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# An Analysis on Multi – Image Classification Techniques

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***Abstract:*** ***Image classification is a process where images are classified based on its visual content. It came into existence to reduce the gap between computer vision and human vision. To classify the images, humans involve lot of efforts and it is time consuming, in order to overcome this, technique such as convolutional neural network and random forest is being used. Convolutional neural network is a class of deep neural network and it is most commonly used for analyzing the images. Random forest is classification algorithms which consist of many independent decision trees. Auto encoding technique is being used to denoise the image. Image inpainting technique is adopted to come up with a complete image which contains missing parts. Image inpainting technique is a process to overcome overfitting.***

***Keywords: Convolutional Neural Network, Random Forest, Deep Learning, Image Augmentation, Image In painting, Auto encoding, Machine Learning.***

## I. INTRODUCTION

Image classification is a systematic approach to categorise the images into its respective categories based on the features of the image [1]. In order to decrease the gap between human vision and computer vision image classificastion came into existence.The model is trained to classify the images into its respective classes. Paper deals about image classificastion using deep learning techniques such as convolutional neural network(CNN) and random forest technique.In addition to this in order to overcome overfitting image augmentation technique is used.Image augmentation technique uses augmentation transforms i.e. traning set images are transformed in such a way to increase the ability of the model to recognize different versions of the image [2]. The transformation includes basic transformation, side-on transformation and top-down transformation. Paper deals about the transformation which includes change in angle. In order to remove the noise from the image image autoencoding technique is being used. Autoencoding is a technique that is used to denoise the image. Auto encoders is used to encode a set of data for dimensionailty reduction in order to remove the noise from the image [3]. Image inpainting technique is being used to come up with a complete image that has missing parts. Inpainting is a technique where damaged, missing, or deteriorating parts are filled to present a complete image. This technique is also used to remove some unwanted objects in the image.

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Convolutional Neural Network are a part of neural networks that is very efficient especially in image classificastion and recognition [4]. It is very much useful in classification of images into respective categories.
Convolutional Neural Network is given an input image and the network assigns weights and biases to various objects in the image and thus be able able to recognize or differentiate the images from the other images , compared to other classification algorithms the pre-processing required is much lower. Architecture of the convolutional neural network is similar to the pattern of neurons in the human brain. Convolutional Neual Network (CNN) captures the temporal and spatial dependencies in the image through relevant filters.
Random Forest is one of the classificastion algorithm that includes various decision trees. Random Forest belongs to ensemble learning method [5]. Adavanatges of Random Forest is that it is very and easy to use this algorithm. In Random Forest decision trees are constructed based on the samples and then prediction is carried out from each decision tree and out of that best solution is selected based on voting. Random Forest is proven to be the best technique as compared to single decision tree as it reduces the over-fitting. After classifying the images using the techniques such as convoutional nural network and Random forest technique, comparison analysis is done on both the tecniques based on the accuracy in order to conclude which technique is best suited for image classfication.

## II. RELATED WORK

**M Manoj Krishna [1]** Discussed about image classification using AlexNet architecture with convolutional neural networks. Images from ImageNet database had been used for classification. Cropping was done on the images and then experiments were being conducted. The results showed the effectiveness of deep learning based image classification using AlexNet.

**Dan C. Ciresan [2]** According to the author flexibility and performance of convolutional neural networks for image classification is high. Paper presented high-performance GPU-based CNN variants trained by on-line gradient descent. Image classification was performed on CIFAR10 dataset and also on MNIST dataset. Feature extractors are neither designed nor pre-wired.

**Nedeljkovic [3]** Discussed image classification based on fuzzy logic. Advantage of fuzzy logic is that it allows natural description. Around 30% of samples were being misclassified. Classification was strongly influenced by the presence of clouds, the regions in the image that were lighter lead to the misclassification.

**Mengje Zhang [4]** Author discusses about the classification strategies for image classification. The paper deals about the multi-class image recognition problems.
Author investigates and explores the dynamic classification methods in genetic programming for multi-class object classification problems and also determines wether the dynamic methods could outperform the current static method for difficult problems.
**Graig Rodarmel [5]** Hyperspectral images expands the capability of using image classification to study detailed characterstics of objects. Paper discusses about the benefit and efficiency of using the principal component analysis approach in image classification as a preprocessing step for classification of the hyperspectral images.

## III. PROPOSED METHODOLOGY

### A. Random Forest

Random forest is one of the classificastion technique which consist of various decison trees. Random Forest is also called as an ensemble learning method. Random Forest is mainly used in classificastion and regression. First Random decision algorithm is given by Tim Kam Ho, it was based on random subspace method [6]. Random forest is a part of supervised learning.
In case of Random Forest creates decision trees on data samples and gets prediction from each decision trees and selects the best by voting method.
Random forest technique is better than single decison tree because random forest technique overcomes overfiting to a very large extent.
Random Forest includes various tasks. Task 1 is to select the random samples from the dataset .Task 2 is that the algorithm constructs a decision tree for each and every sample selected and predicts the result for each decision trre selected , voting approach is used to predict the result .
Task 3 is to select the most voted result as the prediction result.

### B. Convolutional Neural Network

Convolutional Neural Network (CNN) is a part of deep learning technique that is used mainly for image classificastion.
Convolutional Neural Network is also called as space invariant or shift invariant neural networks. Convnets is proved to be sucessful in identifing the images.
Artifical intelligence came up to bridge the gap between the capabilities of machine and human.
Convolutional Neural Network is being provided with an input image, the model assigns the learnable weights and biases to the objects in the image and which helps the model to categorize the images.
Convolutional neural networks doesnt need much of pre-processing [7].
Convolutional neural network includes various layers such as convolutional neuural layer, pooling layer, fully connected layer and ouput layer.
In each layer the identification of edges , shapes and brightness is carried out to classify the images appropriately .
Convolutional layer is used to compute the output of the neurons , computaion is carried out between the weights and small region that are connected to the input. Pool layer is used to perform downsampling across the spatial dimension to create a volume. Fully connected layer is used to compute the class scores where each class score corresponds to the particular category [8].
Output layer is used to predict to which category the input image belongs to out of the class scores. Activation function is used to perform a non-linear transformation on the input before the input goes to the next layer of neurons.
Activation function that is used in this project is sigmoid function. Sigmoid function is a type of activation function that transforms the input value between 0.0 and 1.0 [9]. sigmoid function is one of the activation functions which is more popularly used.

### C. Autoencodng

Autoencoding is a technique that is used to denoise the images that is given as input to the model so that the model will predict the result more accurately [10].
Autoencoding is a technique that is used to encode and as well as to decompose the data into small bits of data and then using it for reconstruction and representation of the orignial data. Two key components of this technique are encoder and decoder.

### D. Image Augmentation

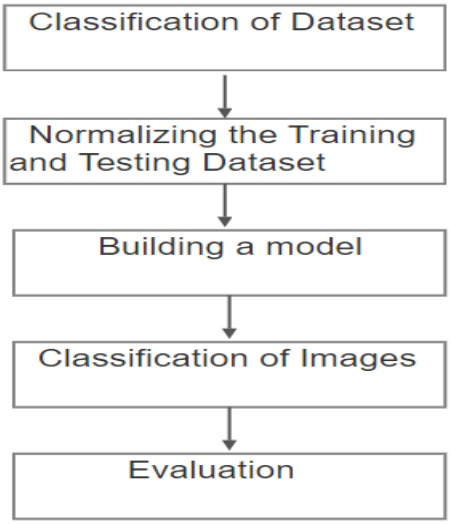
Image augmentation is a technique that uses augmentation transforms i.e the images in the training dataset are transformed in such a way that it increases the ability of the model to predict different versions of the same image.
In this project transformation is done by rotating the images into different angles so that the images are recognized when inputted in different angles [11].
Image augmentation is a technique that is used to overcome the concept of overfitting.
There are 3 types of tranformations such as basic transformation, side-on transformation, top-down transformations.
Basic transformation is about changing the angle and lighting. Side-on transformation is about changing the angle, lighting and flipping along the vertical axis.
Top-down transformation is about changing the angle, lighting and rotating the images to various degrees.

### E. Image Inpainting

Image Inpainting is a technique that is used to come up witha complete image that contains missing parts and some deterioration in images [12].
Image inpainting technique mainly includes reconstruction of the image to provide complete image.

## IV. EXPERIMENTAL SETUP

Process of image classification includes various steps such as collection of dataset, Normalization of training and testing data sets, building a model, classification of images into respective classes and final step is to evaluate wether the predicted class is correct




**A) Collection of Dataset** – Cifar10 dataset is used for image classification. Cifar10 dataset consist of about 60,000 images of 10 categories. Out of 60,000 images 50,000 images are considered as training dataset and the rest 10,000 images are considered as testing dataset. The 10 categories to which the images belong to are cat, dog, deer, truck, aeroplane, automobile, horse, ship, bird and frog.

**B) Normalization of training and testing data sets** – Normalization is process that changes the range of pixel intensity values. To normalize the training and testing dataset the image pixel values are divided by 255. After normalization, the values will be between 0 and 1. Normalization is also called as contrast stretching or histogram stretching.

**C) Building a Model** – Model for image classification is built using deep learning

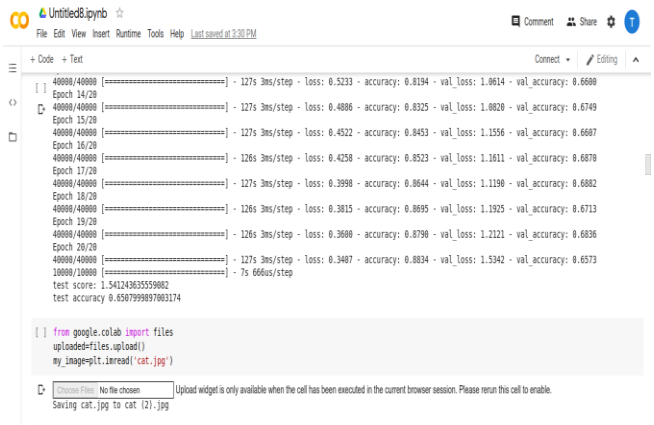


**Figure 1: Result of convolutional neural network.**

techniques such as Convolutional Neural Network and Random Forest technique. Convolutional neural network is a class od deep learning. Convolutional neural network is mainly used for image classification. Random Forest technique is a type of supervised learning. Random forest technique contains various decission trees. One of the decision tree is being selected and it is considered as the result of the classification.

**D) Classification of images** – The model that is built using convolutional neural network and Random Forest has to classify the images into respective categories with a very high accuracy.

**E) Evaluation** – The classification made by the model has to be correct and it should be of very
high accuracy. Convolutional neural network provided an accuracy of about 88% and test accuracy of about 65 % but whereas Random forest provided an accuracy of about 33 percent hence we can infer that convolutional neural network is best suited for image classification as it provides a very high accuracy as compared to random forest.

## V. RESULT ANALYSIS

CIFAR-10 dataset is being used to perform image classificastion. Image classificastion is performed by using two techniques such as convolutional neural network and random forest technique. CIFAR-10 dataset contains about 60000 colour images of 10 classes, out of 60000 images 50000 is used as training dataset and 10000 is used as testing dataset. The images in CIFAR-10 dataset comprises of 10 classes namely aeroplane, automobile, bird, cat, deer, dog, frog, horse, ship and truck.

Convolutional neural network is being used for image classificastion. It provided an accuracy of about 89 percent in classifying the images. Conv2D function is used to achieve this Conv2D function includes the parameters such as filters, kernel_size, padding, data_format, use_bias, kernel_bias_intializer etc. Filters is one of the parameters of Conv2d function which is used to specify the number of filters used in the learning process. Kernel_size parameter determines the dimension of the kernel that is being used. Strides parametr contains an integer value that specifies the steps that is included in the convolution. Padding is the parameter that takes the value as either valid or same.

The figure shows that loss is about 34 percent, accuracy is about 88 percent, validation accuracy is about 65 percent.we can see that val_loss increases and val_accuracy also increases this shows that it might be the case of overfitting or diverse probability values in cases of softmax used in output layer.

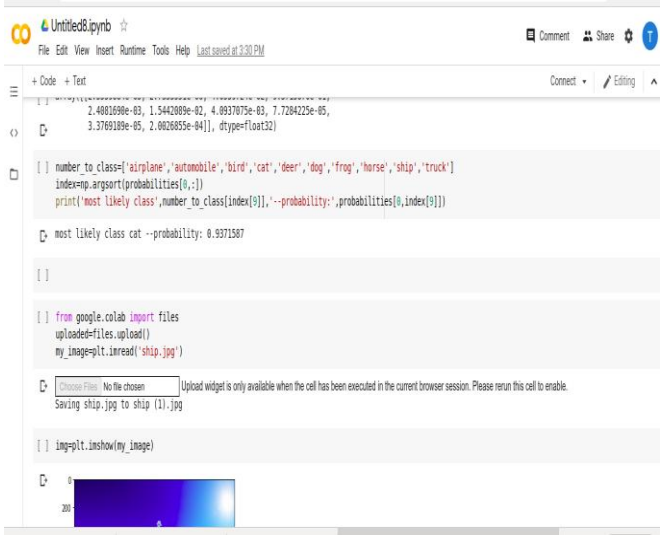


**Figure 2: Prediction of class cat**

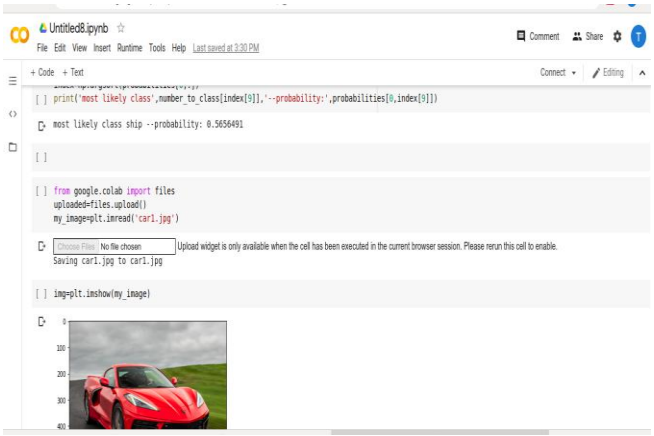



**Figure 3: Prediction of class ship**

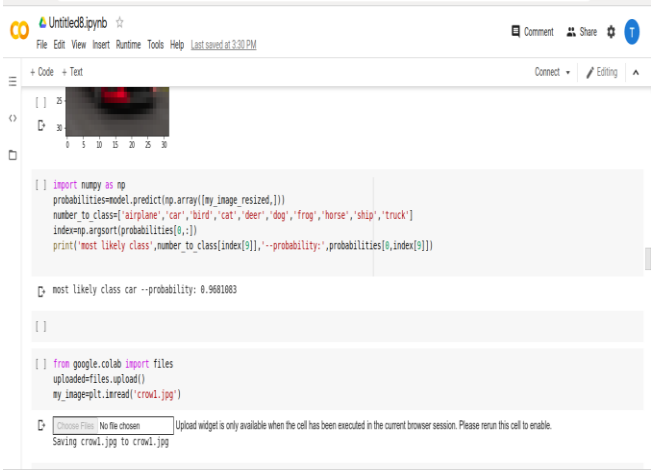



**Figure 4: Prediction of class car**

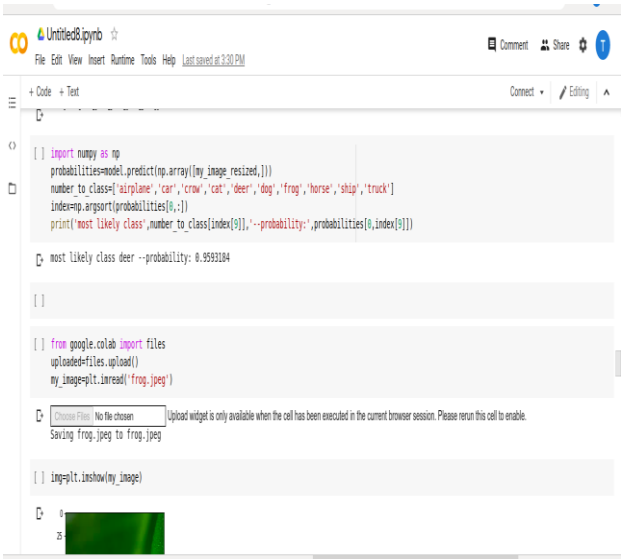



**Figure 5: Prediction of class deer**

The above figure shows prediction of some classes such as cat, ship, car and deer. The class cat is predicted with an accuracy of about 93 percent. The class ship is predicted with an accuracy of about 56 percent. The class car is predicted with an accuracy of about 96 percent and the class deer is predicted with an accuracy of about 99 percent.

Random forest is one of the classificastion technique which consist of various decison trees. Random Forest is also called as an ensemble learning method. Random Forest is mainly used in classificastion and regression.

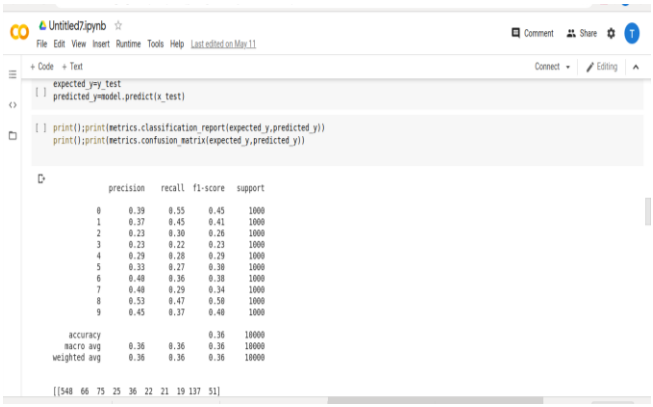



**Figure 6: Result of classification using random forest technique.**

Random forest provides an accuracy of about 33 percent this shows that accuracy of random forest varies at a very huge difference from that of the convolutional neural network. This shows that convolutional neural network provides a high accuracy when compared to that of Random forest from this we can infer that convolutional neural network is best suited for image classification. Autoencoding is a technique that is used to denoise the images that is given as input to the model so that the model will predict the result more accurately. Autoencoding is a technique that is used to encode and as well as to decompose the data into small bits of data and then using it for reconstruction and representation of the orignial data.

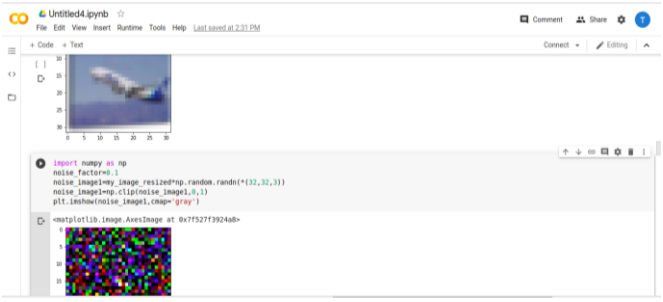



**Figure 7: Adding noise to the image**


**Figure 8: Removing the noise and predicting**

The figure shows that noise is being added to the image when an image is predicted with noise it shows incorrect classification so autoencoding technique is being used to remove noise then the prediction is done correctly it predicted that the image belongs to the class aeoplane with an accuracy of about 56 percent.

Image augmentation is a technique that uses augmentation transforms i.e the images in the training dataset are transformed in such a way that it increases the ability of the model to predict different versions of the same image.

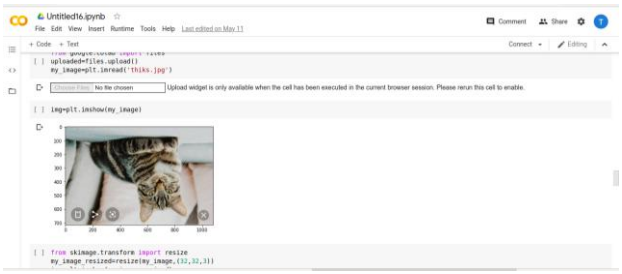


**Figure 9: Result for augmented image**

Above figure shows that image is augmented by rotating in different degree and the result is predicted correctly eventhough the image is augmented.

Image Inpainting is a technique that is used to come up witha complete image that contains missing parts and some deterioration in images.

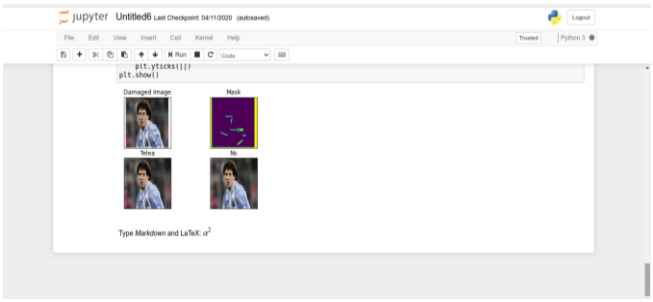


**Figure 10: Image inpainting.**

Above image shows that input of an image is given which has missing parts and by using the technique of image inpainting the complete image is retrieved.

## VI. CONCLUSION

Image Classification is done using two techniques such as convolutional neural network and Random

Forest. Convolutional neural network is proven to be the best for Image classification as it provides high accuracy when compared to that of Random Forest. Convolutional neural network provides an accuracy of about 87 percent and Random Forest provides an accuracy of about 33 percent. Autoencoding technique has been used to denoise the images and to provide better images to the model for classification. In order to predict different versions of the same image and in order to increase the training dataset image utoencoding technique has been used.

Image inpainting technique was used to come up with a complete image that contains missing parts and some deterioration in the images. Various images where given to the model to predict the class of the image. CIFAR 10 dataset is using for prediction of the images. The dataset consists about 60000 images where 50000 images have been used for traning and 10000 images are used for testing purpose.The model can predict 10 categories namely car, ship, deer, dog, bird, aeroplane, deer, horse, truck, frog.

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