Comparative Analysis of Noise Removal Algorithms

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ABSTRACT
This project shows Analysis of various Image Filtering Algorithms implemented over C language on bitmap image format. The Ultimate plan is to research the behavior of noisy image on application of various filtering algorithms to find the best output. Images will be processed or modified on an existing image in an exceedingly desired manner as they represent convertible data. The system shows the difference between the original image and the changed Image once the appliance of algorithms. In this study, it has been noticed that instances of image process occurring all the time in daily lives by using Image Processors. The objective of the image processing is to boost visually or statistically enhance an aspect of image that is bettering it's quality that do not seem to be proper under the original image. The basic principle of the image processing operations over image data that builds a bigger perception, vision and clarity of the image but will not add any new info to the image. This objective is carried throughout the development and implementation of image processing system [1]. Image processing is nothing, but however manipulating an image knowledge to realize an clear and better the quality for higher pictures. However, image processing is nothing however a method of translation between of human visual senses and digital imaging gadgets [2]. The human visual senses does not perceive the globe within the same manner as digital image detectors, with present show technology devices imposing extra noise and information measure restrictions. Important variations between the human and digital sensors are some basic image knowledge manipulating steps for achieving higher transformation for clear pictures. Image processing System therefore ought to be achieved in a manner that with keeping with this scientific methodologies intact so others would possibly reproduce, and validate results. This includes recording and reporting and methodology actions, and applying similar methods to enhance photos.

Keywords
Average filter, Median filter, Mean filter, Adaptive filter PSNR value, MSE value, SNR value.

1. INTRODUCTION
An Image may be a 2-dimensional structuring of varied finite set of digital values referred to as image components or pixels. Noises occur due to the rationale of the imperfect instruments, problem that square measure connected with the information assortment method, and considering natural and internal system problems that degrade the information.

Image Processing deals with manipulation of digital pictures keep in kind of constituent values through a computing machine. It is a uses concepts of signals however primarily specialize in pictures. DIP focuses on developing a computer system that's ready to perform do manipulations on image information [2].

The images taken for this research study is 24 bit BMP images. The BMP file structure is capable of storing two-dimensional digital images of random height, width and resolution, both monochrome and colored images too, in varying color depths, and optionally having a data compression that tells which data compression algorithm is used on image to decrease size and color profiles [3]. It has been considered only BMP image format because this format easily stores 2-dimensional digital pictures of random height, width and resolution, color type with numerous color depths, and optionally with information about compression. These BMP pictures are of the many varieties {the images | the pictures | the photographs} taken for this analysis study is twenty four bit images. Bitmap images consists of two important parts the header and info-header [3].

The header file contains information about the image file. It also contains an identifier which determines the file type. The info-header file contains information about the image, it contains data like image height, image width, image size etc. Also the Bitmap images are used to store digital images data capable of working with any display device [1]. Noises that have considered for this study are only Additive Short Tail Noise also known as Gaussian Noise and Impulsive Noise known as Salt and Pepper Noise.

Noises are those unwanted effects that are created within the image. During image capture, many factors are liable for producing noise within the image. Depending on the sort of disturbances created, the noise will have an impact on the image to completely different results. Typically this study focuses to get rid of certain type of noise. Therefore, in this study, getting most kind of noises and implement completely different algorithms to get free of most of them [4]. Noises in the image are often divided as Impulsive noise (Salt-and-pepper noise), Amplifier noise (Gaussian noise), Shot noises, and Periodic noise. Well they are still more noises however this study interest on removing with Impulsive and mathematician Noises.

1.1 Impulsive Noise (Salt and Pepper Noise)

The term impulsive noise is additionally used for this sort of noise. Different terms are also used to decision this like spike noise, independent noise or random noise. Black and white dots seem within the image due to this noise and thus it was named as salt and pepper noise. This noise arises within the image due to sudden and unprecedented changes in image signal. Dust particles within the image capture supply device or hot faulty parts will cause this sort of noise. Image gets corrupted to such a little extent because of this noise [5]. This can be achieved by adding white and black dots arbitrarily across the photographs. They can be removed.

1.2 Gaussian Noise (Amplifier Noise)

The term Abnormal noise model is that the word of Gaussian noise. This noise is more of associated degree additive in nature and follows Gaussian technique of distribution, which means that every element within the noisy image is a combination of the true component pixel value and a random pixel value generated by the Gaussian distributed noise value. The noise in here doesn't consider the intensity of pixel value at each and every point [6]. The implementation of Gaussian noise to an image is given by:

$$f_g(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{-(x-a)^2}{2\sigma^2}}$$

Where:$f_g(x)$ is that the Gaussian distribution noise in image; a and σ is the mean and standard deviation respectively.Also for removing these noises the alternative of filter is calculated from the character of the task performed by the filter and behavior and sort of information. Thus filters square measure used to take away noise kind digital image by completely different ways:-

1.2.1 Filtering without Detection

In this study, took a window mask across the image for some value of *Ni.e.,* is an integer and that will be moving from right to left and bottom to top of image and apply some arithmetic operation without leaving any pixel value.

1.2.2 Detection with Filtering

In this method, first consider the noisy pixel and then filter them by moving across the image with a mask and perform specific arithmetic operation to detect the noisy pixels and then modifying and then keeping non-noisy pixels intact.

1.2.3 Linear and Non-Linear Filter

Basically consists of the models of median, mean, adaptive filters. Which are discussed in Proposed Method section [7].

This study concentrate in Filtering without using Detection, Linear and Non-Linear Filters in this paper.

2. LITERATURE REVIEW

Previous works on this field included analysis of quality of images and removing noise from images. Those works concentrated on a vast field of noise removal algorithms for different types of images and different types of noises. Also previous works were primarily were focused on identifying different noises and developing corresponding algorithms for the same. But Analysis on application of same algorithm on different noisy images was not considered and also from all the noise removal algorithms which one works the best is not taken into point.

Although the primary focus was to build an universal noise removal algorithm along with keeping in mind the time and space complexity for the images thus helping one get better results for a wide range of noisy test samples without much memory wastage and time, CPU consumption [8].

Through this, able to provide a proper systematic procedure to secure which algorithm could work the best for any test sample thus can be used in the fields of medical and education sectors. Considering the problem of the image distortion of the images caused during the image transmission or conversion and thus main focus in on the denoising of the images [4].

As all know Graphics and Image processing is a developing technology. So noise removal algorithms are needed to improve image quality and helps in returning noises to original style. Also provided some material for the use of some image processing processes is used in most of the image processing systems. So this paper, along with other noisy images it helps us in modeling the various types of noises that can damage the image. Providing the pros and cons or using some filtering methods [7].

3. PROPOSED METHOD

Primary focus is on the Comparison study of various Noise Removal Algorithms applied on an image and also to understand the effects of applying a wrong algorithm to a wrong noisy image. Along with that major emphasis is on providing an friendly user interface for the user that acts faster just to make him understand which filter would work effectively on a particular noisy image and gives best results through a Statistics panel. Along with that worked on some filtering techniques like the mean, adaptive, Double-Window, Minimum Mean Square Error and median filters to remove noises from the images [9].

3.1 Arithmetic Filter

This algorithm works best for removing Gaussian type noise, but at the cost of the sharpness of the image, *i.e*, this algorithm removes noise but after the operation the image becomes blur. The method of operation of this algorithm works the same way as taking the arithmetic mean of N numbers. This filter takes the arithmetic average of all the pixel within a local enclosed region (Mask), in an image [6]. The size of the mask is an important factor which decides the quality of filtration. The larger the size of the filtering mask, more chances for the blurring it becomes, and less distortion for high spatial value frequency details will remain in the filtered image.

3.2 Adaptive Double Window Modified Trimmed Mean Filter

This filtering algorithm is used for impulsive noise removal and does better job than the MMSE filter. This key point in this algorithm is that it uses median estimator to estimate the local mean. A new local mean is then computed with the few pixels which fall under a small gray scale level around the median. This effectively removes outliers in the calculation of the mean estimate, hence improving the estimate of the effectiveness of the algorithm. It is described by creating median filter that is

computed from the local region with double windowing concept and then a noise standard is derived for the same for keeping or the discarding of the pixel value for the mean [8].

3.3 Adaptive Minimum Mean Square Error Filter

The MMSE filter makes use of the formulas for the local variance to determine is the mean filter is that is to be applied to the local enclosed region of an image. The filter works best for the abnormal noise types. The output of the MMSE filter for a pixel located at (*x*, *y*) within an image is high and it basically uses adaptive technique for removing impulsive noises and for variance median too comes into the picture for varying filtering method [8] is

$$\tau(x,y) = \left(1 - \frac{\sigma_n^2}{\sigma_1^2}\right).g(x,y) + \frac{\sigma_n^2}{\sigma_1^2}.K,$$

where σ_n^2 is the variance of the noise and σ_1^2 is the local variance and the parameter K is the output from the local mean filter which is given to the system.

3.4 Contra-Harmonic mean filter

The contra-harmonic mean filter is a a part of nonlinear mean filter that helps in higher removal of Abnormal(Gaussian) style of noise and conserving edges than the mean value filter. The contra-harmonic mean filter is very sensible in removing positive values from negative values of *P* and negative values from the positive values of *P*. If all the pixels included in the calculation of the contra-harmonic mean filter square measure zero, then the output of the filter will additionally be zero [10],

$$Contra - HarmonicMean(A) = \frac{\sum_{(i,j)\in M} A(x+i,y+j)^{P+1}}{\sum_{(i,j)\in M} A(x+i,y+j)^{P}}$$

3.5 Alpha-Trimmed mean filter

This function can filter the image by mistreatment alpha-trimmed mean nonlinear methodology. This function works for solely monochromatic pictures as a result of color distortion happens to the ultimate output once colored image is passed. The alpha-trimmed mean filter is based on changes between a varying median and a averaged mean filter. The alpha-trimmed mean filter is based on variations between a median and a mean filter. It is used when an image contains every scientist and salt and pepper noise. To define the alpha-trimmed mean filter, all pixels covering the pixel at (*x*, *y*) in the image data A that unit given by an enclosed input value of N×N size enclosed mask of *A*(*i*) unit rearranged from minimum to most values supported that this study like to produce these values before applying formula [11].

4. EXPERIMENTAL RESULTS

For the experimental results, considered taking an image considering as noiseless and then applying noises to the image and then application of noise removal algorithms on that noisy images resulted in some distorted and some better quality images because not all algorithms work perfectly for all kinds of images and so as this study is focusing on providing Comparative Quantitative Analysis of different algorithms this study needs some parameters too and they are MSE (Minimum Square Error), PSNR (Peak Signal to Noise Ratio) and SNR(Signal to Noise Ratio) values has they are listed below. Lower the MSE much clear the image, Higher the PSNR and SNR much better the image.

5. CONCLUSION

In this paper, used "Image Processing System". It provides a method that would help in removing noises on Salt and Pepper Noise and Gaussian Noise Type and also along with that system includes noises on to the images using algorithm and removes them with the max efficiency under certain sacrifices. Also providing a graphical platform that gives the user some statistical results about the efficiency of each algorithm under some parameters like the image quality and noise in it. Of Course, there are exceptions to this, System accepts 24 bit Bitmap image files and could only perform 5 Noise Removal Algorithm, as every great software needs a huge area for development in this sector. Also Analysis sector needs every algorithm to be deployed then only it could tell about which algorithm could work the best. Also this processing can be implemented on a computer, as the images needs to clean to understand better about the noise addition and removal techniques and Displaying each modification on them. Filtering the noises out of the images is important step for image processing software so noises always arises in unexpected ways. As Images are all about integer values and applying arithmetic operations that could change the integer values results in a new image.

6. FUTURE APPLICATIONS AND DEVELOPMENT

This study of Noisy Image and Algorithm Comparison can be helpful in developing an automated image noise removal software system for the detection of which algorithm works the best and be applied to an image just after the picture is taken in any device that deals with images for better quality images. It could also serve as a starting point for developing Artificial Intelligence system for the machine to recognize surrounding objects with better contrast and detail to get an idea of what is around. Dependency on other third party noise removal applications can be removed if this system can be integrated into the camera software by default so that end output image will be much better with lesser or no noise. Development could be expected because there are many more noises that are present in the images and corresponding removal of noise can be done. Also better algorithms can be developed or included for the system to work much better. As there are number of image de-noising techniques used but still there is lot to happen. Further studies can be done in this field to provide more effective methodologies. Techniques that are already using may not be able to find the optimum result thus further studies may find the techniques that provide optimum solution to the noise.

Table 1: Analysis of Test Image 1

Original Image	Noisy Image		Alpha Trimmed	Contra Harmonic	MMSE	Arithmetic Mean	MTM

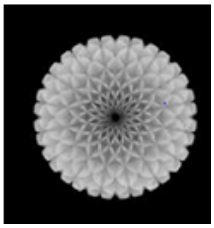
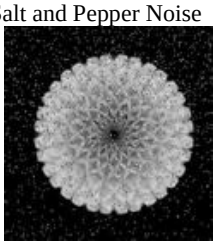
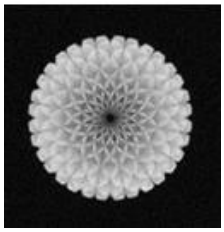
			Mean				
	Salt and Pepper Noise 	MSE	75	13824	3458	195	149
		PSNR	29.380	6.724	2.748	25.230	26.399
		SNR	12.287	0.396	4.293	9.432	11.712
	Gaussian Noise 	MSE	389	433	363	351	504
		PSNR	22.231	21.766	2.532	22.678	21.106
		SNR	5.594	5.395	5.633	5.636	5.380

Table 2: Analysis of Test Image 2

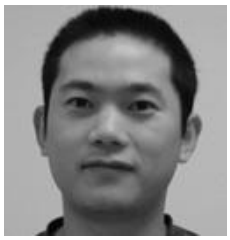
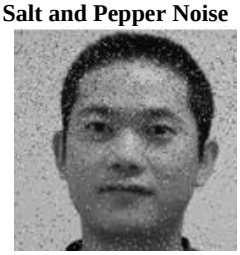
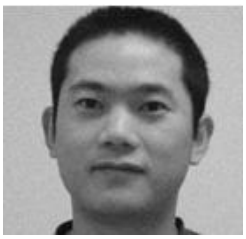
Original Image	**Noisy Image**		**Alpha Trimmed Mean**	**Contra Harmonic**	**MMSE**	**Arithmetic Mean**	**MTM**
	**Salt and Pepper Noise** 	**MSE**	**19**	64	4221	119	45
		PSNR	**35.343**	30.069	11.877	27.375	31.599
		SNR	**17.232**	14.195	5.522	12.992	16.505
	Gaussian Noise 	**MSE**	340	348	355	**336**	416
		PSNR	22.816	22.715	22.629	**22.867**	21.940
		SNR	8.620	8.590	8.523	**8.640**	8.427

Table 3: Analysis of Test Image 3

Original Image	**Noisy Image**		**Alpha Trimmed Mean**	**Contra Harmonic**	**MMSE**	**Arithmetic Mean**	**MTM**
	**Salt and Pepper Noise**	**MSE**	**241**	331	3086	262	292
		PSNR	**24.311**	22.933	13.237	23.948	23.477

		**SNR**	**8.329**	7.071	3.003	7.741	8.178
	Gaussian Noise 	**MSE**	566	582	**383**	456	674
		PSNR	20.603	20.482	**22.299**	21.541	19.844
		SNR	5.029	4.978	**5.416**	5.310	4.757

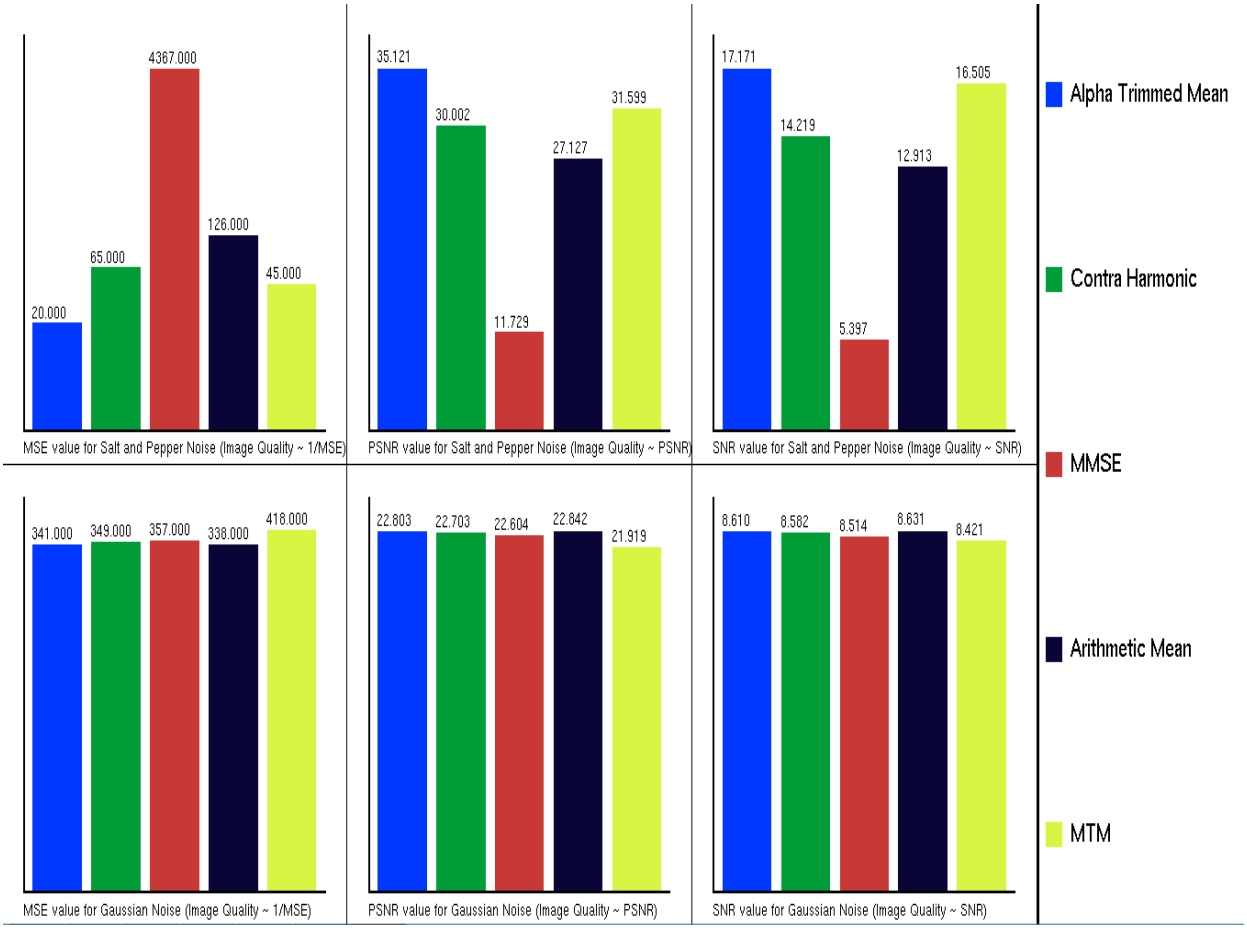


Fig 1: Statistics Graph for Test Image 2

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