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Automatic Noise Detection and Reduction in Images

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Abstract—: Data classification in presence of noise will cause a lot of worse results than expected for pure patterns. In the proposed work we tend to investigate the drawback within the case of deep convolutional neural networks so as to propose solutions which will mitigate influence of noise. The main contributions presented in this proposed work include using convolution neural network as an image classifier for detecting noise in the images and using different opencv2 inbuilt methods to mitigate noise in the images. Though a number of techniques are introduced for this purpose, using neural networks we can achieve a greater accuracy.

Keywords— Convolution neural networks, open cv2, Keras API, Jupyter Notebook, TensorFlow.

I.INTRODUCTION

Research field of computer vision changed significantly over the recent years, mostly due to the advances made in the area of deep learning, In particular, convolutional neural networks were able to achieve progressive leads to the task of image recognition.

Despite the significant amount of research done in this area, most of the work revolves around benchmark datasets, consisting of fairly high quality images. In real-life applications, however, we are often faced with low quality data, distorted by different types of noise, affected by motion blur, difficult lighting and weather conditions, low resolution, combination of these factors, to name a few. The most vital aspect of image processing is denoising. The aim of denoising is to retain the small point of picture by removing the random noise. It plays a major role in the applications that uses digital image processing.[5]

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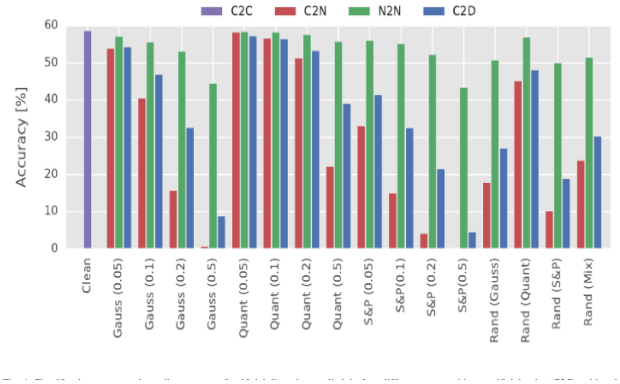
Noise in the images can significantly lead to decrease in accuracy in neural networks classification field.



Fig[1]. Accuracy in presence of noise.

The above bar chart provides vital information regarding the accuracy of some popular neural network in the presence of different types of noises as well as in different artificial and natural scenarios. The above terms used are C2C (without considering the artificial noise), C2N (inclusive of only test set distorted), N2N (inclusion of both training as well as test sets distorted), C2D (considering test set distorted and denoised).

The proposed work is classified into two phases. The Detection phase and the Removal phase. We have used CNN's as Detection tool and different opencv2 functions as a Denoiser.

Application of machine learning technique demand for super wised learning process where programmers must be very specific when deciding on does an image contain actual image or not. So in the proposed work emphasize on deep learning rather than machine learning. Here in deep learning without supervision the program builds the feature set by it. In addition to it is faster method and produces very accurate results.

There are a plethora of denoising filters available such as Median filter, Gaussian filter, Gabor filter, SRAD to name a few. Different filters has different results (calculated as variance between original image and filtered image)[2].

Convolutional neural networks (CNN) are one of the common image processing neural networks which uses back propagation algorithm for adjusting the weights. A neural network model is trained in various ways and an ideal way is to train by providing the data set at the beginning and the other way is called Transfer learning. The proposed work detects the noise in real time also predicts its output and apply the filter if noise is present.

II. RELATED WORK

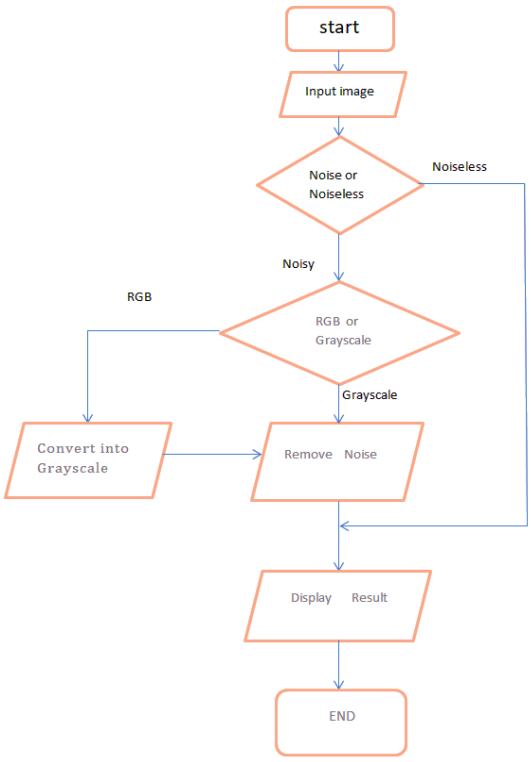
Nvidia's research paper "Noise2Noise: Learning Image Restoration without Clean Data" claims to remove noise with the help of statistical reconstruction using machine learning without even looking through clean data[1]. Google Photos is a mobile application which automatically detects required filter that has to be applied .Noise detection and removal techniques is present in every camera including mobile phones, Digital cameras but none of them uses deep learning technologies. Facebook uses deep learning technology to tag people who are present in the photo. Google's RAISR stands for "Rapid and Accurate Image Super-Resolution," and it's a new technique researchers have developed for creating high-quality versions of low-resolution photos.

The problem in the existing system

Though manufactures are coming up with new software to overcome noise reduction it still persists today in modern day devices. Aggressive use of filters may harm the quality of the image. Some filters may be applied without detecting the noise which softens the image unnecessarily eventually spoiling the image. Whatever the measures we take to reduce noise it is inevitable that noise is generated one way or another through camera system or the electronics present[3]. A compression algorithm may also produce an noisy image. So a reliable, real-time, self-learning approach is necessary.

III. METHODOLOGY

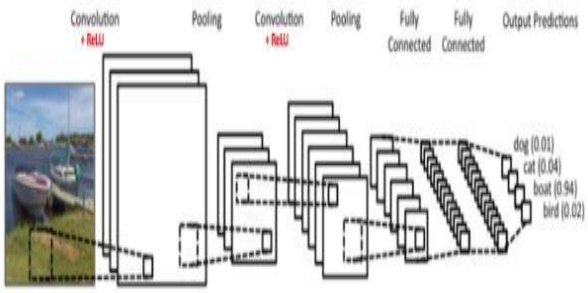
We have chosen deep learning field because it involves wide variety of techniques for image classification and real-time predictions. One of the popular image classification techniques involves convolution neural networks which have different inbuilt procedures for extracting features from the images.



Fig[2]. Flowchart

Convolution neural network:

A **convolution neural network (CNN)** is most applied to analyze the pictures. It is a branch of deep neural networks.



Fig[3]. Overview of cnn's

The CNN consists of various hidden layers, an input layer and an output layer. The hidden layers generally incorporates convolutional layers, RELU layer i.e. activation perform, pooling layers, absolutely connected layers and social control layers.

Stages involved in cnn's:

1. Convolution
2. Pooling
3. Fully connected layers
4. Output

Convolution: The Convolution in CNN is used to extract important factors from the input image. It preserves the spatial relationship between pixels by converting input file to little squares. Every image is considered as a matrix of component values.

Consider a 5x5 image with component values solely zero and one

1	1	1	0	0
0	1	1	1	0
0	0	1	1	1
0	0	1	1	0
0	1	1	0	0

Fig[4]. Matrix representation of image

consider 3 x 3 matrix as shown below:

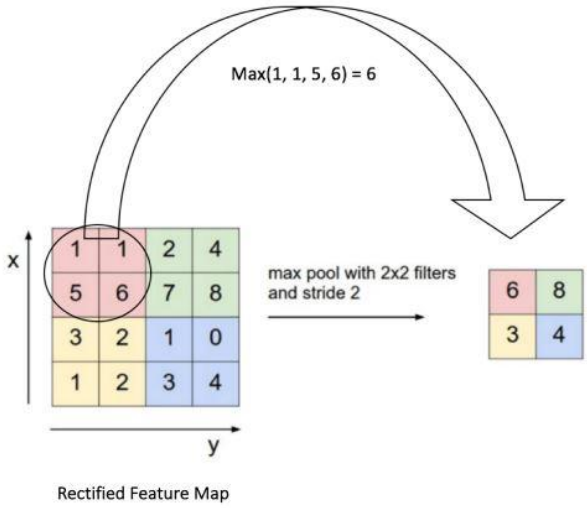
1	0	1
0	1	0
1	0	1

Fig[5]. Filter or Kernel

A 3×3 matrix is termed a 'filter' or 'kernel' or 'feature detector' in CNN field. The matrix developed by scanning the filter over the image and computing the dot product is termed the 'Convolved Feature' or 'Activation' or the 'Feature' Map. The filters acts as feature detectors from the initial input image.

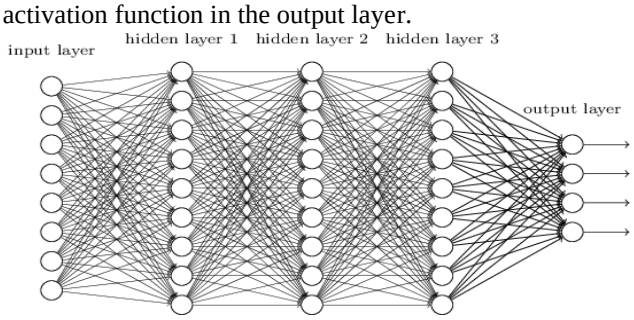
Pooling: Spatial Pooling reduces the dimensions of every feature map however retains most significant info. Spatial Pooling may be of various types: Max, Average, Sum etc.

Below is an example of Max Pooling operation on a Rectified Feature map (obtained after convolution + ReLU operation) by using a 2×2 window.



Fig[5].Pooling

Fully connected network: The term "Fully Connected" mean each nerve cell within the previous layer is connected to each nerve cell on consecutive layer. The Fully Connected layer is made up of a traditional Multi Layer Perceptron. It softmax activation function in the output layer.



Fig[7]. Fully connected network

Output: Predicting whether the image is noisy or not i.e. if the images contain noise in it then it belongs to class 1 otherwise 0.

IV. EXPERIMENT AND DETAILS

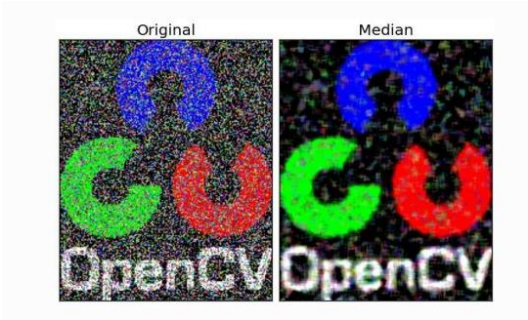
1. Detection of noise in the images :

This module involves detecting the input as noisy or normal image. This module works on the principle of CNN. The Kaggle image dataset which contains 24,000 images of cats and dogs is used. This dataset has been modified with a function which adds speckle noise. This modified dataset is used to train the CNN to predict whether the image is noisy or not. If the image is noisy it belongs to Class 1 otherwise Class 0. If the image is predicted as noisy the image is sent to Denoising module.

Fig[8].Noisy (class 0) Fig[9].Clear (class 1)

2. Denoising the images.

This module involves denoising of the noisy images using OpenCV image libraries. OpenCV provides us with a different image smoothening filters such as Gaussian filtering, Bilateral filtering, Median filtering. OpenCV blurs an image by applying what's called a Kernel. A Kernel tells you how to change the value of any given pixel by combining it with different amounts of the neighbouring pixels. The kernel is applied to each element within the image one-by-one to provide the output image (this operation referred to as a convolution). The median filtering is implemented using a function cv2.medianBlur(). It computes the median of all the pixels under the kernel window and the central pixel is replaced with median value[9]. In the Gaussian and box filters, the filtered value for the central element can be a value which may not exist in the original image. However this doesn't apply to the case in median filtering, since the central component is usually replaced by some element price within the image. This reduces the noise effectively.



Fig[10]. Original vs Median filtered image.

V. CONCLUSION AND FUTURE WORK

Our application will be able to provide real-time solutions for the noisy images problem. By utilising the Tensorflow (keras API) libraries we can save pre-trained model and directly load without any need of training. This model can be utilized in every platform web or mobile. Thus making the application platform-free. Future enhancements include denoising the image using GAN (Generative adversarial network) which helps us to reduce noise without using any external libraries[4]. An application will developed on the mobile and web platform using the Tensor flow Lite library.

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