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Development and Analysis of Enhanced Window Median Filter Approach of Image Denoising

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ABSTRACT: With advancement in technology, everyone is capable of taking pictures. However surrounding environment affect the quality of pictures. Image Denoising helps in eliminating the noise in a picture and enhancing the quality of the picture. When sending photos via any form of electronic communication, noise is a huge concern. Impulse noise that is created by unpredictable voltage is one of the most common types of noise in electronic communication. The comparability of known picture DENOISING approaches is explored in this study, and an original methodology for the elimination of impulse noise has been developed using the median filter and order statistics filter. All of these techniques are capable of preserving details of the image while decreasing impulsive noise. The fundamentals of these strategies are first presented, and then investigated using MATLAB simulation results. The majority of already known approaches can be used to DENOISE photos that have less noise density. In this paper, a novel non strategy is described that outperforms existing non-linear approaches. The assessments are conducted visually, then statistically by determining the Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) of various filtered images.

I.INTRODUCTION

Each Image has some Noise. Images are inherently corrupted by noise during capturing, compressing, and communication due to the impact of the surroundings, the transmission medium, and other factors, resulting in distortion and loss of picture information. Possible following image processing activities, like video processing, image processing, and navigation, are harmed by the existence of noise. The image definition suffers as a result of different interferences and noise. Simultaneously, noise causes the image to blur. The horrible situation was completely submerged. It makes analysis extremely tough. As a result, in order to increase visual quality, humans must suppress undesirable noise. To minimize digital image noise, simple filtering algorithms are applied. Basic filtering methods are used to reduce digital image noise. Filtering by mean, median, Gaussian, and bilateral are all examples of filtering.Noise elimination is the main constraint in digital image handling and sometimes it is very difficult to find out the origin of the noise. Noise can be added in the image acquisition process depends on the quality of cameras, acquisition condition and restoration process, such as illumination level, calibrating or positioning and scene environment. The filtering process has a different task like to remove noise, sharpening the contrast; highlight the contours and detection of edges. These filters are sub separated into linear filters and nonlinear filters. Nowadays digital filters are come into picture because of their convenient, easy understanding, low price, reliability and easy programmability.

Image DENOISING is the procedure of eliminating noise from a noisy picture and restoring the original image. Because noise, edge, and texture are all elements with a high frequency, it's impossible to tell them apart during the DENOISING operation and the DENOISED photos will definitely miss certain information. Consequently, retrieving relevant information from noisy photos throughout the noise elimination process to generate high resolution pictures is a major challenge currently.In fact, picture DENOISING is a well-known issue that has been researched extensively. Nonetheless, it continues to be a big and unfinished process. The major reasoning for this is that picture DENOISING is an inverse issue with no unique solution from a mathematical standpoint. Great advances have been made in the field of picture

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DENOISING in latest generations [1-5].The aim of this research is to look at image DENOISING techniques for impulsive noise that are both efficient and trustworthy. Two methods, median filtering procedures and order statistic filtering technologies have been thoroughly detailed, whereas other approaches have been utilized for simulation and enlightened in the median filtering study. Furthermore, a novel approach for the removal of impulsive noise is presented and deployed, called as adaptive channel based median filtering. The performance of this technique is then compared to that of prior approaches.

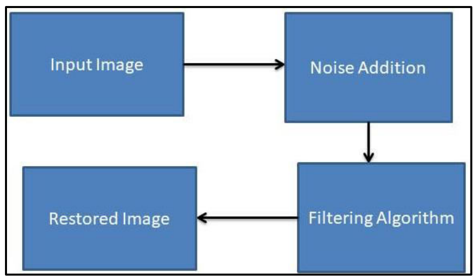

Figure 1: Process of Noise Filtering in An image

II.TYPES OF NOISE

Due to atmospheric disturbances, image acquisition circuit and information is transmitted from the transmitter through communication channel or else during the destination, the different types of noises can be made and it is presented in a picture.Image noise is a type of electronic noise that causes unpredictable variations in brightness or color details of pictures. The image sensor and electronics of a scanning device or camera may make it. Film grain and the inevitable shot noise of a standard photon sensor can likewise cause noise in an image. Noise in an image is an unwelcome offshoot of image catching that obstructs the details that are intended to be seen.
Noise in an image can vary from nearly undetectable spots on a digital snapshot captured in bright luminosity to almost fully noise-free photosensitive and radio cosmological pictures from which a modest quantity of knowledge can be extracted through complex processing. In a snapshot, such a level of noise would be inappropriate because it would be challenging to even identify the subject.

(a) Gaussian Noise

The prime causes of Gaussian noise in digital photographs occur throughout the capture process. Due to the intensity of lighting and its own heating, the sensor has intrinsic noise, and the electrical circuitry associated to the device introduces their own amount of electrical circuitry noise [6]. Noise in an image can be Gaussian, additive, standalone at all pixels, and unrelated of signal strength, and is mostly created by thermal noise, that includes reset noise from capacitor ("kTC")[7]. Amplifier noise accounts for a significant portion of a picture sensor's "read noise," that is, the continuous noise intensity in dark portions of the picture [8]. When more magnification is employed in the blue color channel of a color camera than in the green or red color channels, the blue channel can have higher noise [9]. At larger exposes, meanwhile, shot noise, that is not Gaussian and dependent of signal strength, dominates image sensor noise. There are also numerous Gaussian DE noising procedures.

(b) Salt-and-pepper Noise

It is also termed as spike noise is terms used to describe fat-tail disseminated or "impulsive" noise. Dark pixels will appear in luminous parts and luminous pixels will appear in dusky sections of a picture with salt-and-pepper noise [9]. The ADC mistakes, bit errors in communication, and other factors can generate this form of noise. Dark frame subtraction, median filtering (MF), integrated filtering, and interpolating across shady and intense pixelscan all help to eradicate it.

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III. METHODOLOGY OF PROPOSED SURVEY

Methodology:

In multimedia transmission, images are always favored over texts, yet all of these exchanges face the same issue: "noise." Impulse noise, often described as Salt-Pepper Noise, is a popular type of noise. It is induced by fluctuating voltage induced by transmission or mistake problems in the communication channel. The fixed values of 0 (pepper noise) and 255 (impulse noise) are produced in the pixels by the impulse noise (salt noise).Linear and non-linear noise straining methods are applied. The linear filtering approach employs the procedure in a linear fashion to all of the pixels in the image, without distinguishing between damaged and untainted pixels. Because the procedure covers all pixels in the picture it filters out the untainted pixels, making these filtering strategies ineffective at reducing impulsive noises. Non-linear filtering, on the other hand, is a two-phase filtering method. The pixels are classifiedas damaged or untainted in the first stage, and the degraded pixel is filtered using the provided algorithm in the second stage, whereas the untainted pixel value is kept. The MF, which utilizes the median value to substitute the damaged pixel, is the most extensively used non-linear filter. These filters may reduce impulsive noise while keeping the edges. Process of noise filtering has been revealed in figure1.

Existing Median Filtering Techniques:

The conventional median filter is the most basic of the median filters. The center pixel is filtered using a square window of dimension 2k+1, where k € [1, N]. The pixels in the window are sorted first, and then the middle pixel is modified to the sorted sequence's median value. This is the easiest of the median filtering procedures, and it has been exercised since past few years because of its simplicity.Median filtering is basically a statistical sorting filter. For a certain point (i, j) in the initial image, the median value of all pixels in the vicinity fixed by the median filter is taken as the response of the point (i, j). The median value is separate from the mean value and denotes the value of the element in the mid location in the sorted queue.When the pixels are too large or too small, they do not agree to be selected, so the median filter has a better effect on filtering noise with relatively large or relatively small pixel values, such as: salt and pepper noise, for relatively uniform noise The filtering effect is general, such as Gaussian noise.

The center weighted median filtering method is the second form of median filtering. This is analogous to ordinary median filtering but that the middle pixel in the filtered window is given a weight, for example the middle pixel is reproduced a particular couple of items, which is determined as the weight. The center weighted median filter is named after the fact that the middle pixel in the filtered window is reproduced a specific number of times.The tri-state MF is the next MF employed to eliminate impulsive noise. It creates anew filtering manner by merging the outcomes of the conventional MF and the center WMF.

The progressive median filtering technique [10] is a median filtering procedure that uses a morecomplicated procedure to notice impulsive noises and then filter the pixels. This procedure usesan impulse detector to notice pixels that have been degraded by impulse noise, followed by afiltering procedure to remove the degraded pixels. Both of these identification and filteringalgorithms are used in numerous rounds to guarantee that all noisy pixels are recognized (in thepresence of large degraded image) and that the contaminated pixels are filtered using this way. Inthis procedure, there are two stages:

Step 1: Impulse Noise Detection: This stage generates two image sequencing one of which contains the image's pixel values after DN reiterations and the other of which contains information about whether the pixel is degraded or not. A flag series is the name given to the second image series. Primarily, the flag series' pixel values are all set to 0, indicating that the pixel value is untainted. The flag series is modified to 1 if the pixel is determined as noise after the detection technique is employed and it continues unaffected if the pixel is noise-free.

Step 2: Filtering Phase: The first phase's faulty pixels are filtered in this phase. It filters the image using two image sequences: the flag sequence from the first point and the distorted pixel series.

The adaptive progressive switching filtering approach [11] is a variation of the progressive switching filtering method. This approach, like the last one, filters the image in two stages. The noise detection stage of the impulse noise is comparable to

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the noise detection phase of the progressive switching approach. The noise filtering stage is identical to the preceding procedure, except that the noisy pixels are filtered using an adaptive technique. When a given criterion is not met, while filtering the pixel, adaptive means that the window size is expanded.If the amount of untainted pixels in the window is equal or greater to half of the totalwindow size, the median filtering technique is used; else, the size of the window is augmented by two on each horizontal and vertical sidenumber of pixels in the window and the size of the window is fewer than the optimum defined.

Conventional Adaptive Median Filtering:

To reduce impulsive noise, the adaptive median filter employs noise detection and filtering methods. The window size is used to filter the picture pixels is flexible, meaning that if the stated criteria is not met, the window size is enlarged. If the criterion is fulfilled, the pixel is strained employing the window's median. Consider, *Iij*be the corrupted image's pixel, *Imin*be the least pixel value and *Imax* be the highest pixel value in the window, the applied current window size is W, the full window size is *Wmax*and the median of the window assigned is *Imed*. Next, this filtering technology's algorithm is divided into two tiers, as shown below.

Level A**:**

a) If $Imin < Imed < Imax$, The programme then travels to Level B to see if the present pixel is an impulse because the median value isn't an impulse.

b) Otherwise, the window size is raised and Level A is continued until the median value is no longer an impulse, at which point the procedure switches to Level B; or the full window size is achieved, at which point the median value becomes the clarified picture pixel value.

Level B:

a) If $Imin < Iij < Imax$, The filtered picture pixel is unaffected because the current pixel value is not an impulse.

b) Otherwise, if the image pixel is similar to *Imax*or *Imin*(degraded), the filtered imaged pixel is given the median value from Level A.

Order Statistic Filter:

This type of filter is grounded on estimators and is founded on "order", the sense of order is about some numbers like min (first order statistic), max (largest order statistic).

Let there are N observations X1,X2,X3,…XN of a random variable X, the order statistics are attained by sorting the {Xi} in ascending order. This generates {X(i)} fulfilling:

$X(1) \leq X(2) \leq X(3) \cdots \leq X(N)$

Where {Xi} are the order statistics of the N observations. So, an Order Statistic Filter is a estimator F(X1,X2,X3,…XN). to depend on Cloud service Provider to provide log module to the third party. The proposed model based on logging may ease the challenges of the forensics for nonrepudiation of behaviors in cloud.

Modified Median Filter Method for Noise Removal froma Colored Image:

Step 1: Get the dimensions of the image. The number of color band should be 3.

Step 2: Extract the separable RGB color channels

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Step 3: Make a noisy picture. This has salt and pepper noise dispassionately on each color channel so the noise may be colored.

Step 4: Extract the separable RGB color channels from Noisy Image

Step 5: Smear the median filter on different color channels.

Step 6: Find the Noise

Step 7: Reconstruct the image using Median filter.

Step 8: Repeat the step 1 to step 7 for order static filter

Step 9: compare the results of two filters

Proposed Method:

A novel approach (Enhanced Window Median Filtering Methodology) is used to determine if the image's performance improves when compared to traditional median filtering. The adaptive median filtering mechanism appears to be comparable to this approach. In comparison to the traditional adaptive median filter, a minor alteration is made. In terms of the adaptive median filtering algorithm the adjustment is made in Level B (c). The window size is enhanced by 3 in both horizontal and vertical axes if the median is also an impulsive noise, and the identical technique is used to determine whether the new median generated after extending the window size is an impulse noise. If the noise is impulse, the same process is applied until the window's maximum size is achieved; otherwise, the filtered picture pixel is substituted by the left neighborhood pixel value, as in decision-based MF (with regard to the adaptive MF, a change was made). This novel technique is used to check whether any better filtering of the distorted image can be produced, as adaptive centered techniques are known to include higher straining than those that do not use the adaptive median filtering method.

Image Processing in MATLAB:

Picture processing is the process of converting an image to a digital format and then manipulating it to create a better image or extract relevant information. The majority of image changes is carried out mechanically and depends on a precisely established system. Importing a picture from a digital camera or a scanner, evaluating and altering the picture (data compaction, picture improvement and straining), and creating the intended output picture are all phases in image processing. The necessity to retrieve information from pictures and comprehend their contents has been a primary force behind image processing's growth.The IPT (image processing tool) is a set of functions in MATLAB which improves the numeric computing environment's capabilities. For image processing, analysis, visualization, andmathematical analysis, it provides a broad range of standard techniques and workflow tools. Picture segmentation, image improvement noise elimination geometrical modifications image registration, and 3D image processing activities can all be done with it.A digital picture is a 2 D function f(x,y), where x and y are locational reference points and the amplitude of *f*at any given point is called the image intensity at that location. The image is called a digital image when the values of ‘x,' ‘y,' and the amplitude values of ‘f' are all determinate distinct numbers. The procedure of digitizing coordinate values is known as ‘sampling,' whereas the process of digitizing amplitude values is known as ‘quantization.' A matrix of real numbers is the outcome of sampling and quantification.A digital picture is depicted in MATLAB as:

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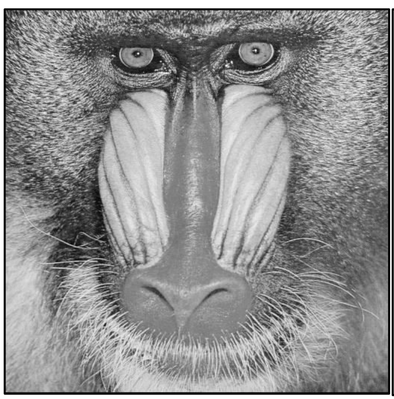
$$f(x, y) = \begin{bmatrix} f(1, 1) & f(1, 2) & .... & f(1, N) \\ f(2, 1) & f(2, 2) & .... & f(2, N) \\ \vdots & \vdots & \vdots & \vdots \\ f(M, 1) & f(M, 2) & .... & f(M, N) \end{bmatrix}$$

IV. SIMULATION RESULTS AND DISCUSSIONS

The proposed method has been implemented with different pictures of dimension 512 x 512 pixels. Salt and pepper noise with density 15 5 has been added to the images through MATLAB noise function (imnoise). The MSE and PSNR of the images are calculated. It should be mentioned that the filtering strategy is better when the PSNR is higher and the MSE is lower. The first original gray scale image is as follows (Figure 2). After adding Salt-Pepper Noise to it, the resultant image is Figure 3.Initially we have used a median filter of size 3 X 3, we get an improved image but there is still some noise left in the picture. Also we have use order-statistics of order 5 on the same noisy image. The resultant image is as follows (figure 4):



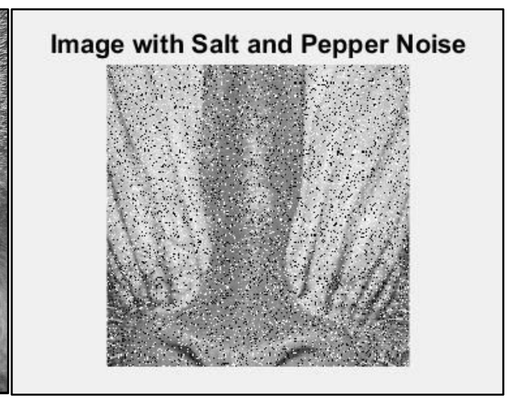


Figure 2: Original Baboon ImageFigure 3: Noisy Baboon Image

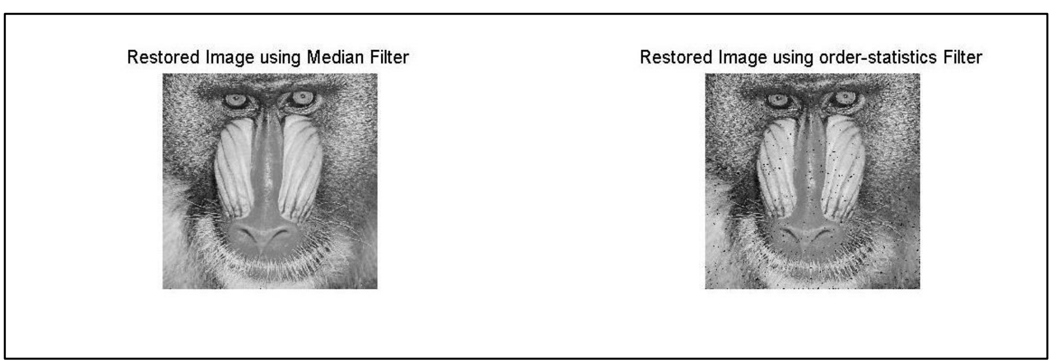


Figure 4: Restored picture using Median filter and order-statistics filters

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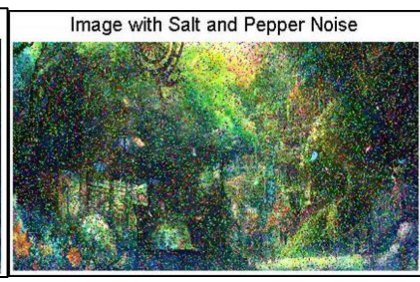
We can see that there is still some noise left with value 3 X 3 of median filter and order 5 of statistic filter. So we change these values as window size 5 X 5 for median filter and order 10 for statistic filter and find the resultant figure as (figure 5).

Figure 5: Improved restored DENOISED Image of Baboon

We can see that after updating the values of Median filter window and order of statistic filter, we get enhanced images of baboon. This is a gray scale picture. Let's try our method on colored images for same parameters.We can see that after updating the values of Median filter window and order of statistic filter, we get enhanced images of baboon. This is a gray scale picture. Let's try our method on colored images for same parameters.The figure 6 displays the primary colored forest image, figure 7 shows noisy forest image, figure 8 shows the image restored using median filter (5 X 5) and figure 9 shows the image restored with order statistic (5). Figure 10 represents the noise recovered from red, green and blue channels respectively.



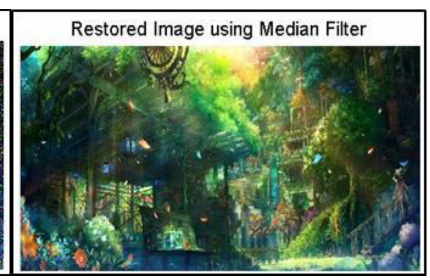
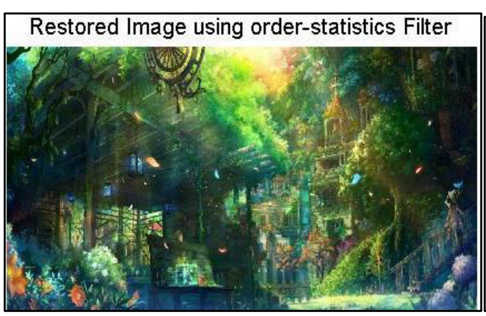


Figure 6: Original Colored Forest ImageFigure 7: Noisy Image of forestFigure 8: Restored image of forest with median Filter



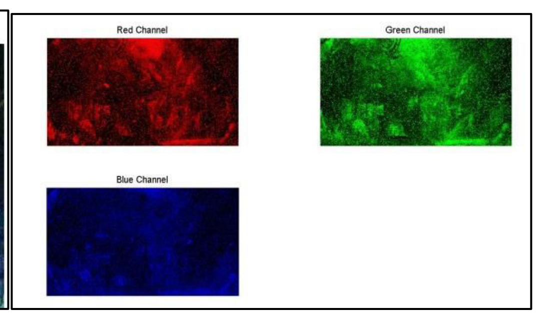


Figure 9: Image using Order Statistic Filter   Figure 10: Noise retrieved from RGB Channels

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After updating the statistic order value from 5 to 25 and see the result (figure 11).Now let us set the value of Statistic order 50 and see the result (figure 12).

Figure 4.11: Statistics order value 25

Figure 4.12: Statistics order value 50

We see that the optimum parameter for median filter is (window size = 5 X 5) and for Statistics order (order =10). We have also compare the PSNR values for Lena image with different node density for different types of Median Filter as shown in Table 1.Abbreviations are as follows:

SM: Standard Median Filter, **CWMF**: Center Weighted Median Filtering, **TSMF**: Tri-State Median Filtering, **PSMF**: Progressive Switching Median Filtering, **APSMF**: Adaptive Progressive Switching Median Filtering, **AMF**: Adaptive Median Filtering, **DBMF**: Decision Based Median Filtering, **EWMF**: Enhanced Window Median Filtering, **PSNR:** Peak Signal to Noise Ratio

Table1: Proportional examination of PSNR of Image Lena for Dissimilar median filter procedures for dissimilar noise density.

Node Density	SMF	TSMF	CWMF	PSMF	AMF	APSMF	DBMF	WEFM
5%	34.33	38.26	36.10	34.62	38.72	40.30	45.00	45.12
10%	32.28	35.90	32.12	31.32	36.62	38.17	41.22	42.26
15 %	29.96	25.86	24.38	27.40	34.24	35.74	36.35	36.99
20%	18.03	19.92	19.91	24.74	32.87	31.13	34.50	34.45
25%	16.22	15.92	15.92	22.31	30.21	30.00	33.00	34.12

Only for low noise density the filtering approaches including ordinary MF, CWMF, and TMF (each applied for 3 x 3 windows) produce decent results. The performance of these filters can be enhanced by increasing the window size, however as the window size grows larger, the image begins to blur. Other filtering approaches, such as PSMF and ASMF work significantly better than the three filtering algorithms discussed above at noise densities of up to fifty percent. However, as the noise level rises, these solutions degrade performance. These two filtering approaches likewise perform poorly when the original image has salt noise on a white backdrop and pepper noise on a black background.Traditional AMF and DBMF

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outperform the other five filtering strategies. The performance is also influenced by the image being evaluated. In the Lena picture adaptive PMF outperforms conventional adaptive MF for noise density up to fifty percent based on PSNR computation, however adaptive median filtering outperforms standard adaptive median filtering for visual effect. This is due to the salt noise, which is still unfiltered on the white background using the adaptive progressive median filtering technique. When the Baboon picture, which has more black areas, is employed, however, the adaptive progressive switching method performs worse than the adaptive median filtering method. In comparison to the standard adaptive median technique, one of the key drawbacks of adaptive progressive switching is that it takes a long time to compute and is not very well adapted for real applications.

V. CONCLUSION AND FUTURE WORK

When all of these filtering techniques are evaluated, it can be stated that they all remove impulse noise using a fixed or variable window size. There is still a requirement for an algorithm that can determine the window size dynamically depending on the picture and noise density degree.Adjusting the filtering parameters adaptively offers clear advantages: the DENOISING intensity can be advanced in smooth sections with a minimal risk of blurring out features, and lower in highly textured parts with less visible noise. Adaptivity may also be simply produced by combining the outcome of various procedures, each of which performs well in a specific portion of an image. Though numerous researches on AWGN removal, few have investigated true image DENOISING. As AWGN is significantly uncomplicated than actual noises, the main stumbling block is the intricacy of actual noises. A thorough examination of a denoiser is a difficult undertaking in this situation. The in-camera pipeline contains numerous components (such as white balance, colourdemosaicing, noise lessening, colour change, and compaction). Some environmental and internal factors, like as lighting, sensors, and camera shake, have an impact on image quality.In conclusion, the purpose of this research is to provide a summary of the existing DENOISING procedures. Because different types of noise necessitate distinct DENOISING procedures, noise analysis can aid in the development of novel DENOISING systems.

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