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Research Article

A Novel Algorithm for Denoising Image with Deep Neural Network and Spatial Filters

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Abstract: When the image is transmitted noise is added during transmission and reception process due to various factor Like thermal noise in antennas or faulty devices, intentionally and interference of other signals. Gaussian noise is prominent among the noises and can be removed. Different methods are available for Denoising. Nowadays Deep neural network along with different algorithms are used which gives satisfactory result. One of the algorithms is proposed in this paper which uses iterative median, low pass-high boost technique along with deep neural network to do the Denoising of a noisy image.

Keywords: Neural network, Convolution, low pass filters, high pass filter, image assessment parameters.

1. Introduction

Digital image play a very important role in our life. They can be used in traffic monitoring, satellite, Television, authentication, Geographical information system, handwriting recognitions, transmission, and reception. So it is necessary to remove noise. Some basic Denoising techniques are discussed in survey paper (L. Sherlin Pravina 2020).

In iterative mean median filtering (u. erkan, 2019; Bhateja, K. 2014) mean filtering followed by iterative median filtering ,low pass filtering and high boost filtering has increased the PSNR ratio value and decreased MSE but image is not clear a bubble type texture is found in the image. So by using the feature of Denoising toolbox in Matlab 2020b and deep neural network using CNN (Zhang, K., 2017) resultant image obtained is clear with good PSNR value and low MSE compared to previous methods.

2. About Deep Learning and CNN

Deep learning was introduced in year 1986 by Rine Dechter. It is a concept in machine learning (S. Colonnese, 2005). It was used earlier for handwriting recognition. In 1998 it was used in speech processing by Leary Heack. Because of connectionist temporal classification (CTC) trained LSTM (Seppo Linnainmaa, 1970; Y. LeCun 1989; H. Dvir, 2020; C. Yao, 2010; Mohammad Aamir Almas 2020) Deep learning is used in Google for speech recognition system in 2015.

Deep learning is used to predict deceases in medical field from 2012, Specially for detection of cancer . Nowadays, Deep learning became a critical component of computing. Convolution neural network (CNN) is one part in deep neural network. It uses a basic mathematical operation called convolution instead of matrix multiplication. In neural network at least one of their layers convolutions is used instead of matrix multiplication to make it convolution neural network. Back propagation is used nowadays to train CNN architecture.

CNN has following distinguishing features. 3D volumes of neurons, local connectivity, sheared weights, and pooling make weight sharing generalization better, lowers the memory requirement and allowing training of most powerful network.

CNN are used in image recognition, video analysis, Natural language processing, Anomaly detection drug discovery, Health risk assessment, checkers game, tine series fore casting and cultural heritage and 3D datasheets.

3. Methodolology

In order to remove noise from image in the proposed method Deep neural network with Denoising toolbox is used with iterative median filtering and low pass high boost filtering is used. Following steps gives the algorithm of the proposed method.

1. Input image is read and then converted to gray level.
2. Add gaussian white noise with SNR ranging from 1 to 12 to obtain noisy image.
3. Use denoising deep neural network to denoise the noisy image using specified network.
4. Apply median filter to further reduce noise step 4 is repeated 50 times to achieve low MSE. The is chosen after trailing with different number of times.
5. Low pass filter is applied.
6. High pass boosting is done using the information of low pass filter.
7. Once again the resultant image filtered using median filter.

The final image after Denoising with above steps is compared with original image to get PSNR and MSE. It can be seen that higher PSNR is obtained and further MSE is decreased to get clear image after Denoising.

4. Results and Analysis

Proposed work is presented on cameraman image for different signal to noise ratio. It is clearly shown that the performance is improved compare to other methods. Figure 1 shows input image, Figure 2 shows noisy image that is image after adding noise with SNR =4(Not in dB).

Figure 1: Input Image

Figure 2: Noisy Image

Figure 3 shows denoised image after applying deep neural network and Figure 4 shows image after applying iterative median filter.

Figure 3: Denoised Image after applying Deep neural network

Figure 4: After applying iterative median filtering

Figure 5: After applying low pass filter

Figure 6: After applying median filtered high boost.

The Figure 5 shows image after applying low pass filter, Figure 6 image after applying high boost filter. Table 1 gives the details of PSNR and MSE values of filtered noisy images when compared with original image for different SNR values.

Table 1: PSNR and MSE for different SNR values

Sl no	SNR	PSNR	MSE
1	1	17.63	1122.40
2	3	22.71	348.32
3	5	24.18	248.19
4	7	24.89	210.84
5	9	25.23	194.96
6	11	25.53	181.70
7	13	25.76	172.59

Equations used to calculate PSNR and MSE are given in equation 1 and 2 where O indicate original image and D indicate denoised image i,j indicate i^{th} row and j^{th} column of image

$$MSE = \sum_{i=1}^{m}\sum_{j=1}^{n}(O(i,j) - D(i,j))^2 \qquad (1)$$

$$PSNR = 10\log_{10}\left(\frac{255 \times 255}{MSE}\right) \qquad (2)$$

Table 2 shows the comparison of the PSNR with MSE after Denoising noisy image using previous Denoising methods and proposed method. All the methods are using deep neural network toolbox of MATLAB.

Table 2: Comparison between different Denoising methods .

Image De-noising methods	Image assessment parameters	
	PSNR	MSE
Wiener filtering	25.0098	849.98
Bilateral filtering	25.09021	83.6294
PCA	26.7834	80.9892
Wavelet based transform variation	26.1243	81.8765
Proposed method	27.4061	118.1610

It is observed that MSE is increased to previous methods due to median filtering but it increases the clarity of resultant image.

5. Conclusion

Using the proposed method the Denoising of Image is achieved to a greater extent without compromising on the Image Characteristics. The performance of the above method is further improved by adding iterative median filter and low pass filtering and high boost. If we apply mean filter before applying iterative median filter higher performance that is PSNR value can be further increased and MSE can be decreased but it increases the time of computation.

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