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Edge Shield Static Median Filter for Removing Noise on Various Types of Images

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ABSTRACT

An image could represent luminance of objects in a scene, the absorption characteristics of the body tissue, the radar cross section of the target, the temperature profile of the region or the gravitational field in an area. In general, any two dimensional function that bears information can be considered an image. An important consideration in image representation is the fidelity or intelligibility criteria for measuring the quality of an image or the Performance of processing technique. Specification of such measures requires models of perception of contrast, spatial frequencies, and colors and so on. The fundamental requirement of digital processing is that images be sampled and quantized. The sampling rate has to be large enough to preserve the useful information in an image. It is determined by the bandwidth of the image.

Keywords:- Image Processing, Image acquisition, Median Filter.

I. INTRODUCTION

Image processing is a rapidly growing area of computer science. Its growth has been fueled by technological advances in digital imaging, computer processors and mass storage devices. Fields which traditionally used analog imaging are now switching to digital systems, for their flexibility and affordability. Important examples are medicine, film and video production, photography, remote sensing, and security monitoring. These and other sources produce huge volumes of digital image data every day, more than could ever be examined manually. A digital image differs from a photo in that the *x, y,* and *f(x,y)* values are all discrete. Usually they take on only integer values, so the image will have *x* and *y* ranging from 1 to 256 each, and the brightness values also ranging from 0 (black) to 255 (white). A digital image can be considered as a large array of discrete dots, each of which has a brightness associated with it. These dots are called picture elements, or more simply pixels. The pixels surrounding a given pixel constitute its neighborhood. A neighborhood can be characterized by its shape in the same way as a matrix. Except in very special circumstances, neighborhoods have odd number of rows and columns; this ensures that the current pixel is in the Centre of the neighborhood.

An image is digitized to convert it to a form which can be stored in a computer's memory or on some form of storage media such as a hard disk or CD-ROM. This digitization procedure can be done by a scanner, or by a video camera connected to a frame grabber board in a computer. Once the image has been digitized, it can be operated upon by various image processing operations. Image processing operations can be roughly divided into three major categories, Image Compression, Image Enhancement and Restoration, and Measurement Extraction. Image compression is involves reducing the amount of memory needed to store a digital image. Image defects which could be caused by the digitization process or by faults in the imaging set-up (for example, bad lighting) can be corrected using Image Enhancement techniques. Once the image is in good condition, the Measurement Extraction operations can be used to obtain useful information from the image.

Digital image processing is concerned primarily with extracting useful information from images. Ideally, this is done by computers, with little or no human intervention. Image processing algorithms may be placed at three levels. At the lowest level are those techniques which deal directly with the raw, possibly noisy pixel values, with denoising and edge detection being good examples. In the middle are algorithms which utilize low level results for further means, such as segmentation and edge linking. At the highest level are those methods which attempt to extract semantic meaning from the information provided by the lower levels, for example, handwriting recognition.

Image acquisition is the process of obtaining a digitized image from a real world source. Each step in the acquisition process may introduce random changes into the values of pixels in the image. These changes are called *noise*. Assume you want to send a photo of your new house to a friend over the Internet. This may be achieved by taking a photograph with a conventional camera, having the film made into a print, scanning the print into a computer, and finally emailing it to your friend. Figure-1 shows the many potential sources of noise.

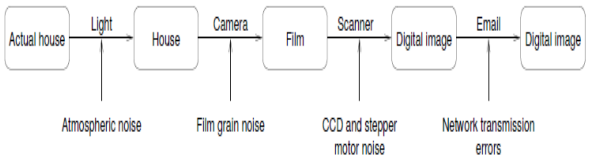

Figure-1: noise may be introduced at each step in the acquisition process.

The air between the photographer and the house may contain dust particles which interfere with the light reaching the camera lens. The silver-halide crystals on the _lm vary in size and are discontinuous, resulting in film grain noise in the printing process. Most scanners use a CCD array to scan a row of the print, which may introduce photo-electronic noise. The scanner's CCD array is controlled by a fine stepper motor. This motor has some degree of vibration and error in its movement, which may cause pixels to be misaligned. The scanner also quantizes the CCD signal, introducing quantization noise. Transmitting the image over the Internet is nearly always a bit preserving operation thanks to error checking in network protocols. However, an image transmitted to Earth from a remote space probe launched in the 1970's is almost guaranteed to contain errors.

II. VARIOUS SORCES OF NOISE IN IMAGES

Noise is a random variation of image Intensity and visible as grains in the image. It may arise in the image as effects of basic physics-like photon nature of light or thermal energy of heat inside the image sensors. It may produce at the time of capturing or image transmission. Noise means, the pixels in the image show different intensity values instead of true pixel values. Noise removal algorithm is the process of removing or reducing the noise from the image. The noise removal algorithms reduce or remove the visibility of noise by smoothing the entire image leaving areas near contrast boundaries. But these methods can obscure fine, low contrast details. The common types of noise that arises in the image are a) Impulse noise, b) Additive noise [1], c) Multiplicative noise. Different noises have their own characteristics which make them distinguishable from others.

Noise is introduced in the image at the time of image acquisition or transmission. Different factors may be responsible for introduction of noise in the image. The number of pixels corrupted in the image will decide the quantification of the noise. The principal sources of noise in the digital image are:

a) The imaging sensor may be affected by environmental conditions during image acquisition.
b) Insufficient Light levels and sensor temperature may introduce the noise in the image.
c) Interference in the transmission channel may also corrupt the image.
d) If dust particles are present on the scanner screen, they can also introduce noise in the image.

Noise is the undesirable effects produced in the image. During image acquisition or transmission, several factors are responsible for introducing noise in the image. Depending on the type of disturbance, the noise can affect the image to different extent. Generally our focus is to remove certain kind of noise. So we identify certain kind of noise and apply different algorithms to remove the noise. Image noise can be classified as Impulse noise (Salt-and-pepper noise), Amplifier noise (Gaussian noise), Shot noise, Quantization noise (uniform noise), Film grain, on-isotropic noise, Multiplicative noise (Speckle noise) and Periodic noise.

A. Impulse Noise (Salt and Pepper Noise)

The term impulse noise is also used for this type of noise [2]. Other terms are spike noise, random noise or independent noise. Black and white dots appear in the image [5] as a result of this noise and hence salt and pepper noise. This noise arises in the image because of sharp and sudden changes of image signal. Dust particles in the image acquisition source or over heated faulty components can cause this type of noise. Image is corrupted to a small extent due to

noise. Figure-3 Show the effect of this noise on the original image (Figure-2).

Figure-2: Original image without noise

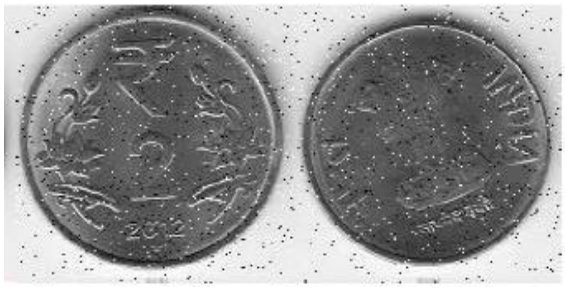

Figure-3: Image with 30% salt & pepper noise

B. Gaussian Noise (Amplifier Noise)

The term normal noise model is the synonym of Gaussian noise. This noise model is additive in nature [4] and follow Gaussian distribution. Meaning that each pixel in the noisy image is the sum of the true pixel value and a random, Gaussian distributed noise value. The noise is independent of intensity of pixel value at each point. The PDF of Gaussian random variable is given by: $P(x) = 1/ (\sigma\sqrt{2\pi}) *e(x-\mu)2 / 2\sigma 2$ $-\infty < 0 <\infty$ Where: P(x) is the Gaussian distribution noise in image; μ and σ is the mean and standard deviation respectively. Figure-4, shows the effect of adding Gaussian noise to Figure-2, with zero mean.

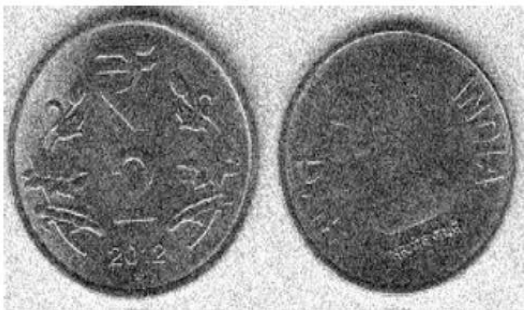

Figure-4: Gaussian noise with zero mean

C. Poisson Noise (Photon Noise)

Poisson or shot photon noise is the noise that can cause, when number of photons sensed by the sensor is not sufficient to provide detectable statistical information [4]. This noise has root mean square value proportional to square root intensity of the image. Different pixels are suffered by independent noise values. At practical grounds the photon noise and other sensor based noise corrupt the signal at different proportions [3]. Figure-5 shows the result of adding Poisson noise.

Figure-5: Image with Poisson noise

D. Speckle Noise

This noise can be modeled by random value multiplications with pixel values of the image and can be expressed as

$$J = I + n*I$$

Where, J is the speckle noise distribution image, I is the input image and n is the uniform noise image by mean o and variance v. This noise deteriorates the quality of active radar and Synthetic aperture radar (SAR) [4] images. This noise is

originated because of coherent processing of back scattered signals from multiple distributed points. In conventional radar system this type of noise is noticed when the returned signal from the object having size less than or equal to a single image processing unit, shows sudden fluctuations. Mean filters are good for Gaussian noise and uniform noise. Figure-6, shows the effect of adding speckle noise.

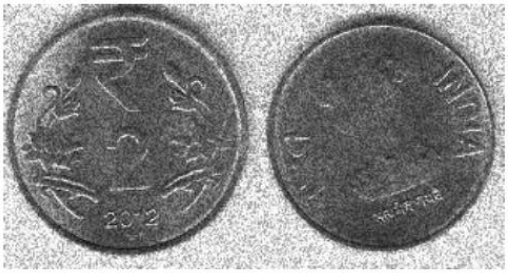

Figure-6: Image with speckle noise

III. IMAGE DE-NOISING

Image de-noising is very important task in image processing for the analysis of images. Ample image de-noising algorithms are available, but the best one should remove the noise completely from the image, while preserving the details. De-noising methods can be linear as well as non-linear. Where linear methods are fast enough, but they do not preserve the details of the images, whereas the non- linear methods preserve the details of the images. Broadly speaking, De-noising filters can be categorized in the following categories:

- Averaging filter
- Order Statistics filter
- Adaptive filter

A. Mean filter

Mean filter is an averaging linear filter [6]. Here the filter computes the average value of the corrupted image in a pre-decided area. Then the center pixel intensity value is replaced by that average value. This process is repeated for all pixel values in the image.

B. Median Filter

Median filter is a best order static, non- linear filter, whose response is based on the ranking of pixel values contained in the filter region. Median filter is quite popular for reducing certain types of noise. Here the center value of the pixel is replaced by the median of the pixel values under the filter region [9] [10].

Median filter is good for salt and pepper noise. These filters are widely used as smoothers for image processing, as well as in signal processing. A major advantage of the median filter over linear filters is that the median filter can eliminate the effect of input noise values with extremely large magnitudes.

C. Order Statistics Filter

Order-Statistics filters are non-linear filters whose response depends on the ordering of pixels encompassed by the filter area. When the center value of the pixel in the image area is replaced by 100th percentile, the filter is called max-filter. On the other hand, if the same pixel value is replaced by 0th percentile, the filter is termed as minimum filter.

D. Adaptive Filter

These filters change their behavior on the basis of statistical characteristics of the image region, encompassed by the filter region.BM3D is an adaptive filter. It is a nonlocal image modeling technique based on adaptive, high order group-wise models.

IV. RESEARCH METHODOLOGY

Research methodology is a systematic way to solve a problem. It is a science of studying how research is to be carried out. Essentially, the procedures by which researchers go about their work of describing, explaining and predicting phenomena are called research methodology. It is also defined as the study of methods by which knowledge is gained. Its aim is to give the work plan of research.

Research flow shows the entire flow the research. And it carries the problem into proper way to find the solution. Number of steps is followed to achieve the desired result.

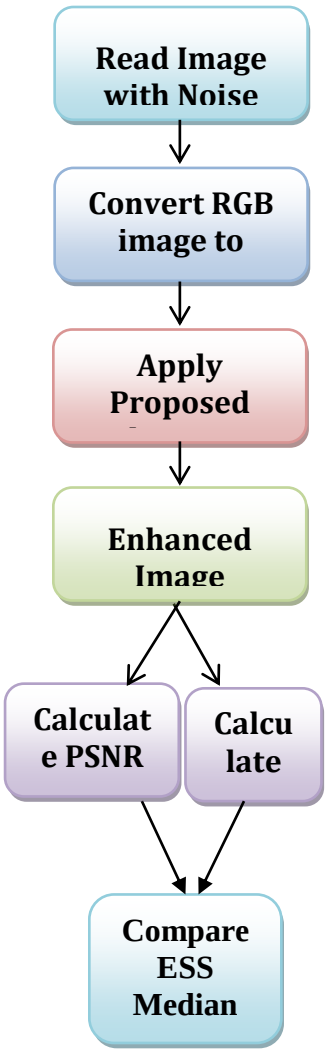

Figure-7: Research Flow

The Figure-7 shows the flow of the research carried. Initial step of the research flow is reading the image with noise. The image used here is true color images which have the RGB values. Then the image is converted into gray scale image with noise for processing with Edge shield static median filter. After the conversion the Edge shield static filter is applied to remove the noise from images. Finally image quality metrics PSNR and MSE is calculated to Enhanced image. After the calculation of PSNR and MSE values of ESS median filter, compare these values with existing median filters.

V. READING IMAGE

Reading Image is an initial task in image processing. An image can me read with the file format with image's name and corresponding directory where the image stored. The image can be either gray scale or color image. The first step in MATLAB image processing is to understand that a digital image is composed of a two or three dimensional matrix of pixels. Individual pixels contain a number or numbers representing what grayscale or color value is assigned to it. Color pictures generally contain three times as much data as grayscale pictures, depending on what color representation scheme is used. Therefore, color pictures take three times as much computational power to process.

Here images are read with noise. Noise is the dust particle of image which degrades the image quality. The type noise here taken to process is Gaussian noise. Noise is introduced into images usually while transferring and acquiring them. The main type of noise added while image acquisition is called Gaussian noise while Impulsive noise is generally introduced while transmitting image data over an unsecure communication channel, while it can also be added by acquiring.

VI. RESULTS AND DISCUSSION

Still images are visual representations that do not move. Text is ideal for transmitting information in a highly articulate manner that can be consistently interpreted irrespective of the user. Still images, however, allow the content creator to convey information which can be more freely interpreted by the user. A picture does indeed paint a thousand words but the meaning of the picture will vary from user to user. Images can be acquired from clip art collections on CDROM or through the use of a scanner. Noise is occurring in still images during the acquisition process. Noises are the unwanted dust particles, filters are used to remove those noises in images. Proposed Edge Shield Static Median filter is used to remove the Gaussian noise that occurs on the image

. The effect of the proposed Edge Shield Static Median filter in still images is noticeable. A number of still images are taken and evaluated with the use of Edge Shield Static Median filter. Some of the results are shown in Table-1.

IMAGE	NOISY IMAGE		EDGE SHIELD STATIC MEDIAN FILTER	
STILL	MSE	PSNR	MSE	PSNR
Baby	281.5493	23.6353	246.1405	24.2190
Charlie	254.4840	24.0742	188.1981	25.3847
Dog	343.8284	22.7674	298.7554	23.3776
Entrance	373.4400	22.4086	329.2497	22.9556
Girl	336.5572	22.8602	292.8767	23.4640
Monkey	347.0654	22.7267	289.8590	23.5089
Remote	326.9327	22.9862	268.9243	23.8345
Tower	370.0080	22.4487	327.4097	22.9799
Women	246.8843	24.2059	204.2118	25.0300
Fly	293.1277	23.4602	266.4666	23.8744
Bear	292.3745	23.4714	268.3916	23.8431

Table-1: PSNR And MSE Values Of Processed Still Images

The table-1 shows the result of different images processed with Edge Shield Static Median filter. The PSNR values are improved in decimal vise and error rate is decreased noticeably.

In baby image, noisy image have the PSNR value 23.635 and wiener filter have the value as 23.7082. After applying the Edge Shield Static Median filter PSNR value increased as 24.2190. The difference between the image PSNR values is 0.5108. The quality of the image in PSNR vise improved as 0.5 percentages. The other images like fly, entrance, bear, etc... Also have the PSNR value increased by the ratio 0.7%.MSE value of noise image of Charlie is 254.4840, after applying the wiener filter the error rate is reduced by 232.6073 and the Edge Shield Static Median filter reduces the error rate as 188.1981the value of reduced error rate is near 65. By comparing all the images the mean square error is reduced near 45% from the noisy image. The performance of Edge Shield Static Median filter on still image is showed as graph.

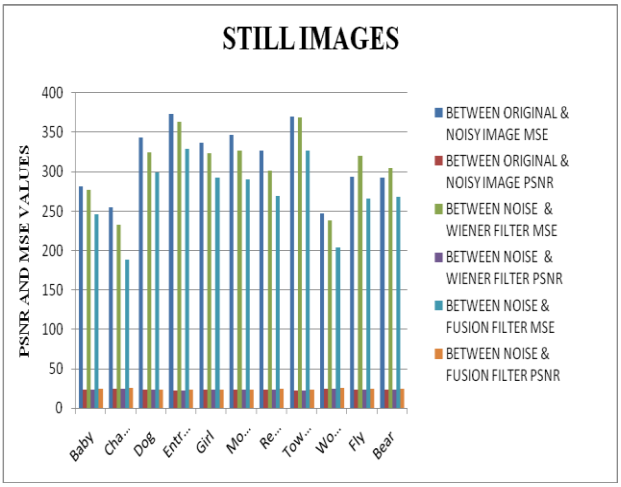

Figure-8: Performance Of Edge Shield Static Median Filter On Still Images

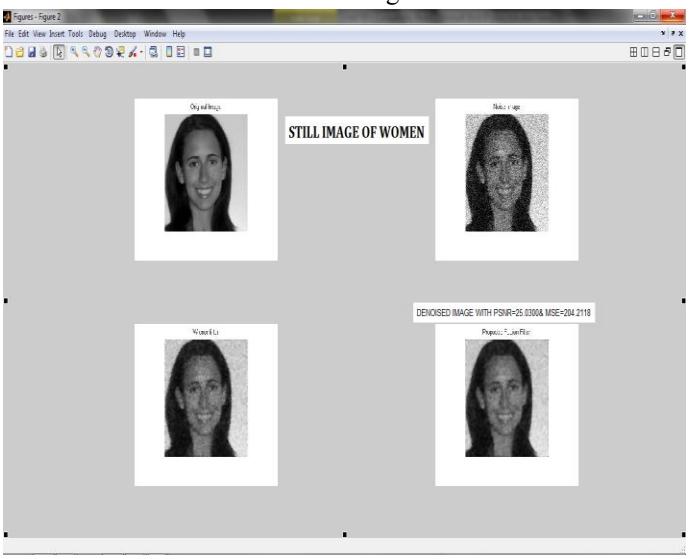

Figure-9: Edge Shield Static Median Filter Applied On An Image Of Women

Result of Edge Shield Static Median filter is Figure-8 shows the graphical representation of processed MSE and PSNR values. The chart shows the MSE and PSNR values of noisy image, MSE and PSNR values of image after applying the wiener filter and Image values after applying the Edge Shield Static Median Filter. The graph visually shows the difference between existing method and proposed method. Figure-9 shows the screen shots of result after applying the wiener and Edge Shield Static Median filter with improved

PSNR and MSE values. The values are calculated between the noisy image and the enhanced image.

VII. CONCLUSION

And the Edge Shield Static Median filter works better in still images than the medical images and satellite images. The obtained results of still images are closed to the original images. Most of noises are removed in all kind of images.

Through the results the proposed Edge Shield Static Median filter produces better results on removing the Gaussian noise on images. And Edge Shield Static Median filter produces improved results on still images. In still images PSNR values are increased by 0.7 % overall and the MSE values is decreased by 45%. In medical MRI images PSNR values are increased by 0.8 % and the MSE values are decreased by 40%. In X-ray images MSE values are decreased by 35% and the PSNR values are increased by 0.7%. Processed satellite image have PSNR values 0.4% and MSE value is decreased by 20%.The results shows clearly the Edge Shield Static Median filter works effectively on still images. The peak errors are increased in the ratio of below the 1%. So this will not produce any distortion in the images.

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