Image De-Noising Algorithms: A review

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Abstract- **In the field image processing and computer vision there is one fundamental challengethat is image de-noising where the underlying goal is to enhance the original image by removing noise from a noisy image.The prime factor which reduce the quality of image is noise. It hide the important details and information of an image.Noise may be caused by the different internal or external environment. Image de-noising plays an important role in a wide range of applications such as image restoration, visual tracking, image registration where obtaining the original image contents are essential for strong performance. Various algorithms have been proposed for image de-noising, but there is one problem that image noise suppression remains same like in situations where the images are acquired under poor conditions where the noise level is very high. In this paper we discuss different noise removal filters for different noises.**

Key words:- salt and pepper noise, mean square error, peak signal ratio, normalized coefficient, root mean square error, image enhancement factor

I. INTRODUCTION

The field of digital image analysis enables computers to extract, modify and enhance digital images. Noise is any undesired information that contaminates an image. Noise appears in image from a variety of sources. The acquisition process is the primary process which converts an optical image into a continuous electrical signal and by which noise appears in digital images. When an image gets corrupted with noise during the processes of acquisition, transmission, storage and retrieval, it becomes necessary to suppress the noise quite effectively without distorting the edges and the fine details in the image so that the filtered image becomes more useful for display or further processing.

Image filtering is a process by which we can enhance images. Image filtering is used to remove noise, sharpen contrast or highlight contours in the images. A filter is a software routine that changes the appearance of an image or part of an image by altering the shades and colors of the pixels in some manner. Filters are used to increase brightness and contrast as well as to add a wide variety of textures, tones and special effects to a picture. Filters can enhance the images by removing imperfections like noise, blur to some portion of image so that portion will be out of focus and so on. The choice of filter is often determined by the nature of the task and the type and behavior of the data. Noise, dynamic range, color accuracy, optical artifacts, and many more details affect the outcome of filter functions in image processing. Images are often corrupted by random variations in intensity, illumination, or have poor contrast and can't be used directly.

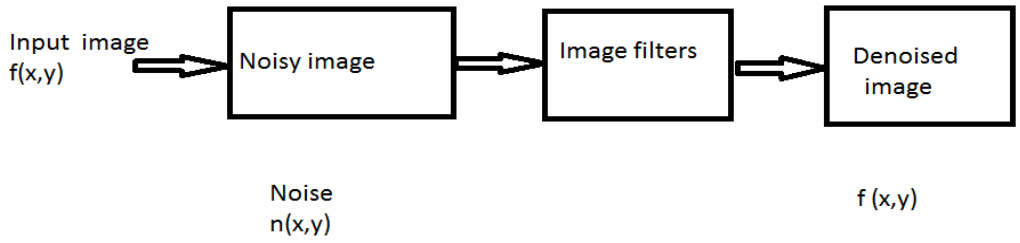

Figure 1.1 de-noising of the noisy image

A. Salt and Pepper Noise

Salt and pepper noise is a type of noise where the image contains certain percentage of noisy pixels. The value of the noisypixels is therefore completely uncorrelated with the value of the same pixel in the clean image. Salt and Pepper noise contains random occurrences of both black and white intensity values.This noise can arisedue to errors during transmission of an image. There are many image filters used to remove this noise from the noisy image like Standard Median Filter, Adaptive Median Filter and Switching Median Filter etc.

B. Image Quality Metrics

- MSE (Mean Square Error):-The first term is the MSE. The MSE is the cumulative square error between the reconstructed and the original image. The MSE is often called quantization error variance σq2 and its formula is given by

$$MSE=\sigma_q^2=\frac{1}{N}\sum_j\sum_k[f(j,k)-g(j,k)]^2 \quad (1)$$

where the sum over j, k denotes the sum over all pixels in the image and N is the total number of pixels in an image. The lower the value of MSE, the lower the error.

- RMSE (Root Mean Square Error):-RMSE is a frequently used measure of the differences between values predicted by a model or an estimator and the values actually observed. RMSE is a good measure of accuracy. A lower value for RMSE means lesser error and this result in a high value of PSNR. Its formula is given by

$$RMSE=\sqrt{MSE} \quad (2)$$

- PSNR (Peak Signal to Noise Ratio):-Other important term related to image quality metrics is the PSNR. PSNR is a measure of the peak error. It is used to test the change in the quality of image after applying various attacks. The mathematical formula is given by

$$PSNR = 20 * \log10 \frac{2^n-1}{RMSE} \textbf{ or } PSNR=20*\log10(255/RMSE) \quad (3)$$

where n is the number of bits used to represent per pixel value and 255 represents the maximum value of each pixel. Logically, a higher value of PSNR is good because it means that the ratio of signal to noise is higher. Here, the 'signal' is the original image, and the 'noise' is the error in reconstruction. So we can say that a scheme having a lower RMSE and a high PSNR is a better scheme.

- NC (Normalized coefficient):- Two images are similar if value of normalized coefficient is near 1. The formula for calculating NC value is as follows:-

$$NC = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w(i,j)*w'(i,j)}{\sum_{i=1}^{n}\sum_{j=1}^{n} w^2(i,j)} \quad (4)$$

- IEF (Image Enhancement Factor):- Used to check the enhancement of image. The Formula for calculating IEF value is as follows:-

$$IEF = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}\{\eta(i,j)-Y(i,j)\}^2}{\sum_{i=1}^{}\sum_{j=1}^{}(\hat{Y}(i,j)-Y(i,j))^2} \quad (5)$$

II. LITERATURE SURVEY

Thirilogasundari et al [8] proposed switching median filter. Consists of two stages detection stage and filtering stage, in detection stage neighborhood mapping based algorithm used to detect the corrupted pixels. In filtering stage the corrupted pixels. In the filtering stage the corrupted pixels are filtered by using fuzzy membership function. The proposed algorithm restored images which highly corrupted up to 90% density.

Karthik et a[l] stated that the algorithm replaced the noisy pixels by trimmed median values 0' and 255'0the noise pixels is replaced by the mean value of all the elements presented in the selected window. It provided the better results than the standard median filter, decision based algorithm, and modified decision based algorithm and progressive switched median filter. Modified cascade filter tested against different gray scale and color images and given better peak signal to noise ratio and image enhancement factor.

Hosotani et al [3] proposed a novel noise reduction method for images using image segmentation. Used high resolution analysis called 2D NHA. Provide an edge preserving method implemented by a 444compounded method consisting of canny edge detection and mean shift algorithm.

Djurovic et al [2] applied the block matching and 3D filtering (BM3D) scheme in order to refine the output of the decision base, adaptive median techniques obtained results are excellent surpassing current state of the art for about 2 DB for both gray scale and color images.

Pranay et al [6] proposed algorithm has been tested at low, medium and high noise densities on gray scale images and also tested in real time images. Proposed filter exhibits better performance in comparisons MF, DBA, MDBA, MDBUTMF, and MNF Filters in terms of high PSNR .this method takes a very short little time between 2 to 5 seconds in 10 % to 90% noise density.

Xunbo et al [9] suggested a new algorithm for salt and pepper noise removal which combines the nonlocal mean filter and adaptive median filter. the experimental result shown that this method not only high PSNR but also pleasure visual results even that noise level at high as 90%

Zhang et al [10] told that an efficient algorithm to remove salt and pepper noise. This algorithm takes noisy pixels as missing data for inpainting and adaptively select convolution mask for iterative filtering in terms of the detailed textures of their local regions many experiment have been conducted and comparisons have been also done.

Guorong et al [5] stated that an efficient three stage scheme for the removal of salt and pepper noise based on an efficient impulse detector, an adaptive mean median filter and the total variation inpainting method was proposed. The performance of this method evaluate by application to the two images corrupted by salt and pepper noise with a wide range of noise level from 10% to 80% and comparison with some state of the art salt and pepper noise remove filters. The experimental result shown that this algorithm perform much better than other existing denoising method in terms of both objective measures and visual quality.

Ahmed et al [4] presented novel two stage filter for removal of salt and pepper noise. Noisy pixelsdetected by adaptive fuzzy filter. Weighted mean filter is used to denoising. Experimented results shown that the proposed filter is superior to state-of-the-art filters, and moreover, can restore meaningful image detail at levels of corruptionas high as 97%.

Zhang et al [7] provided an improved method based on AMF that performed better in restoring image corrupted by high levels of SPN. It has much higher detection accuracy than AMF especially for high-level SPN. The computational time is similar for each level of SPN. Experimental tests have shown that theproposed AWMF method could perform better than many other existing filters.

III. COMPARISON OF VARIOUS FILTERS

Salt and Pepper Noise is a combination of black and white intensity values present in an image. We can ensure that image containing noise has dark pixels in bright regions and bright pixels in dark regions are salt and pepper. This type of noise can be caused by dead pixels, analog to digital converter errors, bit error in transmissions, faulty camera sensors etc.

- SMF (Standard Median Filter) is a non-linear filterused to remove Salt and Pepper Noise from corrupted image by replacing the individual pixel by the median value of the pixel from a chosen neighborhood. It works well at low noise density but when the noise density is increased, it removes fine details from the image like sharp corners and thin lines.

- AMF (Adaptive Median Filter) is an enhancement over SMF. It preserves maximum amount of original information of an image. It is a combination of SMF and CWMF (Center Weighted Median Filter).CWMF is used to detect whether the pixel is noisy or not. When the noise density is increased, the number of replacements of corrupted pixel increases. So, for better performance of AMF, the window size is increased. It leads to blurring of image.

- To overcome the drawbacks of AMF, (DBA Decision Based Algorithm) was proposed. The image is denoised by using 3*3 window sizes. At high noise density, the median value is also noisy. In such case, neighboring pixel is used for replacements. It leads to streaking effect in the image.

- DBUTMF (Decision Based Unsymmetrical Trimmed Median Filter) removes the drawback of streaking effect at higher noise density. At high noise density, if the selected window contains all 0 or 255 or both values then the trimmed median value cannot be obtained. So, this algorithm does not give better results at very high noise densities.

- MDBUTMF (Modified Decision Based Unsymmetrical Trimmed Median Filter) was introduced to remove the drawback of DBUTMF by giving better PSNR value. At a higher noise density, MDBUTMF calculates the mean of the processing window (if all the elements in the window are 0 and/or 255). However, at a higher noise density, the probability of the event that the entire pixels (in the local window) are noisy is high. Therefore, this replacement produces dark patch-like surface in the restored image.

An improved and robust mean filter is proposed.In this method, first task is to detect the noisy pixels in the corrupted image. If pixels are between maximum [255] and minimum [0] gray level values, then it is a noise free pixel, else pixel is said to be corrupted or noisy. Now process only the corrupted pixels to restore the noise free pixels. Further un-corrupted pixels are left unaffected.

IV. CONCLUSION

After analysis of different techniques, compress that there isparticular technique for particular noise in images, and provide the better result, but for different noise does not provide good result. There are different techniques that can be used for number of noises, but not all like NL mean algorithm, from this we can say there are no method for all types of noises.

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