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Image De-Noising Algorithm Using Adaptive Modfied Decision Base Filters

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Abstract-
The removal of noise is a crucial and challenging task in the field of image processing, essential for obtaining high-quality, noise-free images. This area of research is continuously evolving, with the analysis and design of more sophisticated filters being imperative to enhance image information and achieve superior results. Numerous filters have been developed to address the presence of noise in various types of corrupted images. These filters are designed to target and eliminate different kinds of noise, such as Gaussian noise, salt-and-pepper noise, and speckle noise, among others. The application of denoising algorithms plays a pivotal role in filtering these images. By implementing various filters, researchers aim to mitigate the noise and improve the clarity and accuracy of the image data. Despite the advancements in denoising techniques, applying these filters can sometimes result in inefficiencies at the pixel level. This challenge arises because the filters, while removing noise, may also inadvertently blur fine details or alter important features of the image. Therefore, it is essential to strike a balance between noise reduction and the preservation of image details. . For instance, linear filters, such as the mean filter and the Gaussian filter, are widely used due to their simplicity and effectiveness in reducing Gaussian noise. However, they may not perform well with non-Gaussian noise and can cause blurring. Non-linear filters, like the median filter, are more effective against salt-and-pepper noise and better preserve edges but may struggle with other noise types. Advanced techniques, such as wavelet-based denoising and deep learning-based methods, have also been explored. Wavelet-based denoising involves decomposing the image into different frequency components and selectively attenuating the noise, which is typically high-frequency. This method can efficiently reduce noise while preserving important features.These methods can learn complex noise patterns and effectively distinguish between noise and actual image details, leading to significant improvements in image quality. Moreover, adaptive filters have gained attention for their ability to adjust their parameters based on the local image characteristics. This adaptability enables them to perform well across a range of noise types and image conditions, further enhancing their effectiveness.
Keywords: Image Denoising, Salt and Pepper Noise, Spatial Filtering

Introduction

In recent decades, images with digitization are play a main role in versatile applications such as CT scan images, satellite television, astronomy, and geographical information system [1].Generally, the digital images are collected by utilizing image sensors and transmitted through eitherwired or wireless networks [2-3].The image quality is degraded by the noise, which is referred as a low frequency irregular pattern of digital images. During image acquisition, noise is automatically introduced by sending and receiving the images on noisy environment [3]. So, it is important to eliminate the noise presence in the image pixels, but the removal of noisy pixels from the digital image is a crucial task [4].Recently, various denoising algorithms are developed to denoise or restore the noisy pixels from the digital images. The main target of the image denoising algorithms is to eliminate the noisy pixels without the degradation of image edge information details, texture, and global contrast of the images [7]. Some of the image denoising algorithms developed by the researchersfor reducing the noisy pixels in the digital images are wiener filter [8], non-local mean filter, finite response impulse filter, etc. developed a non-linear transform technique filter to eliminate noise from the digital images. In the field of image processing, noise removal is a fundamental and challenging task that is crucial for obtaining clear and accurate images. Noise can significantly degrade image quality, obscuring importantdetails and complicating analysis. Consequently, developing effective noise removal techniques has become a central focus for researchers. Various filters and algorithms have been designed to address this issue, each targeting different types of noise and offering unique advantages. These methods range from traditional linear and non-linear filters to advanced wavelet-based and deep learning approaches, each contributing to the ongoing quest for noise-free images. Balancing noise reduction with the preservation of essential image details remains a key challenge, driving continuous innovation in this dynamic field.Noise in images can arise from various sources, including sensor imperfections, environmental conditions, and transmission errors. This unwanted variation can manifest in multiple forms, such as Gaussian noise, salt-and-pepper noise, and speckle noise. Each type of noise poses distinct challenges and requires specific strategies for effective removal. The primary goal of noise removal is to enhance image quality while preserving the essential details that are crucial for accurate interpretation and analysis. Types of Filters and Their ApplicationsTo address the presence of noise in corrupted images, numerous filters have been developed, each designed to target specific types of noise. These filters can be broadly categorized into linear and non-linear filters, with more advanced techniques such as wavelet-based denoising and deep learning methods gaining prominence in recent years.Linear Filters Linear filters, such as the mean filter and the Gaussian filter, are widely used due to their simplicity and effectiveness in reducing Gaussian noise. The mean filter works by averaging the pixel values within a defined neighborhood, thereby smoothing out noise. However, it can also blur edges and fine details, which is a significant drawback. The Gaussian filter, which applies a Gaussian function to weigh the neighboring pixels, is more sophisticated and can reduce noise while preserving edges better than the mean filter. Despite these advantages, linear filters are generally less effective against non-Gaussian noise.Non-Linear

FiltersNon-linear filters, like the median filter, have been developed to address some of the limitations of linear filters. The median filter replaces each pixel's value with the median value of the neighboring pixels, making it particularly effective against salt-and-pepper noise. This approach preserves edges better than the mean filter but may struggle with other types of noise. Non-linear filters are beneficial in scenarioswhere maintaining edge integrity is crucial, such as in medical imaging and remote sensing.Advanced Denoising Techniques As image processing needs have grown more complex, advanced denoising techniques have been developed to achieve better results. Two notable methods are wavelet-based denoising and deep learning approaches. Wavelet-Based DenoisingWavelet-based denoising involves decomposing an image into different frequency components using wavelet transforms. By analyzing these components, it is possible to selectively attenuate the high-frequency noise while preserving the low-frequency signal that contains important image details. This method is highly effective in reducing noise and has the advantage of being adaptable to various types of noise. Wavelet-based techniques are particularly useful in applications where preserving fine details is critical, such as in astronomical and medical imaging.

2. PROPOSED WORK

The developed filter effectively removed various noises like speckle noise with better Peak Signal-to-Noise Ratio (PSNR) value, but the developed filter required more logical components to perform denoising operation.

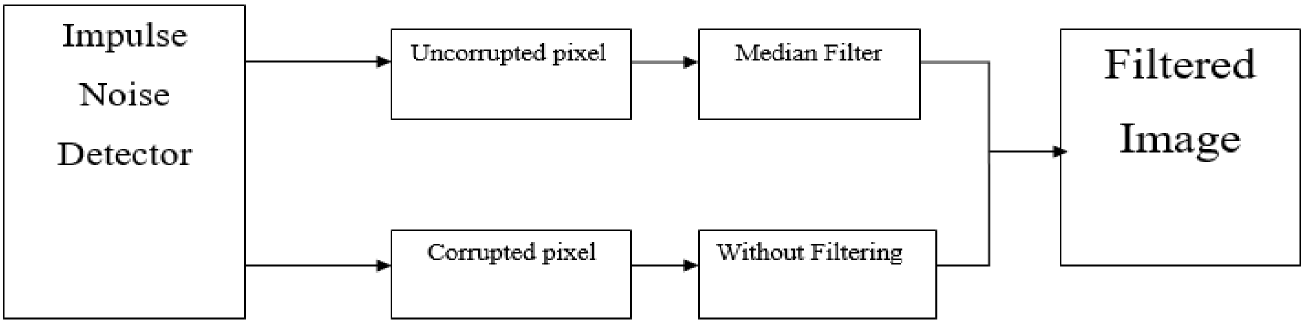

Fig: 1 Proposed Non-Linear Filtering process

In this proposed technique or algorithm, initially Impulse noise detector is connected to detect the noise presence in the images. Next the noise detector is applies the image as input to the both corrupted and uncorrupted pixels levels based on the image noise levels. After detecting the noise level, if the pixels of the image are corrupted then the image pixels are applied to the median filtering technique for the filtering process. If the the pixels in the images are corrupted then the image pixels are applied to the no filtering for the further processing. These two outputs of the no filtering process and median filtering process images are applied to the filtering process generates the filtered image. In this algorithm including filtering process different types of enhancement and mathematical operations also used to generate the efficient and noisy fewer images as an output

Peak Signal to Noise Ratio (PSNR): is an engineering term that describes the relationship between a signal's maximal potential power and the power of noise that tampers with the signal to reduce the accuracy of its representation. The decibel scale is typically used to express PSNR as a logarithmic amount since many signals have a very wide dynamic range.

$$\text{PSNR}= 20 \log \frac{MAX}{\sqrt{MSSE}} \text{ dB}$$

When assessing the reconstruction quality of photos and videos that have undergone lossy compression, PSNR is frequently used.

PSNR is most easily defined via the mean squared error (MSE). Given a noise-free m×n monochrome image I and its noisy approximation K, MSE is defined as

$$\text{MSE} = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}(I(i,j) - K\,(i,j))^2$$

The main proposed research algorithm is the calculation and removing of the noise presence in the images. The resultant image after applying the proposed algorithm generating the denoised image as a output. The design and implementation of the proposed algorithm is to generate efficient noisy less image without degradation of the image.

- function VarName1 = importfile (file_name, startRow, endRow)
- VARNAMEE1 = IMPORTFILE1(FILE_NAME)
- VARNAMEE1 = IMPORTFILE1(FILE_NAME,
- VarName1 = importfile1('output_R.txt',1, 16154);
- delimiter = ' ';
- if margin<=2
- start_Row = 1;
- end_Row = infi;
- end
- format_Spec = '%q%[^\n\r]';
- file_ID = fopen(file_name,'r');
- raw{row, 1} = numbers{1};
- end

3. Methodology

In this proposed algorithm initially input image is the grey image. Input is applied to the addition of noise to add the noise to the image for checking the proposed algorithm. Once adding the noise to the input applied image is again applied to the adaptive median filtering process for further filtration processing. Adaptive median filter is used to remove the addition noise from the applied image after the addition of the noise in the image. To get the noisy less image filtered image is having threshold to adjust the contrast level of the image. Based on the threshold level the image enhancement is calculated and analyzed across the algorithm process. After the threshold level of the image is applied through the modified decision based median filtering technique for further and finalized resultant output image with denoising from the image.

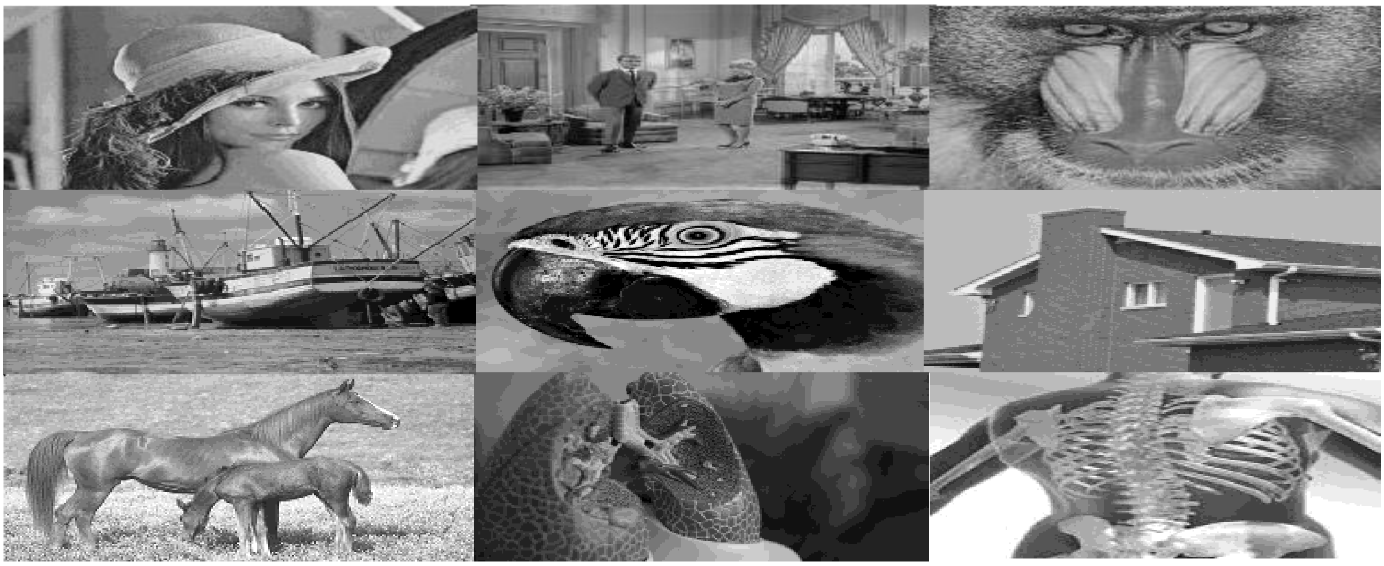

Fig 2. Input images under consideration

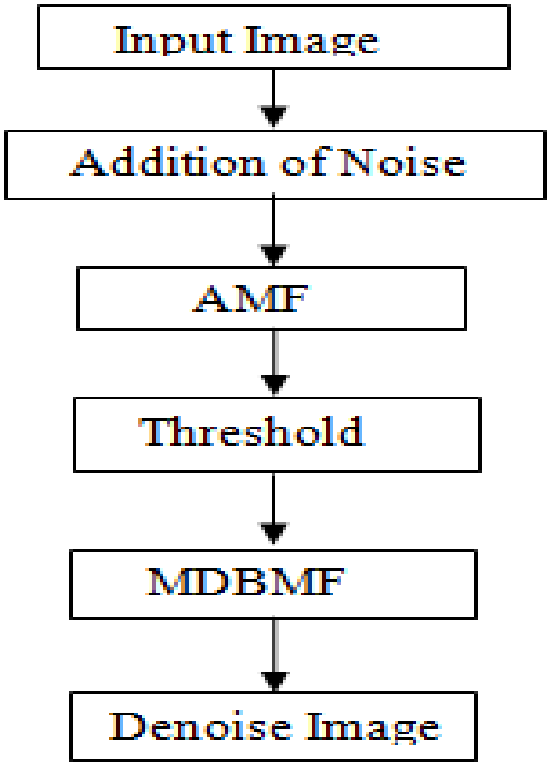

Fig: 3 Proposed Denoising Algorithm

Steps involved in proposed system:
First step: Intial X=4, X_{Max} =26, X_{Min}4
Second step: [K, L]=M(img) no.of rows and no.of.columnsin the image
Third step: assume Pixel=Wxy, Wupp=255, Wlow=0
Fourth step: calculate Wmed
Fifth step: on condition that X ≤ Wupp at that point in time enter fifth step otherwise X=X+2 increase the window sizeby 2
Sixth step: on condition that X ≤ Wupp at that point in time enter third step Pixel(x,y) corrupted replaced by Wmed otherwise Pixel(x,y) not corrupted
Seventh step: on condition that Wlow <pxy<Wupp at that point Pixel(x,y) Uncorrupted and it is left unchanged.
Eight step: on condition that Xxy !=0 &&Xxy != 255 at that point in time Pixel(x,y)corrupted replaced by Pmed.
Ninth step: on condition that Wxy ==0||255 && neighbour-pixels == 255at that point in time X=X+2 (Increment Window Size) END IF
Tenth step: MOVE X TO Wxiyj
Eleventh step: Repeat from first step to tenth step until windowreaches the last pixel.

4. RESULTS AND DISCUSSION.

The proposed algorithm is efficient for removing the presence noise in the image and results the denoising image. The performance of the image is calculated based on the different parameters. Various steps integrated in the proposed algorithm are specified in the paper for remove the presence noise from the images. The main techniques used in the proposed algorithm for denoising the applied images are produced as noisy fewer images. For the proposed algorithm different types of median filters are integrated in the system. In this proposed algorithm different filters are combined and integrated to get the noisy less images for the applied addition noisy images. Finally a result of proposed algorithm system reduces and eliminates the noise of denoised images. The performance of noisy less images is lower compared to our proposed algorithm system, which is integrated combination of adaptive median filter and decision based median filter.

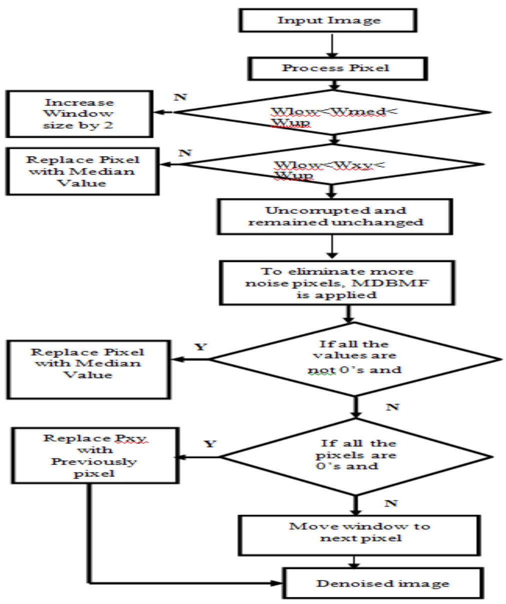

Fig: 4 Flow Chart of proposed algorithm system

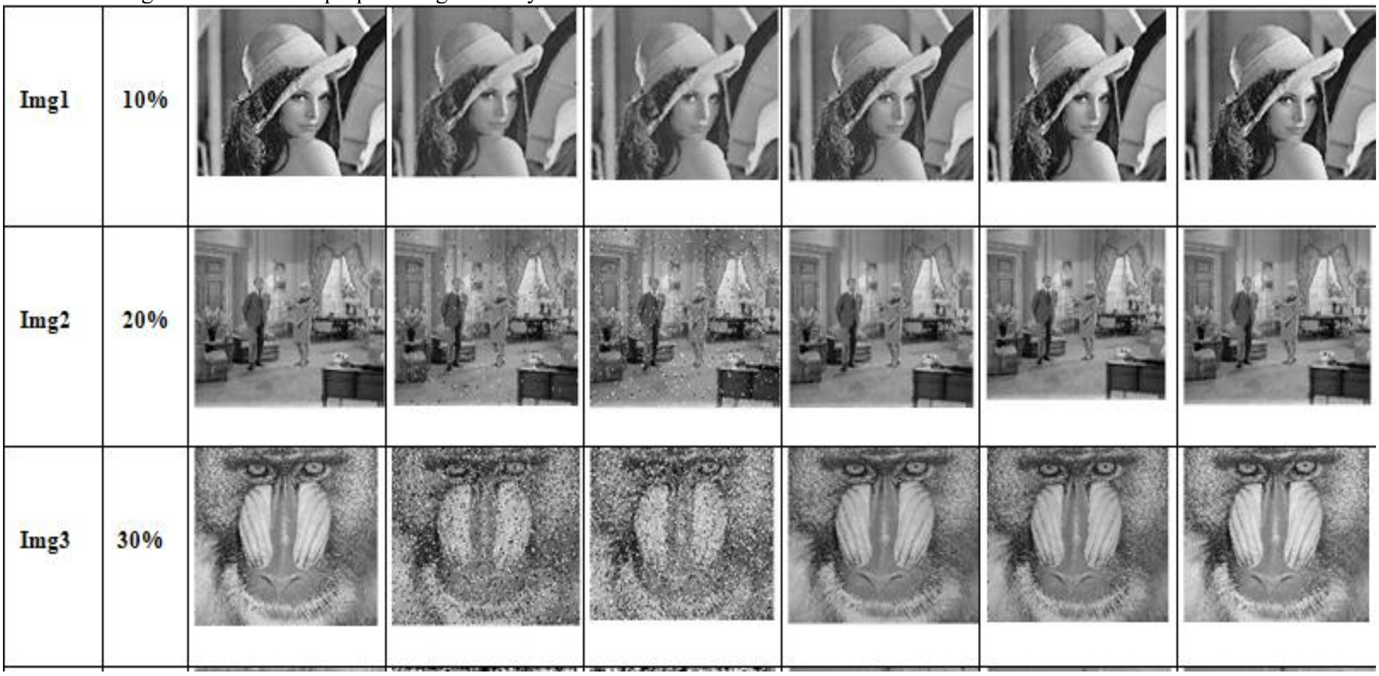

Fig: 5 Images for testing the algorithm with variable noise percentage from 10% to 30%.

Table: 1 PSNR values comparison

Input image	% of Noise	AMF	MF	WMF	UMF	DBMF	PROPOSED (AMF & MDBMF)
Image 1	10	40.3935	28.8162	39.5208	41.6611	36.5658	42.8348
Image 2	20	39.1667	27.0304	33.5305	40.3633	37.5613	40.3797
Image 3	30	36.5041	21.6876	31.8830	39.1212	34.8407	39.3296

Table 1 represents the various PSNR values of three different images as shown above with variable noise such as 10%, 20% and 30% with the comparison of five different algorithms and the proposed technique and comparative graph is shown in figure 6, it is observed that when compared with the all the exisiting methods proposed method has successfully achieved the better results of PSNR

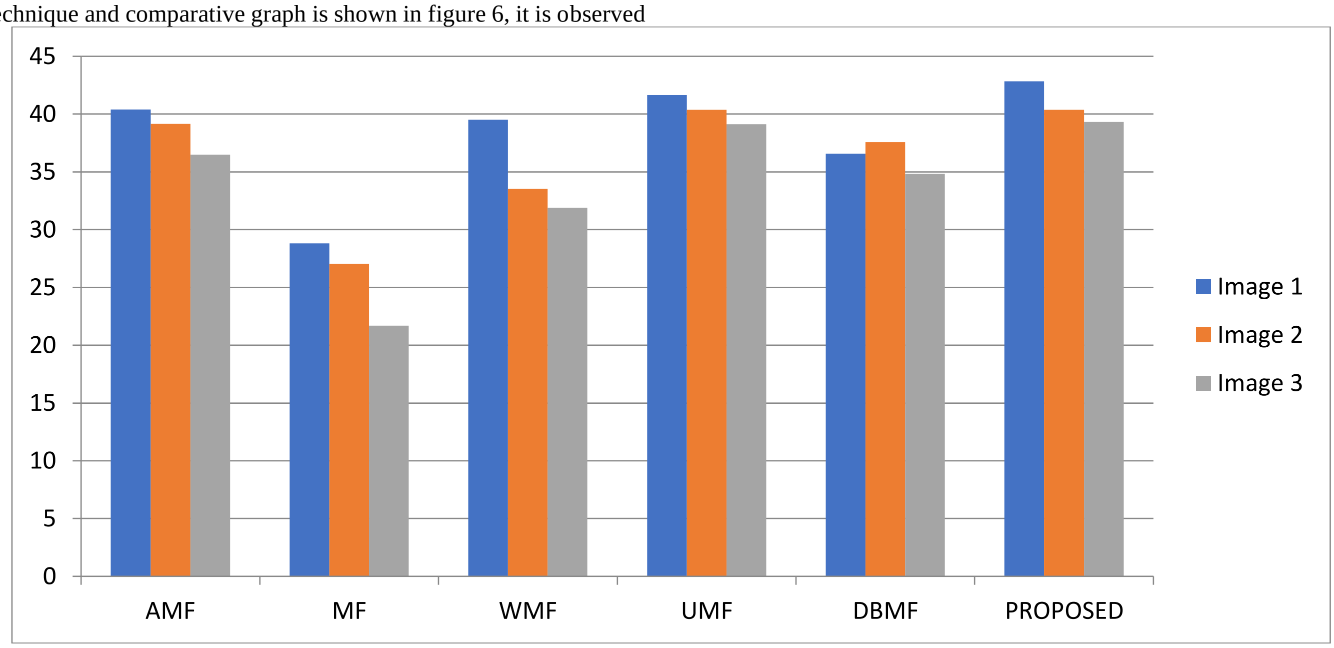

Fig 6: comparative graph of PSNR.

Table: 2 MSE values comparison

Input image	% of Noise	AMF	MF	WMF	UMF	DBMF	PROPOSED (AMF & MDBMF)
Image 1	10	5.9392	15.3395	7.2611	4.4357	3.8015	3.3853
Image 2	20	7.8785	32.0952	28.8426	5.9807	6.7796	5.9582
Image 3	30	14.5435	55.0531	42.1485	7.9609	9.2733	7.5878

Table 2 represents the various MSE values of three different images as shown above with variable noise such as 10%, 20% and 30% with the comparison of five different algorithms and the proposed technique and comparative graph is shown in figure 6, it is observed that when compared with the all the existing methods proposed method has successfully achieved the better results of MSE which results in the minimum error

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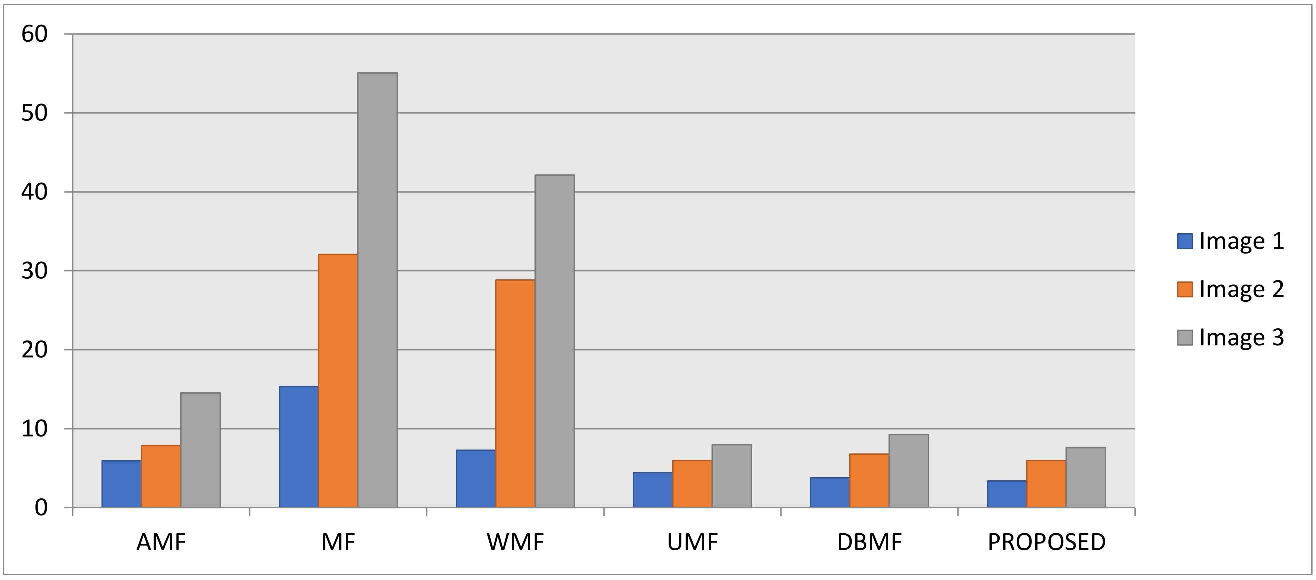

Conclusion

Noise removal is a pivotal and evolving research area within image processing, essential for achieving high-quality, noise-free images. The ongoing development and refinement of various denoising filters and algorithms are crucial to tackling different types of noise and maintaining the integrity of image details. Linear, non-linear, wavelet-based, and deep learning approaches each offer unique advantages and face distinct challenges. Adaptive filters, with their ability to adjust based on local image characteristics, represent a promising direction for future research. As the field advances, the balance between noise reduction and detail preservation will remain a central focus, driving the creation of increasingly sophisticated and effective noise removal techniques. This progress is vital for enhancing the clarity and accuracy of image data, ultimately benefiting a wide range of applications in science, medicine, engineering, and beyond.

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