

Auto Encoders and Decoders Techniques of Convolutional Neural Network Approach for Image Denoising In Deep Learning

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Abstract

Image Denoising (I.D) is the process of eliminating noise from the Images. The noise present in the images may be caused by various conditions which are practically hard to deal with. The procedure of eliminating noise from images given is recognized as image denoising. The noise in the photos might be generated by a variety of factors that are difficult to deal with. In order to process images for purposes such as object segmentation, detection, and tracking, it became a critical job to eliminate the noise from an image and to restore a high resolution image. The image is first given a layer of noise ranging from 1% to 10%, and then the CNN model is used to denoise it. The denoised image is next subjected to qualitative and quantitative analysis. The encoder and decoder layers of the CNN model are responsible for denoising the image. This strategy focuses picture denoising using the Auto encoders and decoders of convolutional neural network (CNN) model in deep learning, but the median filter tends to remove image information. The results of the analysis and experiment show that the CNN model is more effective than other traditional/standard image filtering techniques at removing noise and restoring image details and data.

Keywords: Image Denoising, Noise, Convolutional Neural Network, Auto Encoders and Decoders, Deep Learning.

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INTRODUCTION

Image noise is a form of electronic noise that results in unpredictable fluctuations in image illumination and color info. Image sensors and scanners or digital camera electronics can do that. The inevitable shot noise of film grain and the ideal photon finder may also cause image noise. It is an unwelcome byproduct of image detection. It also obscures details. The mentioned word "noise" originally meant "unwelcome signal" because unwelcome electrical fluctuations in the AM radio signal produced audible acoustic noise ("static"). Unwelcome electrical oscillations in devices used are denoted to as "noise" by analogy.

I.N can be ranged from nearly undetectable spots on a digital snap which is occupied in brightest light to almost fully noise-free optical and radio astronomical images from which a certain pleasurable. An image captured with such uppermost level of noise would be impractical as a result of it would be solid to acknowledge the subject.

A. Types of noise

- Gaussian noise:

Digital photography's most prevalent source of Gaussian noise is the taking of the picture process. Due to the intensity

of the brightness and its temperature, the sensor has inherent noise, and the electric circuits connected to the sensor each produce their own proportion of electronic circuit noise.

- Salt-and-pepper noise:

Spike noise which are also called as Salt-and-pepper noise are indicators that fat-tail scattered noise is "impulsive." Through salt-and-pepper noise, black pixels appear in the lively sections of an image, whereas bright pixels appear in the dark areas.

- Read noise:

Any voltage oscillations in the signal distribution chain that cause analogue to digital elements to deviate from the smooth value proportional to the photon total are known as read noise.

- Shot noise:

According to classical theory, the leading noise in an image from an image sensor's brighter areas is caused by numerical quantum oscillations, or variations in the number of photons recognized at a certain contact level. Photon shot noise is the name given to this type of noise.

B. Noise reduction

The process of reducing the amount of noise from a signals generated is recognized as noise reduction (N.R). Acoustic and Image noise lessening procedures are obtainable. The signal may be disturbed to some amount by noise reduction approaches. Both analogue and digital signal processing kit have features that make them disposed to noise. All of these forms of noise—random/white noise with a constant frequency distribution, frequency-dependent noise produced by tools, machines, or signal processing methods—are instances of noise.

C. CNN

CNN is one of the most efficient algorithms in the deep learning which can be used for various purposes. In this model we are using Cnn technique for the effective denoised image retrieval by removing the maximum amount of noise possibly can be eliminated.

D. Auto encoders and decoders

Encoding is a technique used in machine learning for converting categorical variables into numerical/digital values so that it could be easily used. In the model we use Auto encoding for easy encoding of the image dataset which is followed by the auto decoding process for recreating the processed image which is compressed in the encoding process.

E. In general

Signals are altered to varying degrees by noise reduction techniques. To avoid signal alterations, the local signal-and-noise orthogonalization technique might be utilised. We use the Deep learning (CNN) technique to conduct effective noise reduction in this case.

LITERATURE SURVEY

Literature survey can be considered to be one of the main steps in the software development process In the initial development of a device, it is important to find the time factor and economy, which are the company's strengths. If these conditions are met, the next step should be to indicate which operating systems and languages can be used for further development of the tool. Developers need a lot of external support once they start building their tools.

The study of numerous denoising techniques for digital images exposes that wavelet filters out performs the various additional typical spatial domain filters. Wavelet filters operates by flattening over a fixed window and it produces artifacts round the present object and occasionally it causes over smoothing therefore producing blurring of image. An essential quality of any good image denoising type is that it should remove as much noise as possible while preserving edges.^{1,2}

The analysis shows that ADF (Anisotropic Diffusion Filtering) outpaces all additional denoising techniques together in forms of pictorial eminence and objective assessment and conserves outstanding results over a large and different test datasets, which shows its use in real-life. Contemporary denoising methods in the occurrence of noise existing in abdominal CT images. This type of relative study helps to gain the most appropriate denoising technique for researchers that can be helpful in real life situations.³

Automatically describing the image content is a basic problematic in artificial intelligence (AI) that together attaches CV and also natural language processing. Here we present a generative model based on a deep iterative architecture that uses and combines both machine translation and computer vision. This can be used to generate natural sentences that narrate a particular image.⁶

Filtering noise to rebuild a higher-quality image is a key step in digital image processing for tasks including object segmentation, tracking, detection, and recognition. For denoising of image, we'll utilize a CNN model from deep learning. The merits of using this CNN model over regular/outdated image denoising approaches which includes median filtering, Wiener filtering, and average filtering is that the constraints of the mentioned model can be optimized through network training however the parameters of traditional image denoising algorithms are standard and cannot be accustomed while performing the filtering, resulting in a lack of adaptivity.^{4,8}

The continuous interaction of radiated microwave radiation with target locations creates SAR images. The fundamental goal of the image despeckling mentioned is the removal of the speckle noise while preserving critical SAR elements like texture, corners, and structures. SAR image is typically high-dimensional, and retaining the corner and edge components are big challenges.⁵

The visual quality of the approach is assessed, through additional metrics such as PSNR, SSIM, and UIQI.

Speckle noise is a type of granular design spreading, generally shown as multiplicative noise that cause an affect to the SAR images and all the coherent images. That is why, despeckling tactics are much wanted to increase the excellence of SAR images. But, there is trade-off amid the preservation and the speckle reduction of fine specifics in the despeckle SAR image.⁹

A Cresceptron framework is presented for involuntary algorithm design through understanding of rules and concepts, as a result conflicting from the outdated mode where humans stipulate the rules comprising vision procedure. The Cresceptron is verified on the job of visual recognition: recognition of three-D general stuffs from two-D photographic pictures of the natural acts and segmenting if the identified objects are from the cluttered image background.⁷

It is explained the wake-sleep method, which is an unsupervised learning procedure for the multilayer network

of the stochastic neurons. Top-down "generative" connections reconstructs the picture in one of the layer from the picture in the layers above, whereas bottom-up "recognition" connections turn the given input into representations in the consecutive hidden layers. Recognition connections drive neurons in the "awake" phase, and generative connections are altered to maximise the likelihood that will be reconstructed the right activity vector in the layer underneath. Neurons which are driven by generating connections in the "sleep" phase, and recognition connections are altered to maximise the likelihood of producing the right activity vector in the layer overhead.¹⁰

EXISTING METHOD

The existing method present an image denoising procedure grounded on joint effect of the wavelet transform and the median filtering. The process in the system performs removing the most of the noisy data from the image and thereby maintaining the quality. The level of wavelet breakdown is limited to three. The Root Mean Square Error (RMSE) and index Peak Signal to Noise Ratio (PSNR) displays the obvious upgrading of image denoising above various other approaches. The block diagram of existing process is shown below.

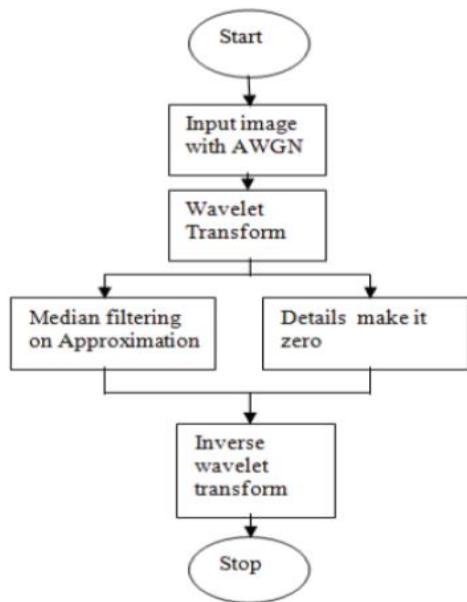


Figure 1: Block diagram of Existing system

PROPOSED WORK

We cover our suggested work for picture denoising utilising the (CNN) model in deep learning in this part. This analysis is carried out by adding 1% to 10% noise to the image and then using the CNN model to denoise it¹⁴. The denoised image is next subjected to qualitative and quantitative analysis. The proposed model's block diagram is illustrated below.

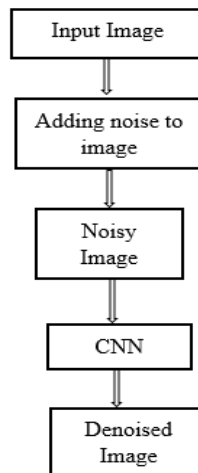


Figure 2: Block Diagram for Proposed Model

The above planned method consists of the following modules

- **Load Dataset:**

The dataset is considered with images which are used for denoising. The dataset we are using consists of images gathered from different sources¹⁵.

- **Pre-processing:**

Resizing and reshaping the images into appropriate format so that the images can fit in output canvas that appears on the screen.

- **Adding Noise:**

Add some noise to the images which is considered as the preprocessing step for training of the data for further processes.

- **Training:**

After adding the noise the images dataset is sent into the model to remove the noise.

- **Testing:**

After adding the noise and trained, test for the results and draw the graphs.

- **Noise Removal:**

We get the reconstructed images with denoised and calculate the mean square error and PSNR value to complete the process of quantitative analysis.

A. CNN (Convolutional Neural Network)

A convolutional neural network is a type of deep neural network used to evaluate visual images/images in deep learning. Getting the desired output image from the input image requires several stages. An output layer, input layer, and an hidden layers together make up a convolutional neural network(cnn). Internal layers in a neural network which are usually known as secreted since the activation function and concluding convolution together cover their outputs and inputs¹⁶.

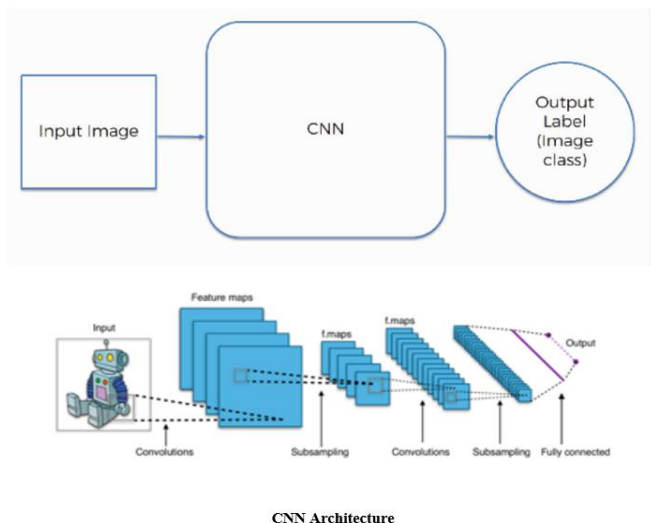


Figure 3: CNN Architecture

Step 1: Convolutional Operation

A convolution operation introduces feature detectors, which are important filters in neural networks. We will also look at feature maps, how to explore the limits of such maps, how to recognize patterns, detection levels, and finally how to graph the results.

Step (1b): ReLU Layer

The second part of this step following above step will involve the Rectified Linear Unit or ReLU. In this We will cover ReLU layers and explore the way in which linearity functions in the context of Convolutional Neural Networks.

Step 2: Pooling Layer

A pooling layer serves to reduce the spatial size of the convolutional function. Smaller sizes reduce the computational power required to process the data. Average pooling and max pooling are two different types of pooling. However, Nexus goes into a special pooling method, max pooling. In any case, I would consider some possibilities, such as summarizing averages (or sums). This step ends with a demo on how to use a co-visual device that definitely covers the topic as a whole.

Step 3: Flattening

This step involves a simple application of the flattening process and the process of moving from the pooled layer to the flattened layer when trading on the CNN.

Step 4: Full Connection

Everything we used so far in this model will be united in this step. Learning this will give you a better understanding of how CNNs work and how the "neurons" they form learn how to classify photos.

RESULTS

The results consist of both qualitative and quantitative values. The qualitative results are presented in the form of images and quantitative results are presented in the form of mean square error and PSNR value. We have also plotted the accuracy and loss plot graph.

The following figure consists of the images which are preprocessed and are used as the input.

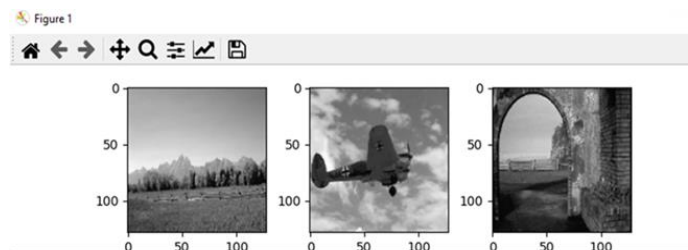


Figure 4: Image without noise

Figure consists of the images which are processed and are obtained as output in first half of code. This images are obtained by adding 1 to 10% noise to input image dataset.

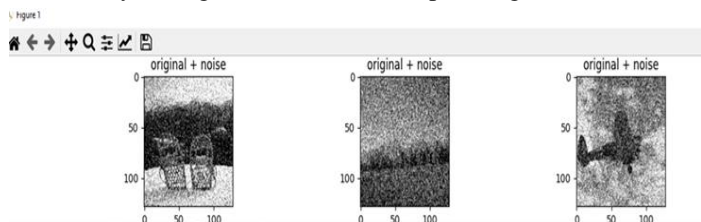


Figure 5: Image with noise

The final output consists of denoised images obtained by performing CNN algorithm on noised images (shown in above figure).The reconstructed images contains less noise compared to the input images we have given.

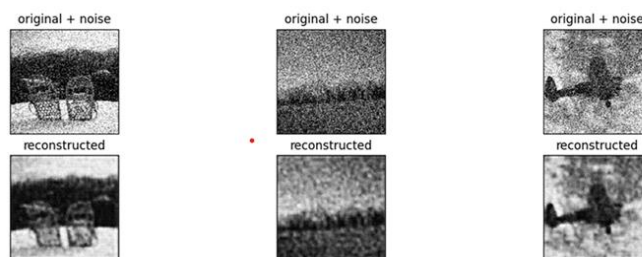


Figure 6: Image with noised and denoised image

Further the quantitative analysis of given dataset is done by calculating the mean square error and PSNR Value The obtained values are shown below.

- **Mean square error=0.0396003723144**
- **PSNR value is=31.076905458884664**

The PSNR Value we obtained by using cnn is 31% which is best value obtained compared to other algorithms.

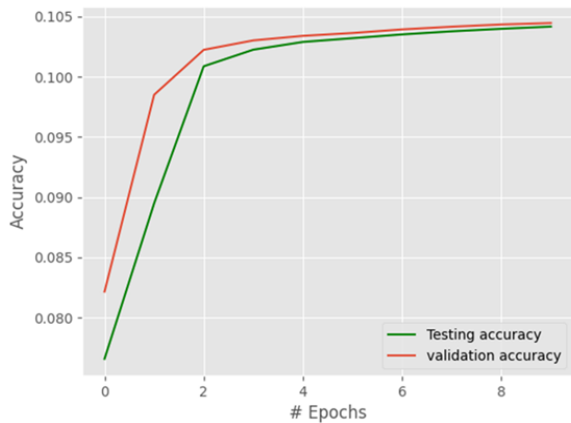


Figure 7: Accuracy Plot

Figure shows the graph of the accuracy plot where the testing and validation accuracy are drawn with accuracy on x-axis and epochs on y axis.

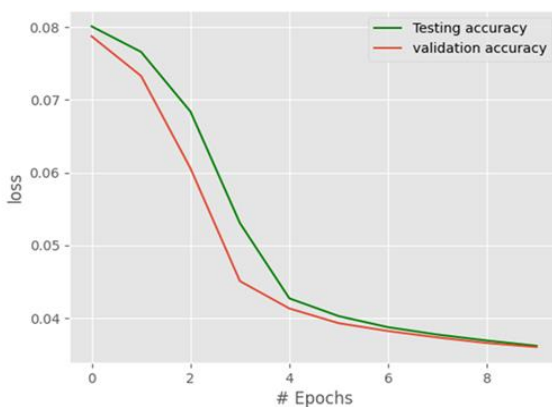


Figure 8: Loss Plot

Similarly figure shows the loss plot graph with the loss on x-axis and epochs on y-axis. The lines drawn are testing and validation accuracy.

CONCLUSION

A deep learning strategy for image denoising is presented in this paper. In model, CNN (Convolution Neural Network) Network is used for the process of denoising a given image. It is taken into account that the input image contains noise that must be denoised. We add noise to a noise-free image before sending it through the CNN network, which is split into encoder and decoder halves. The aforementioned CNN layers to denoise the image after the training are used.

FUTURE WORK

In the future, Improving Picture Denoising results by using

Deep Learning techniques, which improve image visualization can be performed. As a result, saving image data with minimal loss and without losing any of the image's edges becomes easier Where the denoised image is valuable in medicine and can also be used in other fields without losing image information.

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