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IOT BASED REAL TIME TOBACCO LEAVES DETECTION AND CLASSIFICATION USING DEEP LEARNING

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Abstract: At present, manual processing is done for tobacco leaves harvesting and segregation. Real time detection and classification of tobacco leaves is one of the biggest challenges in tobacco cultivation. Fast and accurate classification system of uncured tobacco leaves, helps farmers during curing process with less computational resources. In this paper, a fast reliable and accurate pipeline for real time tobacco leaves classification using deep neural networks is presented. In the proposed work, we have used our own captured Indian soil produced tobacco leaves image data set and classified into several classes based on the curing process. The model is trained and compared using various deep learning architectures based on their top-1 and top-5 accuracy. The proposed model is trained with 720 green tobacco leaves, which achieved 92% of top-1 accuracy after implementing various data augmentation techniques. CNN is one of the best performance models and is used extensively for image classification purposes. One of the major characteristics of CNN is its self extracting feature property which hugely helps in segmentation and classification problems. In our proposed system, we compare some of the well known pre-defined CNN architectures such as ImageNet, GoogleLeNet, VGGNet, AlexNet, Inception V3 and V4, ResNet, DenseNet, ConveNet etc trained and tested on our dataset. Ourmodel is further run on the Raspberry Pi 3 for real time classification.

Keywords: Classification, Features, Tobacco leaf, Grading, Deep learning, Convolutional Neural Networks (CNN).

1 Introduction

Tobacco is also one of the commerical crop and cultivated only in few countires around the world. The quality of the tobacco leaf play an important role for the former in the international market. Depends on the quality of the tobacco leaves the price may vary. The quality of the tobacco leaves are evaluated on certain parameters. One of the important parameter which affects the quality and price is grading. The grading of tobacco leaves means separation or classification of leaves based on certain attributes like color ,texture, shape, humiduty etc and garding can be performed in many stages. One of the important stages are grading tobacco leaves after a curing process called flue cured tobacco leaves grading. Before curing process a seggregation of leaves can takes place. The main purpose of this stage is to apply an qdeuate tempature to the uncured tobacco leaves for the purpose of getting good quality tobacco fcv leaves. This process requires realtime classification system for the purpose of achiving good product quality by using techniques.

From the decade, many of the applications are incorported with intelligent system. That is the system are developed self learning mechanism called artificial inteligence. Already many more machine leaning techinques are exists today. One of the machine leaning tecahique is deeplearining. Convoultional Neural Networks(CNN) is the one of the self learning mechanism model in a deep learining approach.

At last decade, a deepleaning apporcahes has been widely used in many applications like Image processing, Text summerization, Image and video analysis, Image claaification, object detection and tracking, scene labelling etc. Many of the models like Autoencoder, Sparse decoding,Deep Neural Netowrks and Convolutional Neural Networks are commenly used in Deep larning approach. CNN is one of the bset and high performance model is used extensively for image classification. one of the characteristics of the CNN is self leaning mechanism like self extracting features, segmantation and classification. due to rapid growth of CNN many of the CNN bassed architecture hass been develoeped. Some of the pre defiened architecture are ImageNet, GoogleLeNet, VGGNet, AlexNet, Inception V3 and V4, ResNet, DenseNet ConveNet etc..

For our proposed system, a CNN model has been developed for real time detection and classification of tobacco leaves. The proposed model is then compared with the CNN pretrained model like Alexnet,ImageNet,VGGNet, and GoogLeNet. Some of the features are used for detection and classification of tobacco leaves either it by manual or automatic system. On these features idetification and classification is limited to human visual capabilities. Still the classification is processed by human inspection. Due to the complexity and the grading exprets an automated system is praposed to increases the quality of the tobacco leaves for curing process.

Significant uses of the computer vision and image processing technique is the real world applications like industrial automation, business analysis, biological and material sciences, medical application. To address variouse issues realated to the above applications some of the technology like deep neural networks, image processing, pattern, classification and recognition, artificial intelligence etc are used. İmage classification plays an vital role in machine vision. İmage classification includes series of a processing steps such as preporcessing, segmentation, fetaure extarction and classification. due to advancement in technology a feature extraction and classification is integarted into a deeplearning farmework. One of the component of the deeplearning in image classification is the use of convolutional

neural network architecture. İn our proposed an efficient deep learning neural network architecture have been developed for our own dataset. For the same data set , variouse pre defined architecture have been uesd to evaluate the accuracy.

2 Literature Review:

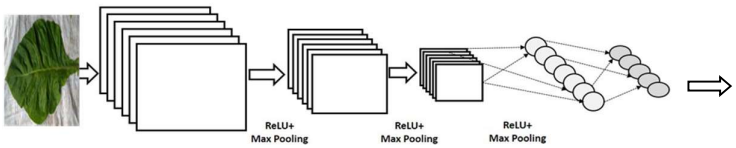
CNN is one of the imporved machine learning approach has been widely used for object detection,classification, image and video recognition problems. CNN is derived from human visual system and it is a multi layered supervisied neural network , which can learn features automatically from datasets. Variouse different types of architecture were introduced for object detetcion and classification. The LeNet[9] architecture is one of the first and basic standard structured convolutional layers. AlexNet[8] were introduced ,it performs significantly higer in image classification. Due to advances in CNN architecture, after AlexNet larger CNN architecture were introduced. VGG-19[9] is featured with 19 layers and GoogleNet[10,11] fetaured with 22 layers were introduced. ResNet[9] featued with 152 layers were introduced and it performs comparetively achives higer accuracy on image classification.ImageNet[8] was introduced and achives outstaing accuracy in large scale image classification. This is designed for larger datasets to yeild best reults on MNIST and CIFAR[11]. One of the way to increase the performance of the deep neural netowks is by increasing the size of the network levels. İncresing size includes increasing network levels called increaing depth and increasing width by incresing number of units at each level. Increasing networks leads in increaing a number of parameters also increased to use of computational resourecs[11].

Guru et all[12] proposed, machine vision based classification of tobacco leaves for automatic harvesting. In this proposed method CIELAB color model is used for segmentation, color and texture features such as GLTP, LBP, LBPV is proposed to increases the classification accuracy. This system achieved the classification accuracy 86.9% on GLTP [12]. Srdjan Sladojevic[4] et al., proposed DNN based recogntion of plant diseases by leaf image classifiaction. Different types of plant diseses were trained and achived 91% of accuracy on class test and 96.3% of accuracy on average. Yu sun[5] et al., proposed a system for plant identification in natural environment using deep learining. Around 10000 of 100 classes images are collected using mobile camera and achived 91.78% of accuracy on classification. Alvaro Fuentes[2] et al.,proposed a deep learning based approach to detect diseases and pets in tomato plants using R-CNN.both VGG net and ResNet architectures are uesd as deep meta architecture. The praposed one achives average precession of 86% in VGG net and average precession of 85.9% in ResNet. Keke Zhang[3] et al.,praposed a deep learning model for identifying tomato leaf diseases. AlexNet, GoogLeNet, ResNet were used as a backbone of the CNN and achieved 97.28% of accuracy.Serawork wallelign[7] et al. proposed soybean plant disease identification using CNN and used 12763 leaf images for training and achived 99% of accuracy.

İn our proposed system , a Convolutional Neural Network is designed for tobaaco leaves image classification. Along with our CNN architecture, also datasets have been trained with variouse pretrained CNN architecture and also done comparative study on tobacco leaf classification results with respect to accuracy and loss.

Architecture:

The network architeccture of the praposed system is as shown in the below figure. İt comprises many types of layers such as convolutional layers,maxpooling layers, dropout layers and fully connected layers. During traing input to convolutional layer is a fixed size of 224 x 224 x 3 RGB image from input layer. The final architecture of our proposed one is similar to resnet and has 4 stages. The architecture performs initial convolutional and max pooling using 7x7 and 3x3 kernel size respectively. İt has 3 residual blocks containing 3 layers each after the first stage. The size of the kernels used to perform the convolution operation in all 3 layers of the block of stage 1 are 64,64 and 128 respectively. The curved arrow refer to the identity connection. The dashed connectd arrow represents the convolution operation in the residual block, is performed with stride 2, hence the size of an input will be reduced to half in terms of height and width but channel width will be doubled. As we progress from one stage to another stage the channel width is doubled and the size of the input is reduced to half. For deeper networks,bottleneck diegn is used. For each residual function, 3 layers are stacked one over the other. The three layers are 1x1,3x3,1x1 convolutions. The 1x1 convolution layers are responsible for reducing and then resotring the dimensions. The 3x3 layer is left as a bottleneck with smaller input or output dimentions. Finally the network has an average pooling layer followed by a fully connected layer having four neurons for four class.The last fully connected layer is followed by output layer. The softmax regression is commenley used in the last fully connectd layer for classification problems. Some of the layer are hidden and equiped with ReLU activation non linear function. Batch normalization have been used in our network to improve the performance.



Input (tobacco images) Conv layer pooling layer FC layer output (4 Classes)

Fig: Architecture of the Proposed Model

Methodology:

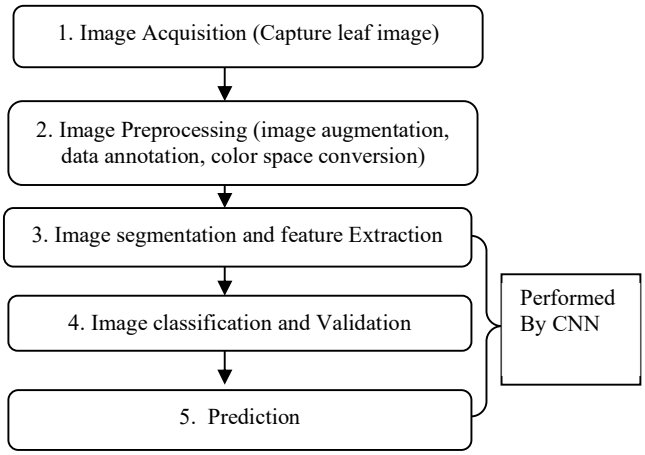


Fig: The praposed methodolgy for image classification

İmage Aquisition:

For experimentation tobacco leaf images have been captured using mobile camera. Around 720 images have been used as an input for model. All images are captured in different envinomental conditions. Image data sets are a green uncured tobacco leaves, theses are acquired in agricultural tobacco processing area. All images are featured by three channels (Red, Green, and Blue channel) and all images are labelled with high resolution images blonging to 4 types of categories.

Image Augmentation:

To increase and achive more accuracy from the model we have to give more numbers of images to model. İmage augmantation is one of the method to increases the input image dataset size. İt can also be uesd to reduce overfitting problem on image dataset. Many image augmentation method haved applied to increse the size of the data set. Some of the image augmentation methodlike translations, transformation, roatations, scaling,shifting, shear,horizontal flip,zooming, mirroring etc. To perform all the opertaions the image data generator have been used. Antoher method of performing an image augmentation is by altering the pixel values with respect to the intensity of RGB channels. The principle component analysis is the method to convert intesities of the RGB channels. İn our implementaion , more than three thousand images are created using image agumentation from 720 original images.

Image Segmentation and feature extraction:

İmage segmentation is a process of extraction only a required portion from the original image. One of the inbuilt feature and advantages of the CNN is self feature extraction and segmentation. By using of this we performed feature extraction and segentation.

Implemantation:

Our own CNN architecture have developed based on ResNet. Our own data set have been used as input for this system. The system is implementaed using Google Colab with TPU environment. An algorithm for the proposed CNN archituctre modle is as shown below.

Algorithm: Over all algorithm for tobacco leaf image classification and prediction.

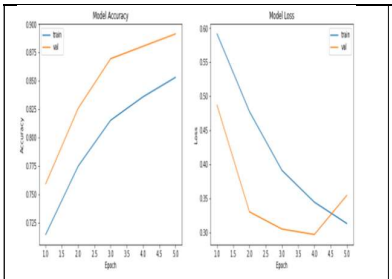
Input:images form data sets containing original image in varioure size captured with camera.

Output: Labelled predicted image after classification along with accuracy and loss.

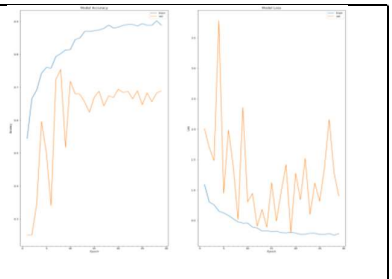
Path← set the path of the dataset.
Files← get all files names of samples from dataset path
For i in Files do
    A[]← perform image augmentationfor training and validation.
    A[]← Resize an image to reduce number of parameters for network.
End
For i in A[] do
    Data←read all pixel values from image and assign to array.
    Label← label the corresponding image which is belonging to class.
End
#Split data for training and testing.70% of the data is machine learing and 30% of the data #is for validation
Train,Test←{{Data,Label},70%,30%}
CNN←Build,compile and run layerd model for classification.
Loss,accuracy= CNN.Evaluate # evaluate model for overall accuracy and loss.
Prediction← load all untrained images for prediction.
For d in prediction do
    Pred←CNN.Predict #predict class from untrained samples
End
END

For the same dataset we condcuct experinment on variouse pre defiened CNN architure and done the comparative study on different pretrained model.

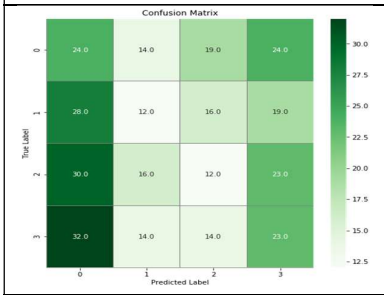
Results:



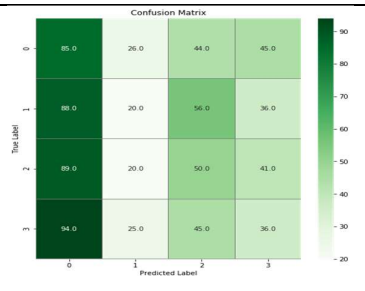
VGG accuracy and loss



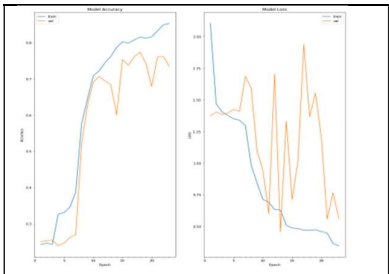
MobileNet accuracy and loss



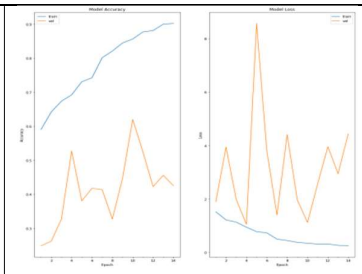
VGG confusion matrix



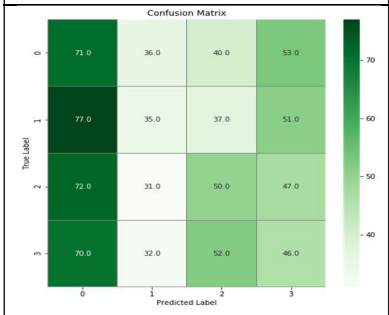
MobileNet confusion matrix



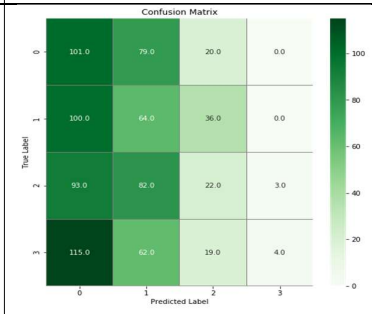
GoogLeNetaccuracy and loss



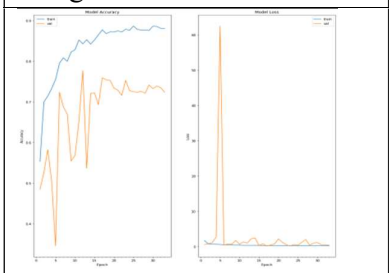
ShuffleNet accuracy and loss



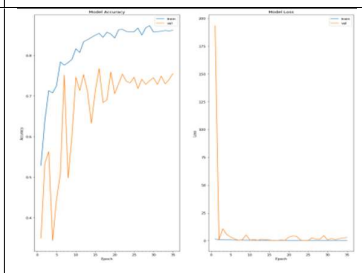
GoogLeNet confusion matrix



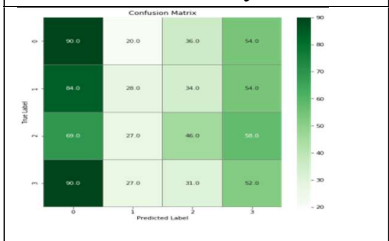
ShuffleNet confusion matrix



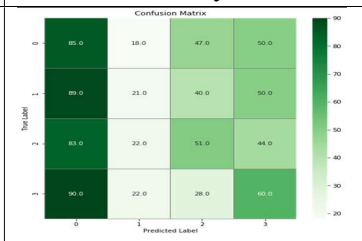
DenseNet Accuracy and Loss



ResNet Accuracy and Loss



DenseNet confusion matrix



ResNet confusion matrix

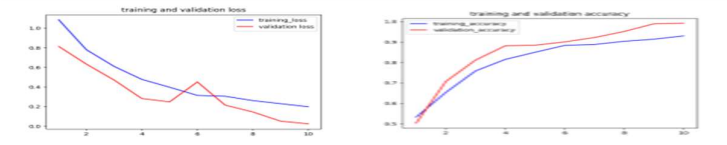


Fig: Proposed CNN Accuracy and Loss

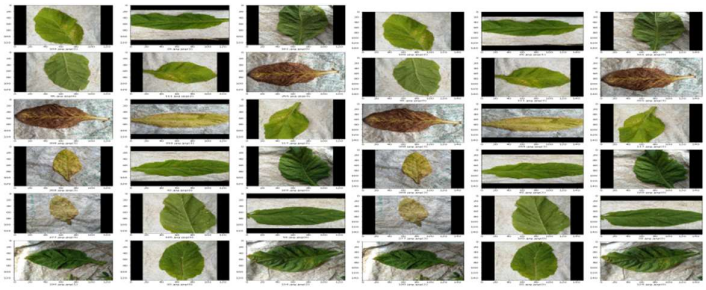


Fig: prediction of the untrained tobacco leaves by VGG Net and MobileNet

Conclusion:

İn this work we have developed a new Deep Convolutional Neural Networks for Tobacco leaves image classifcation. The our proposed system achive better accuracy than any other existing system. An implematation of this system is benifical for community group of farmer for segrigation of tobacco leaves for curing process to achive good quality of tobacco. İn this study we also done comparision with other predefirned architecture. The porposed one has achives relatively good accuracy on tobacco image classificaton.The model is trained and compared using various deep learning architectures based on their top-1 and top-5 accuracy. The proposed model is trained with 720 green tobacco leaves, which achieved 92% of top-1 accuracy after implementing various data augmentation techniques

The futurework work of the proposed system is to enhance the exixting functionalites to perform tobacco crop disese detection and crop loss analysis.

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