Ocampo, E.P. Dadios, "Mobile Platform Implementation of Lightweight Neural Network Model for Plant Disease Detection and Recognition", IEEE 10th International conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Enviroment and Management (HNICEM), Baguio, Philippines, 29 Nov-2 Dec2018.

[14] S. Dubey, M. Dixit, "Facial Expression Recognition using Deep Convolutional Neural Network", International Symposium on Advanced Intelligent Informatics (SAIN), Vol.8, No.1 pp. 96- 101, Aug 2018.