Modern Deep CNN Based Median Filter Method for Salt and Pepper Noise Elimination

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Abstract:-- **In the field of image analysis, one of the most active research areas is the suppression or reduction of impulsive noise. The elimination of salt and pepper noise is considered an essential step in the process of picture restoration, despite the fact that it is a more challenging task than the elimination of pure noise. As a direct consequence of this, there have been a minuscule number of publications in this sector. In this research, an unique technique for eliminating salt and speckle noise from very dense salt and pepper noisy images is proposed using an Iterative Modified Decisions based Asymmetrical Trimmed Median Filter. This filter is utilised to remove salt and speckle noise from photos. The current MDBUTMF is unable to rebuild the original picture from the loud one if the broad swaths is larger than 70 percent. The performance of the suggested method is tested with a number of different measures, such as the Square Error Error (MSE) and the Signal-to-noise Ratio (SNR) (PSNR). Simulated findings make it abundantly clear that the suggested method surpasses all qualitative and quantitative fidelity requirements. This is demonstrated by a comparison with MDBUTMF.**

index terms: Image processing, impulsive noise, wavelet transform, noise density, IEF.

I. INTRODUCTION

Noises that are injected into digital images during the capturing and/or transmission phases can be represented by Additive Gauss White Noise (AGWN), motion blur, or Mixed Gottingeniand Impulse Noise (MGIN). [16, 22], [20] These three types of noise can be employed. The addition of accidental white noise (AWGN) to an image during its phase of capture can be conceptualized as the addition of a value from a zero-mean random variable to each input image. This value is inserted into each image.

The ideal filter for removing AWGN would have been able to clean pixels within a particular local area of an image while preserving the crispness of the region's borders at the same time. An input image that has been processed with a linear filter may successfully remove noise, but this comes at the expense of significant edge blurring. Some linear filtering [10, 12, 14, 19], [23] has in fact been presented as a solution to this issue. These linear filtering methods concentrate on using local image measurements to identify edges and then smoothing them so that they are smaller than the majority of the image. The most prevalent type of noise is known as impulse noise, which is sometimes referred to as salt and pepper noise [8, 9, 18]. It is possible to create an approximation of impulse noise by arbitrarily replacing a portion of images with random images while preserving the integrity of the remaining pixels [17, 21].

Because the filters that were designed specifically for the elimination of AWGN treat the pixels that make up the impulse noise as edges and preserve them, they do not operate very well when applied to impulse noise. Yildirim et al. categorized the various types of filters that were suggested for the purpose of minimizing impulsive noise as follows: 1) The basic median filter, which replaces the centre pixel of the filtering window with the median filter price of all images in the same window, does a good job of removing noise, but it blurs visual features and thin lines even at low noise levels; 2) approaches that rely on impulse sensors, which aim to determine whether the centre pixel of the filter frame has been influenced by an impulse; and 3) h A few examples of thresholding variants include the Standard Median Filter (MF), the Requires Adaptation Filter (AMF), the Adaptive Normalized Method (A WA), the Switching Mean average Filter (SMF), the Judgment Based Algorithm (DBA), the Decision Based Asymmetric Snipped Mean average Filter (DBUTMF), and the Modified Decision Premised Inverted Snipped Median Filter (DBUTMF) (MDBUTMF). The typical Median Filter (MF) [1, 5, 6, 11, 15] has the drawback that it is only effective when the vast majority of the image is less than 20 percent; if it is higher than 20 percent, edge as well as image features are destroyed. This is the case when the vast majority of the image is less than 20 percent. When there is less background noise, the Adaptive Median Filter (AMF) [2,3, 4, 13] functions more effectively.

The method known as Modified Decisions Based Asymmetrical Trimmed Median Filter (MDBUTMF) [7] does not result in an improvement in quantitative or visual integrity. In terms of visual clarity, Mean Square Error (MSE), and Maximum Signal-to-Noise Ratios, the Advanced Modification Statistical Signal Asymmetric Trimmed Middle Filter (AMDBUTMF) technique that was suggested beats previous methods (PSNR).

The remaining paper is organised in the following fashion: In Section II, a concise introduction to the Modified DecisioniBased Asymmetrical TrimmediMedian Filter is presented. In Section III, we go over the details of the suggested algorithm. A comprehensive analysis of the method that was suggested can be found in Section IV. In Section V, the results of simulations with a variety of images are presented for consideration. The final portion of the paper, the conclusion, can be found in Section VI.

II. MODIFIED DECISION BASED UNSYMMETRIC TRIMMED MEDIAN FILTER (MDBUTMF)

The basic concept that underpins the development of the filter is the utilization of a processing pixel known as PY to eliminate noisy pixels from a selected time window of 3x3. PY is a corrupted pixel if it equals 0 or 255. In the event that the selected window contains nothing but 0s and 255s, the mean component of the window will be used in place of the pixel PY. If the currently selected pane does not contain all components as 0s and 255s, then the 0s and 255s need to be removed before calculating the median value of the total pixel elements.

It has been decided to use the median value rather of the PY. This process is carried out throughout the entirety of the image. Furthermore, MDBUTMF has another flaw: it believes that all pixels with a value of 0 or 255 are with noise, and as a result, de-noised photos must not comprise any pixels with a high pixel level. This is because MDBUTMF thinks that all pixels with a value of 0 or 255 are with noise.

III. CONVOLUTIONAL NEURAL NETWORKS (CNN)

A convolutional neural network (CNN) is a subtype of neural network, which was covered earlier. A typical neural network will have a system that consists of one or more convolutional layers, occasionally followed by a subsample layer, and then one or even more convolution layers. The discovery of a visual process in the mind known as the visual cortex served as the impetus for the development of CNN. The visual system is made up of a huge number of cells that can detect light in brief, overlapping sub regions of the visual field that are collectively referred to as the visual field. The more complex cells work as local filters over input space, and they have a wider range of visual field to choose from. The convolutional operation in a CNN [69] is what makes it possible for the cells in the cerebral system to perform their functions. The CNN shown in Figure 4.1 can be used to recognize common road signs. A local receptive field is a collection of features that are positioned in a teeny-tiny neighborhood in the layer that comes before it. The characteristics of each layer draw their messages from this set of features. By making use of the local receptive fields, characteristics are able to recover fundamental visual properties such as oriented edges, end-points, corners, and so on. These features are then afterwards included by the protocol stack. In the traditional approach to pattern and picture recognition, a feature map that was developed by hand collects meaningful data from the input and removes variants that are unrelated to the task at hand. Following the extractor comes the trainable classifier, which is your run-of-the-mill neural network that categorises feature maps according to predetermined criteria.

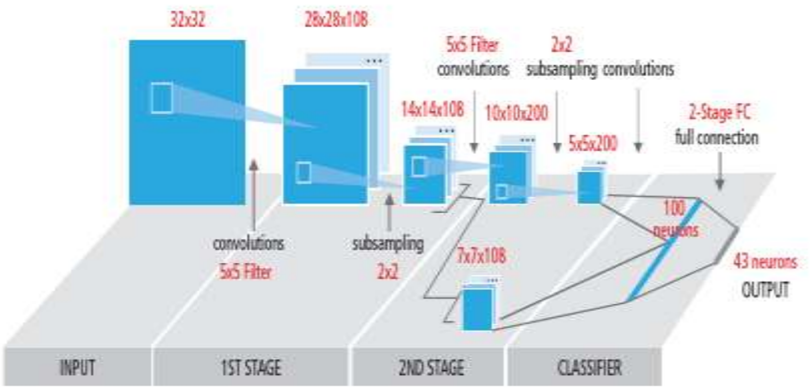


Figure 1: Typical block diagram of a CNN [69]

Convolutional neural networks (CNNs) use convolution layers as feature extractors. They are not, on the other hand, crafted by hand. Even through the entirety of the training process, the convolution filter kernel weights are chosen. Convolutional layers have the potential to recover local characteristics due to the fact that the reflexes of buried nodes are restricted to being local. CNNs are used for a variety of tasks, including the identification of images and features, the recognition of voices and spoken languages, and the study of videos. The use of convolutional neural networks is becoming increasingly common for a number of different reasons. The process of extracting features uses traditional pattern matching models and is done by hand. In CNNs, the weights of the convolution layers used for feature extraction and the fully-connected layers used for classification are determined during the training phase. The updated network architectures of CNNs result in lower memory and computation complexity needs, and they also provide superior performance for scenarios in which the input contains local correlations (e.g., image and speech).

IV. PROPOSED ALGORITHM AMDBUTMF

The Advanced Modification Statistical Signal Asymmetric Trimmed Middle Filter (AMBUTMF) that has been suggested finds the disturbance in the distorted picture first. The noise level of the storage pixel is evaluated to determine its status. If the processed pixel value is between the minimum of l and the maximum of 254, then the pixel is considered to have no noise. When processing an image using AMDBUTMF, if the processing data point is either 0 or 255, the pixel is considered to be a loud pixel. The following is an outline of the algorithmic stages involved in this method:

ALGORITHM STEPS

Step 1: Add O's to image's Third Row, First Section and Last Row, Last Column.
Step 2: Create a 3 by 3 window and set the Processor pixel to PY in the window.
Step 3: Repair the image that has been corrupted: If the processed pixel value is between 0 and 255, it is an incorruptible pixel with no change in value.
Step 4: PY is a corrupted pixel if it equals 0 or 255. The following are examples of pixel processor scenarios:
Case I If the selected pane contains just 0s and 255s, PY is substituted with the average of the window's components.
Case ii): If no O's or 255's appear in any of the items in the selected window, remove them, sort in increasing order, and calculate the median value of the remaining elements. PY should be replaced with median value.
Step 5: Repeat steps 2–4 until you've processed all of pixels in image.
Step 6: Repetition of stages 2–5.
Step 7: Remove the additional rows and columns of 0's that were entered in step 1.

V. ILLUSTRATION OF AMDBUTMF ALGORITHM

The provided image should be checked for salt and pepper noise. If the image is noisy, increase the number of zeros from around image's comers to retain the edge details. When the image's size is reduced to 258 x 258, it's simple to process it with a 3x3 window with PY as the functional block.

$$\begin{array}{cccccc} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & & & & & 0 \\ 0 & & & & & 0 \\ 0 & & \text{Image} & & & 0 \\ 0 & & & & & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array}$$

Case i): If indeed the processing pixel would not be a 0 or 255. Then it doesn't need to be processed, as seen in the example below.

$$\begin{bmatrix} 12 & 15 & 98 \\ 34 & <25> & 16 \\ 22 & 67 & 66 \end{bmatrix}$$

"25" denotes the process pixel (PY). Because "25" is noise-less number.
Case ii): If processor pixels is either 0 or 255, and all of window components are both 0s and 255s, then processing is required as shown.

$$\begin{bmatrix} 255 & 255 & 0 \\ 0 & <0> & 255 \\ 255 & 255 & 0 \end{bmatrix}$$

The value "0" denotes the processor pixel, also known as PY. Due to the fact that the window's elements only contain 0s and 255s. Due to the fact that the average income will now be either 0 or 255, the processed pixel does not need to be replaced with the median value any longer. During the processing stage, image pixels should be replaced with their mean values so that this problem can be avoided. The typical person here has 170 points. 170 should be substituted for the number of processing pixels. In the third possible scenario: In the event that the processed pixel value for the selected window is either 0 or 255, and all of the other pixel values are free of both noise and sound, then the data is processed in the manner depicted.

$$\begin{bmatrix} 167 & 215 & 0 \\ 128 & < 0 > & 255 \\ 223 & 211 & 90 \end{bmatrix}$$

The storage pixel PY is represented by "0." First, organize the aforementioned matrices in a 1-D array like [167 215 0 128 0 255 223 211 90] to remove the noise from the current cell. The pixel values in the specified area will be [167 215 128 223 211 90] because after 0s and 255s have been removed. The median value is 189 in this case. PY stands for processing pixel, while 189 stands for 189.

V. SIMULATION RESULTS AND DISCUSSION

The suggested method is evaluated using greyscale photographs with a resolution of 256 by 256 pixels and is exclusively concerned with salt and pepper noise. The noise density might range anywhere from ten percent to ninety percent at any given time. The MSE and PSNR are two quantitative measurements that are used to evaluate the success of denoising.
PSNR statistics, which stand for "Peak Signal to Noise Ratio," are utilized to evaluate the quality of an image:

$$PSNR\ in\ dB = 10log_{10}\left(\frac{255^2}{MSE}\right)$$

$$MSE = \frac{\sum_i \sum_j (\gamma(i,j) - \gamma(i.j)^2)}{M \times N}$$

$$IEF = \frac{\sum_i \sum_j (n(i,j) - r(i,j))^2}{\sum_i \sum_j (x(i,j) - r(i,j))^2}$$

The total of squares represents the MSE for both of the images. When the PSNR values are higher, it means that the stego-image is more similar to the original picture.
Figures 1 and 2 show the results of attempting to restore a Lena picture that was either 50 percent or 90 percent corrupted by utilizing known and suggested methods, respectively.

It has been demonstrated that colour descriptors have a considerable impact on a number of different types of visual evaluations. In various more jobs, texture measurements are required in order to account for surfaces that have an irregular colour pattern or an unusual shape. As was mentioned before, we made use of aspects such as size and shape in addition to colour and texture. The simulation is used to demonstrate various imaging and restoration techniques such as super resolution, registration, and transformation. After reaching this conclusion, we employ a method known as a nonlocal mean filter in order to get rid of the salt and pepper noise. As a consequence of this, the first picture will act as a reference picture, and the second picture will have its coordinates translated to those of the reference picture. A updated judgment trimmed median filter is applied in order to reduce the amount of noise and improve the overall quality of the image.
There is an RGB combination that can be found in the original image as well as in the photos that were supplied. The very first thing that happens in image processing is the acquisition of images. You will need both of these elements in order to take images using digital technology.

EXPERIMENTAL RESULTS OF DIFFERENT IMAGES

Figure 2: Original Input Image a

Figure 3: Original Input Image b

The first is sensor, which is physical device that detects and responds to energy emitted by object to be photographed. The scanner is the second component. It is a device that converts the sensing equipment's output into digitally. In a camera phone, for instance, the sensors provide a voltage energy proportionate to the amount of light. The outputs are converted to digital data by the digitizer. Noise is generated during the image capturing process.

Toggle between RGB and grayscale images or colour maps. To begin, we must convert an RGB or colour image to a grey image by diminishing the hue and saturation data while keeping luminance. This could be single, uint8, uint16, double, or if the source is an RGB image. The input image's class is same as generated image's.

Figure 4: Image shifted focused on reference image

Here, the original input image is used as a source images or a reference image, which is plotted with function of x & y and moved with absolut value in shifted image, then taken a cross correlation of pixel and plotted with exact amount.

Figure 5: Image registered focused on reference image

Figure 6: Image shifted focused on reference image

So, after applying Projective Transforming on the image and selecting control points (that should be the same in both images), image obtained after interpolated of fundamental high - resolution model may be seen here.

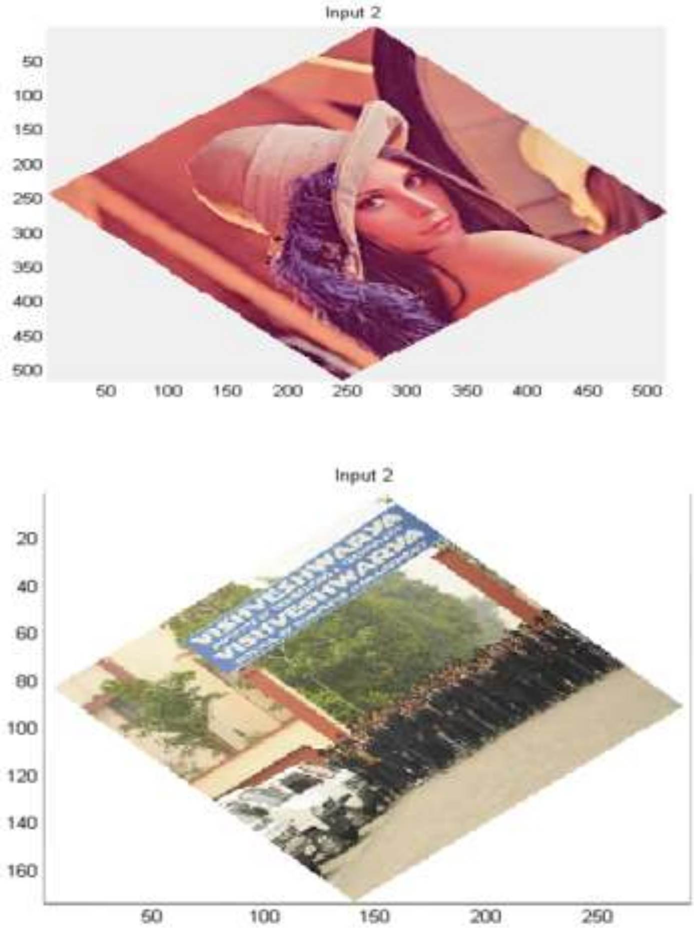


Figure 7: Lena & VGI Image interpolation

For the grey image, I used the altered trimmed filter, first applying lossless mode to eliminate the noise, then putting salt and speckle noise in image with cushioning, and then applying the parts of salt and pepper noise in image after a few cycles. Apply Fox news modified choice trim median filter at this stage to reduce noise from image and obtain output. After that last stage, use a new Matlab technique to eliminate extra padding and assess quality output again, as well as determine the system performance.

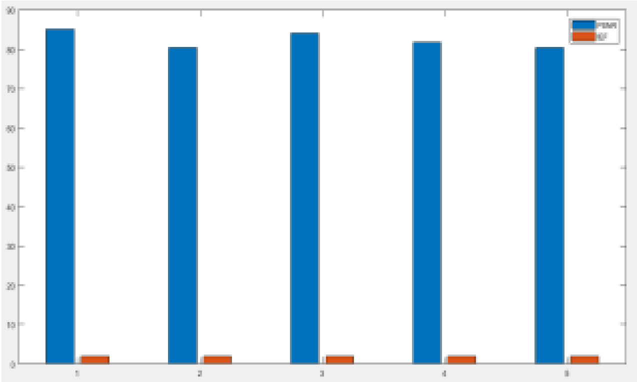
original image with noise added

Figure 8: Lena & VGI Image noise removals

The goal of calculating image's quality and then comparing them will reveal which image is superior for noise removal. Such an approach is mostly owing to the noise filtering algorithm's very accurate noise detection, which has a high noise system equipped, and our method outperforms the gamma correction and other traditional edge-preserving methods. PSNR (peak signal-to-noise), SNR (signal-to-noise), and MSE (mean squared error) are all high; MSE (configurations error) is low. This suggested method is a quick way to get rid of salt and pepper sounds.

Table 1: Performance Table for same image but for different format

S. No	PSNR	IEF	Image Format
1	82.0362	1.0652	Lena.jpg
2	78.5312	2.2352	VGI.jpg
3	81.0358	2.0371	VGI.png
4	80.7523	3.2950	VGI.bmp
5	79.2852	2.1162	VGI.gif



1=lena.jpg; 2=VGI.jpg; 3=VGI.png; 4=VGI.bmp; 5=VGI;

Figure 9: Bar chart of PSNR & IEF

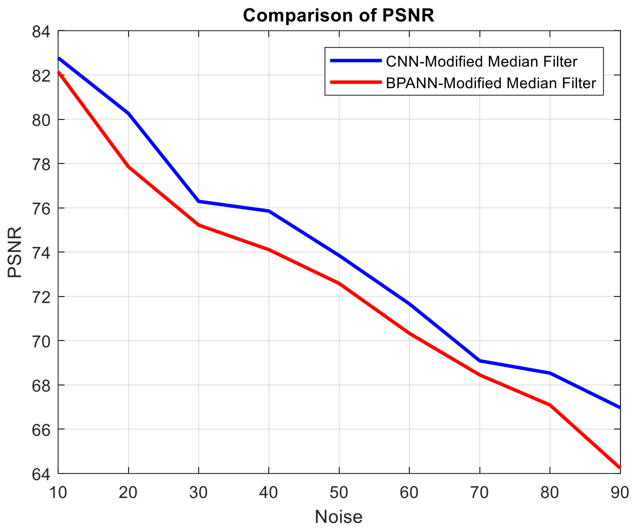


Figure 10: Comparison of PSNR for ANN and CNN based algorithms with Noise

VI. Conclusion

An algorithmic approach, in most cases The advance modification decision-based asymmetric trim median filter, abbreviated as AMDBUTMF, is being developed and tested for use with a variety of denoised images derived from a variety of file types. The statistics from the simulation clearly reveal that the method that was devised performs better than existing methods in terms of PSNR and MSE when it comes to eliminating sound with a high density. The performance of the approach is examined using grayscale photos with a variety of noise densities. The technique that has been proposed is superior in terms of its ability to reduce the effect of noise, particularly at high noise concentrations. This approach is also applicable to a wide variety of noises, including speckle noise, Gaussian noise, random noise, and others.

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