Face Image Analysis under Various Noisy Backgrounds Using Gaussian Median Filtering [GMF]

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Abstract--- Today, image processing penetrates into various fields, but till it is struggling in quality issues. Hence, image enhancement came into existence as an essential task for all kinds of image processings. Various methods are been presented for gray scale image enhancement, especially for face image. In this paper various filters are used for face image enhancement. However, the authenticity of noises that might insert into an image document will affect the performance of face recognition algorithms. Hence, different filtering algorithms are presented for noise elimination using various filtering algorithm. In order to improve of the image quality Gaussian Median filtering has been applied. The experimental result shows that this method provides better enhancement in term of quality when compared with the existing methods such as Mean filter, Wiener Filter and laplacian filter. The peak Signal Noise Ratio (PSNR) and Mean Square Error (MSE) are been used for similarity measures.

Keywords— Mean Filter (MF), Median Filter, Wiener Filter, Gaussian Median Filter (GMF),PSNR, MSE.

I . INTRODUCTION

In the computer era there is a rapid growth in the field of information technology and the security system was suffering from various issues. Today, criminals have been entered into the field of information technology called cyber crime. Lot of security systems has emerged to solve the various security issues such as password, username, secret codes, but failed due to cyber attacks. In order to overcome such security issues the biometric system has been emerged with various features such as face recognition, fingerprints recognition, gait, palm print, voice, signatures etc.

Every human being can identify a faces in a scene with no effort, with an automated system such objectives are the very challenging one due to various factors which affects the quality of the image. Hence, face recognition system has been used to verify the identity of an individual. It can be accomplished by matching process using various methods and features such as geometric, statistical, low-level features which are derived from face images.

Since last decades, researchers are involved on face recognition in image processing and they achieved so many mile stone for this. Because face recognition is the critical stage to identify the face in images due to pose, presence or absence of structural components, facial expression, occlusion, image orientation. Above all, Noise is prime factor of reducing face recognition rate. Several methods have been evolved to increase recognition rate.

Filters are widely accepted to remove impulsive and high frequency noise for signal and image processing. The concept of filtering has its roots in the use of the Fourier transform for signal processing in the so-called frequency domain. Spatial filtering term is the filtering operations that are performed directly on the pixels of an image. The process consists simply of moving the filter mask from point to point in an image at each point (x, y) and the response of the filter at that point is calculated using a predefined relationship.

II. RELATED WORK

In recent years, considerable progress has been made in the area of face recognition with the development of many techniques. Even these techniques perform extremely well under various constrain, the problem of face recognition in uncontrolled by noisy environment remains unsolved. Image noise can originate in film grain or in electronic noise in the input device such as scanner digital camera, sensor and circuitry or in the unavoidable shot noise of an ideal photon detector. Noise affects the identification of images in authentication and also in pattern recognition process. The identification of the nature of the noise [1] is an important part in determining the type of filtering that is needed for rectifying the noisy image. Noise in imaging systems is usually either additive or multiplicative [2]. The basic types of noise can be further classified into various forms [3] such as amplifier noise or Gaussian noise, Impulsive noise or salt and pepper noise, quantization noise, shot noise, film grain noise and nonisotropic noise.

A model [4] proposed with noise removal filtering algorithms. Most of them follows certain statistical parameters and know the noise types. Applying various a filtering algorithms that is sensitive to additive noise to an image that has been degraded by a multiplicative noise which does not provide best results. Many algorithms have been developed to remove salt & pepper noise in document images with different performance in removing noise and retaining fine details of the image.

Various filtering techniques exist to perform the inverse of the imperfections in the degraded image [5], [6]. These filtering techniques are application oriented. Some filtering techniques perform better than the others techniques based on the noise category. These filters are used in a variety of applications [7] efficiently in preprocessing module.

III. NOISE TYPES

The noise is characterized by its pattern and its probabilistic characteristics. There is a wide variety of noise types while this paper focus on the most important types they are Gaussian noise, salt and pepper noise, poison noise, impulse noise, speckle noise.

A) Gaussian Noise

Gaussian noise is statistical noise that has its probability density function equal to that of the normal distribution, which is also known as the Gaussian distribution. In applications, Gaussian noise is most commonly used as additive white noise to yield additive white Gaussian noise.

B) Salt and Pepper Noise

Salt and pepper noise is a form of noise typically seen on images. It represents itself as randomly occurring white and black pixels. Salt and pepper noise creep into images in situations where quick transients, such as faulty switching, take place.

C) Speckle Noise

Speckle is a complex phenomenon, which degrades an image quality. Speckle noise is a multiplicative noise. The speckle noise follows a gamma distribution [8]. Thus, denoising or reducing the noise from a noisy image has become the predominant step in image processing. For the quality and edge preservation of images we have taken different denoising techniques into consideration.

IV. EXISTING METHODOLOGY

4.1 Filters

Generally filters are used to filter unwanted things or object in a spatial domain or surface. In digital image processing, mostly the images are affected by various noises. The main objectives of the filters are to improve the quality of image by enhancing is to improve interoperability of the information present in the images for human visual. A general structure of a filter mask is as follows.

-1	-1	-1
-1	N	-1
-1	-1	-1

Fig.1.1 Filtering Mask

Image filtering can be used for many aspects which includes, smoothing, sharpening, noise eliminating and edge detection etc. A filter is defined by a kernel, which represented is a small array and applied to each pixel and its neighbours within an image.

4.2 Frequency and Spatial Filters

The frequency domain technique is based on the convolution theorem. It decomposes an image from its spatial domain form of brightness into frequency domain components and is represented as the following equation

$$g(x,y) = h(x,y) * f(x,y) \quad \text{...... (1)}$$

Where $f(x,y)$ is the input image, $h(x,y)$ is a position invariant operator and $g(x,y)$ is the resultant image from the convolution theorem.

$$G(u,v) = H(u,v)\, F(u,v) \quad \text{........ (2)}$$

Where G, H, F is the fourier transform of g, h, f respectively. The transform H (u, v) is called transfer function of the process. Here the edge in f(x,y) can be boosted by using H(u,v) to emphasis the high frequency component of F(u,v). In case of spatial filter works on pixels in the neighbourhood of the pixel. The operation on sub image pixels is defined using mask or filter with the same dimension.

4.3 Mean Filter (MF)

The Mean Filter is a linear filter which uses a mask over each pixel in the signal. Each of the components of the pixels which fall under the mask are averaged together to form a single pixel. This filter is also called as average filter. The Mean Filter is poor in edge preserving. The Mean filter is defined by:

$$h[i,j] = \frac{1}{M} \sum_{(k,l)\in N} f[k,l] \quad ----(3)$$

Where M is the total number of pixels in the neighborhood N. Mean filtering is a simple, intuitive and easy to implement method of smoothing images, i.e. reducing the amount of intensity variation between one pixel and the next. It is often used to reduce noise in images.

The idea of mean filtering is simply to replace each pixel value in an image with the mean value of its neighbours, including itself. This has the effect of eliminating pixel values which are unrepresentative of their surroundings. Mean filtering is usually thought of as a convolution filter. Like other convolutions it is based around a kernel, which represents the shape and size of the neighbourhood to be sampled when calculating the mean.

4.4 Wiener Filter

The wiener filtering method requires the information about the spectra of the noise and the original signal and it works well only if the underlying signal is smooth. Wiener method implements spatial smoothing and its model complexity control correspond to choosing the window size [9].

$$G(u,v) = \frac{H^*(u,v)Ps(u,v)}{|H(u,v)|2Ps(u,v) + Pn(u,v)} \quad \text{..... (4)}$$

Where

H(u, v) = Degradation function

H*(u, v) = Complex conjugate of degradation function

Pn (u, v) = Power Spectral Density of Noise

Ps (u, v) = Power Spectral Density of un-degraded image

Wiener filtering is able to achieve significant noise removal when the variance of noise is low they cause blurring and smoothening of the sharp edges of the image. Detection of emotions in highly corrupted noisy environment this approach involves removal of noise from the image by the Wiener Filter for an automatic system for the recognition of facial expressions is based on a representation of the expression [10].

4.5 Laplacian Filter

Laplacian is a 2-D isotropic measure of the second spatial derivative of an image. The Laplacian of an image highlights regions of rapid intensity change and is therefore often used for edge detection. The laplacian is often applied to an image that has first been smoothed with something approximating a Gaussian smoothing filter in order to reduce its sensitivity to noise. The operator normally takes a single gray level image as input and produces another gray level image as output.

V. PROPOSED METHODOLOGY

By considering the inefficiency of the existing image enhancement methods there is a need to propose a new methodology for face image enhancement which leads to improve the quality of the image. A novel filtering technique is proposed with the hybridization of Gaussian filter with Median filter.

5.1 Gaussian filtering

Gaussian filters are a class of linear smoothing filter with the weights chosen according to the Gaussian functions. Mainly these kind filters are used to smooth the image and to eliminate the Gaussian noises.

$$h(m,n) = \frac{1}{\sqrt{2\pi\sigma}} e \frac{m^2}{2\sigma^2} \text{ X } \frac{1}{2\pi\sigma} \frac{n^2}{e2\sigma^2} \quad .... (5)$$

From the above equation 5 shows the Gaussian filter is separable. The Gaussian smoothing filter is very good in noise removal in normal distribution function. This filter is rotationally symmetric the amount of smoothening is all direction. The degree of smoothening is governed by variance T.

5.2 Median Filtering

Then Median filter, the most prominently used impulse noise removing filter, provides better removal of impulse noise from corrupted images by replacing the individual pixels of the image as the name suggests by the median value of the gray level The median of a set of values is such that half of its values in the set are below the median value and half of them are above it and so is the most acceptable value than any other image statistics value for replacing the impulse corrupted pixel of a noisy image for if there is an impulse in the set chosen to determine the median it will strictly lie at the ends of the set and the chance of identifying an impulse as a median to replace the image pixel is very less. A commonly used non-linear operator is the median, a special type of low-pass filter. The median filter takes an area of an image (3x3, 5x5, 7x7, etc.), sorts out all the pixel values in that area and replaces the center pixel with the median value. The median filter does not require convolution. The best known order-statistics filter is the median filter, which replaces the value of a pixel by the median of the gray levels in the neighborhood of that pixel,

$$f(x,y) = \underset{(s,t)\in S_{xy}}{\text{median}} \{g(s,t)\} \; --- \; -(6)$$

The original value of the pixel is included in the computation of the median. Median filters are quite popular because, for certain types of random noise they provide excellent noise reduction capabilities, with considerably less blurring than linear smoothing filters of similar size.

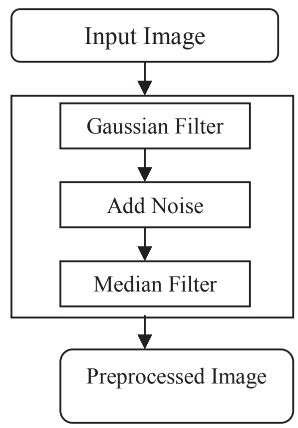


Fig.1.2 Process flow of GMF Model

The above figure 1.2 shows the process flow of the proposed preprocessing technique. Initially, the input image is selected from the standard fingerprint database. Then the Gaussian Median filter is applied on the input image for image enhancement of Gaussian filter and Median filter to eliminate the noise presents in the image. In order to enhance the clarity of the image the median filter is applied with the amplification factor A. Finally the preprocessed image has been obtained with better quality.

VI. SIMILARITY MEASURES

6.1 Mean Squared Error (MSE)

Mean square error is given by

$$MSE = \frac{1}{MN} \sum_{i=1}^{M} \sum_{i=1}^{N} \left[g(i,j) - f(i,j) \right]^2 \quad .... (7)$$

Where M and N are the total number of pixels in the horizontal and the vertical dimensions of image, g denotes the Noise image and f denotes the filtered image.

6.2 Peak Signal to Noise Ratio (PSNR)

The peak Signal to Noise ratio is calculated by:

$$PSNR = 10 \log_{10} \left(\frac{255^2}{MSE} \right) \quad .... (8)$$

For the image quality measures, if the value of the PSNR is very high for an image of a particular noise type then is best quality image.

VII. ALGORITHM

Input : Input image from IDB

Output : Preprocessed Image

Step 1: Read an image from the image database (IDB)

Step 2: Add Noise to an input image.

Step3: Apply Gaussian filter on the input image.

Step 4: Then apply Median filter on the input image.

Step 5: Calculate PSNR values.

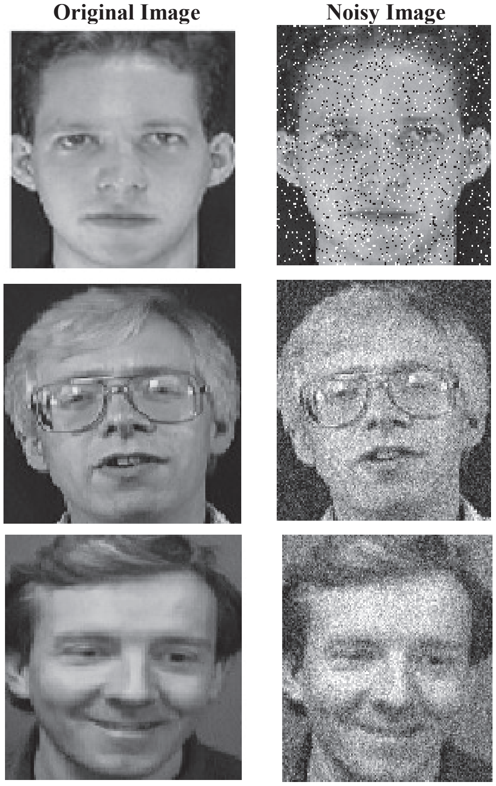
Step 6: Repeat step 2 and step 4 for all images in database (IDB).

Step 7: Stop

VIII. EXPERIMENTATION & RESULTS

The performance of the existing filters is measured by conducting the following procedure. The performance of the filters is measured by applying noise on the face images. The sample face images downloaded are used to analysis this work. For our experiments, the sample facial images from the standard ORL face image database are used. It contains a total of 4000 images containing 40 subjects each with 10 images that differ in poses, expressions and lighting conditions. Figure 1.3 shows the sample images used in our experiments used noise. From the figure 1.4 shows noise removed using mean filter, wiener filter and proposed Gaussian Median filter.

Original Image **Noisy Image**



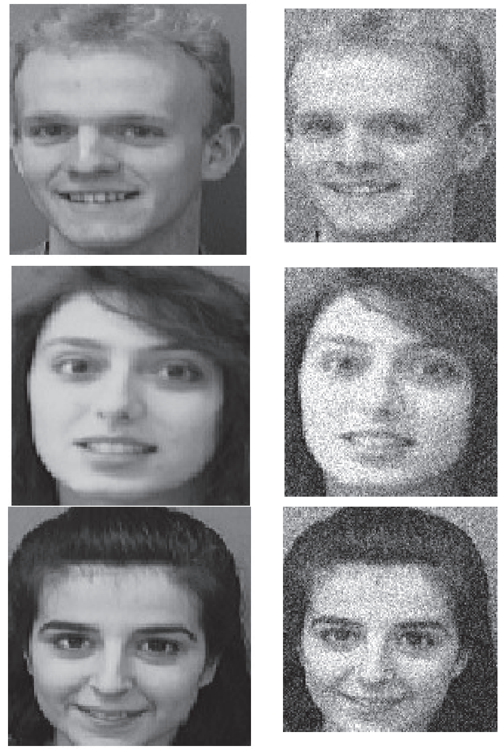
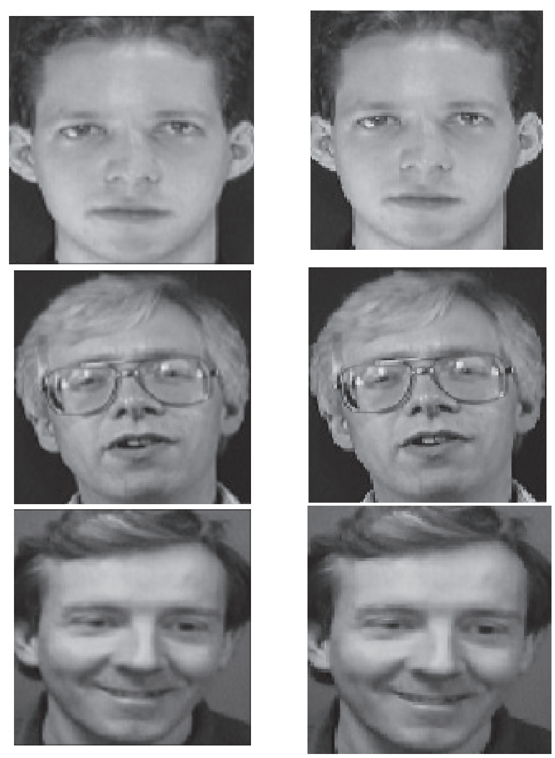
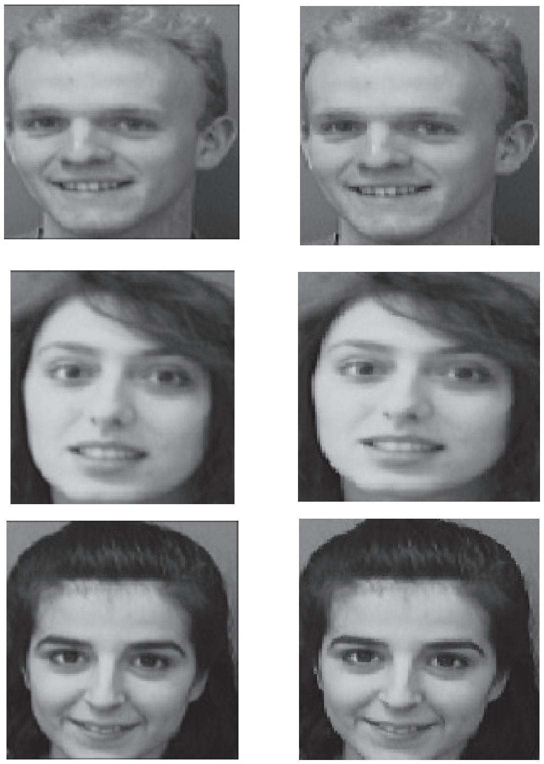


Fig.1.3 Sample and Noisy image

Mean Filter **Wiener Filter**





Laplacian Filter **Gaussian Median Filter**

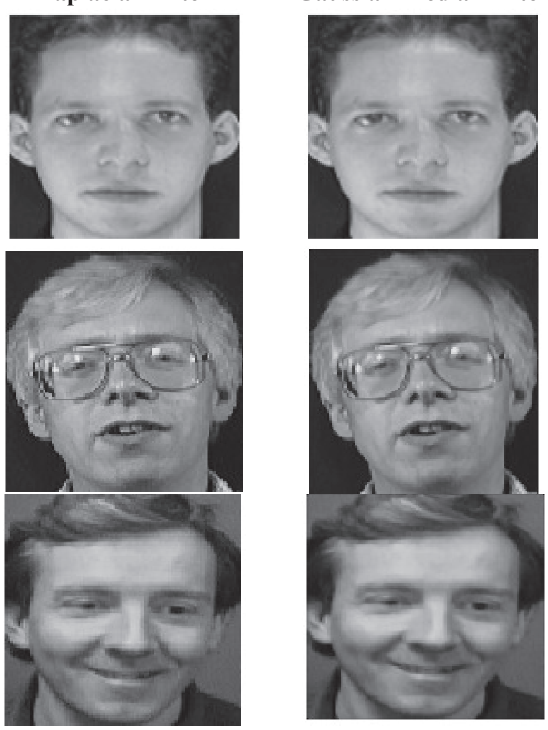


Fig.1.4 Output image

Image Id	Mean Filter	Wiener Filter	Laplacian Filter	Gaussian Median Filter
1	43.71	8.53	55.14	49.31
2	60.73	12.71	50.48	62.40
3	33.73	9.48	36.60	42.02
4	61.09	14.0	39.03	77.64
5	37.63	8.02	29.87	41.93
6	64.72	13.44	44.35	75.56
7	55.14	13.75	40.26	57.37
8	31.96	7.34	29.81	32.66
9	42.94	10.84	31.37	36.29
10	45.24	9.56	25.89	58.13

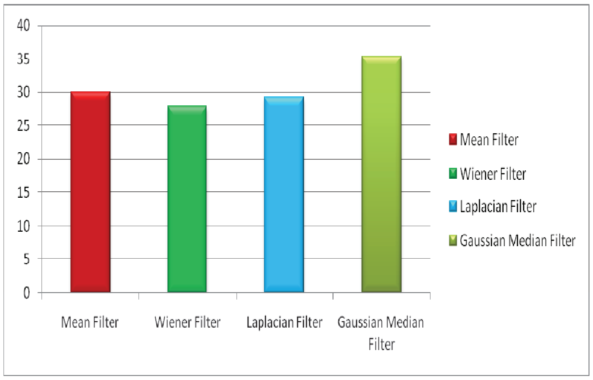
Table 1. MSE Comparison Values

From the table 1 shows the experimented values obtained from different preprocessing methods. It shows the selected face image from the database. The performance was evaluated using the Mean Square Error (MSE) and Peak Signal Noise Ratio (PSNR) in order evaluates the quality of the image. By the analysis of the values in the table the Gaussian Median filter is better with less MSE and high PSNR values. In order to evaluate the performance of the Gaussian Median filter considered the obtained results with the existing Mean filter, Wiener filter and laplacian filter are shown in the following table 2.

Image Id	Mean Filter	Wiener Filter	High Boost Filter	Gaussian Median Filter
1	31.75	28.85	30.78	35.31
2	30.33	27.12	29.26	33.06
3	32.88	28.39	27.55	37.37
4	30.30	26.69	28.47	33.75
5	32.40	29.12	30.10	37.40
6	30.05	26.87	29.79	34.09
7	30.74	26.78	28.05	33.79
8	33.11	29.50	27.69	37.50
9	31.83	27.81	28.12	36.05
10	31.60	28.35	29.33	35.58

Table 2. PSNR Comparison Values

From the below figure 4 shows the pictorial representation of the performance evaluated. By analysing the obtained results the proposed model produced the best results. Hence the Gaussian Median filter is an efficient one.



IX. CONCLUSION

In this paper, the noise removal of images based on Gaussian Median filtering has been presented. The experimental result proves the effectiveness of this approach, providing good PSNR values when compared to existing methods. The performances of PSNR values of proposed Gaussian Median filtering when compared to existing methods Mean filter, Wiener Filter and Laplacian Filter are investigated independently. The proposed Gaussian Median filtering produces better results with 35.39% accuracy compared with existing methods gives 30.05 % accuracy for Mean filter, Wiener Filter with 27.94% accuracy and laplacian Filter with 29.26% accuracy. Moreover, the computational cost of the algorithm is very low. Therefore, the proposed algorithm candidates itself for implementation is in simple low-cost cameras or in video capture devices with high values of resolution and frame rate. The proposed scheme is capable of achieving at least comparable and often better performance than existing iterative filtering techniques.

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