A Survey of Image Denoising and Noising Technique

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***Abstract* - Most image processing applications require noise elimination. For example, in applications where derivative operators are applied, any noise in the image can result in serious errors. Impulsive noise appears as a sprinkle of dark and bright spots. Transmission errors, corrupted pixel elements in the camera sensors, or faulty memory locations can cause impulsive noise. Linear filters fail to suppress impulsive noise. Many linear and nonlinear filtering techniques have been proposed earlier to remove impulse noise, however these filter often bring along blurred and distorted image of details. Filtering an image to attenuate noise while keeping the image details preserved is one of the most important issues.**

***Index Terms* - Image Processing, Denoising, Nosing, Filtering**

I. INTRODUCTION

Noise is the most annoying problem in processing. One way to get rid of this problem is the development of such a robust algorithm that can perform the processing tasks in presence of noise. The other way is to design a filtration process to eliminate the noise from images while preserving its features, edges and details. Noise introduces random variations into image that fluctuate the original values to some different values. Causes which may introduce noise to images include flaws in data transmission, imperfect optics, sensor malfunctioning, processing techniques and electronic interference [4].

II.NOSING Technique

Real images are often degraded by some random errors this degradation is called noise. Image noise is the random variation of brightness or color information in images produced by the sensor and circuitry of a scanner or digital camera. The acquisition or transmission of digital images in real world is often interfered by different kinds of noise. The occurred noise may be Gaussian noise, Impulse noise, Rayleigh noise, Gamma noise, exponential noise, Periodic noise, speckle noise, etc. The spatial property of a noise is that it is independent of spatial co-ordinates and uncorrelated with image itself. The presence of noise gives an image a mottled, grainy, textured, or snowy appearance. No imaging method is free of noise, but noise is much more prevalent in certain types of imaging procedures than in others.

Some of the techniques apply simple filters, such as average filters, max filters, min filters, median filters, alpha-trimmed mean filters and Gaussian filters for image de-noising. These filters reduce noise at the cost of smoothing the image and relocating the edge pixels. One of the widely used denoising techniques is a linear filtering technique, in which a corrupted image is convoluted with constant matrix or kernel, which fails when the noise is non-additive. Another type of denoising technique uses non-linear filtering techniques which are rich and powerful methods applied over corrupted noisy gray scale or color images to provide noise free image. One of the widely used non-linear techniques is Median filters based approaches, in which procedures blurs the image if kernel size is increased, while removing the noise [1].
Some of the common types of noises are explained below:

1.1.1 Impulsive Noise:

Impulsive noise can be caused by malfunctioning camera photo sensors, optic imperfections, electronic instability of the image signal, aging of the storage material, faulty memory locations in hardware or transmission errors due to natural or man-made processes.
Common sources of impulsive noise include also lightning, strong electromagnetic interferences caused by faulty or dusty insulations of high-voltage power lines, car starters, and unprotected electric switches. These noise sources generate short time duration, high-energy pulses which disturb the regular signal, resulting in the acquisition of color image samples differing significantly from their local neighborhood in the image domain [2].
Two types of filters are used for noise reduction
1. Linear filters accomplish noise reduction with blurring.
2. Non-linear filters have a good edge and image detail preservation properties that are highly desirable for image filtering.
Impulse noise is generally caused by the achievement or broadcast of digital images through sensors or communication channel (e.g., bit errors or mixed spontaneous and Gaussian noise). Image transmission noise is caused by various sources: among others, there are manmade phenomenon, such as car explosion systems, industrial machines in the surrounding area of the receiver, switching transients in power lines, and various unprotected switches. In addition, natural causes, such as lightning in the environment and ice cracking in the glacial region, can also change the broadcast process.

1.1.2 GAUSSIAN NOISE

Gaussian noise[3] is statistical noise following Gaussian probability density and introduce in the image at the time of acquiring of image. While this noise follows Gaussian distribution and hence in common it can be removed nearby averaging operation. Common choice used for removing gaussian noise is classic linear filter such as Gaussian filter, this is accepted method to remove Gaussian noise, however this filter has a inclination to blur edges which may cause information loss in various visually important areas. The field of image restoration[5] (sometimes referred to as image deblurring or image de convolution) is worried with the reconstruction or evaluation of the unspoiled image from a blurred and noisy one. Essentially, it tries to carry out an operation on the image with the reason of the inverse of the imperfections in the image configuration system, by using the accessible information of the dreadful conditions process.

III.DENOISING

Denoising of an image refers[4] to the removal of noise from the observed image and is often used as a pre-processing step before understanding and analysis of the image scene can take place. Various non-linear filtering methods have been proposed in the literature aimed at preserving edges during image denoising. Anisotropic diffusion is one of the most popular non-linear filtering methods, uses local conduction coefficients of the gra- dient magnitude function allowing it to preserve as well as sharpen the edges. However, it is well known that the original Perona and Malik scheme tends to over sharpen edges, is a slowly converging non-linear iterative process, and may result in a piecewise smoothed version of the image. While the over- sharpening and slow convergence issues may have largely been overcome by works such as regularized and robust anisotropic diffusion remains ill-suited for denoising of images containing textured patterns.

IV. IMAGE FILTERING

4.1 Adaptive Filtering

An image-blurring[5] means is modeled as a type of an optical diffusion process in physical phenomena. So an image-sharpening process is described as its inverse diffusion. Any optical image capturing system is significantly accompanied with vague impression as defined by point multiply function. It is often modeled mathematically by the forward Gaussian convolution and then the captured image is sharpened by toward the back Gaussian deconvolution. A great diversity of image sharpening algorithms were developed so far for the inverse diffusion process. Methods such as the linear unsharp masking and Laplacian filter are most widely used for image sharpening. The USM are the Laplacian operator are defined as second-order derivatives and realized as local spatial filters. Although these image sharpening filters are simple and work well in many applications, they have two main drawbacks,

(1) the linear operator is very sensitive to noise, resulting in unpleasant granularity, and

(2) they often enhance too much high contrast areas, resulting in unpleasant overshoot artifacts.

Various approaches were proposed to reduce the noise sensitivity based on the use of nonlinear operators . The improved USM algorithms were mostly applied to monochrome images. The same idea, of course, can be applied to color images. Note that a color image has a variety of edge profiles, depending on the characteristic of object colors in a scene. Therefore a conventional linear filter also enhances image noise in color channels, resulting in unpleasant artifacts in the same way as monochrome image.

4.2 Median Filter

Applying median filter unconditionally across the entire image as practiced in the conventional schemes would inevitably alter the intensities and remove the signal details of uncorrupted pixels. Therefore, a noise-detection process to discriminate between uncorrupted pixels and the corrupted pixels prior to applying nonlinear filtering is highly desirable. The standard median filter (SMF)[6] is the most typical one due to its good denoising power and computational efficiency . However, this method operates uniformly across the image and tends to modify all the pixels without distinguishing noisy pixels from noise-free pixels, thus some details and edges are smeared when the noise level is over 50%. Median filtering has been established as a reliable method to remove impulse noise without damaging edge details. The Standard Median Filter (SMF) is effective only at low noise densities.

Various types of median filter can be defined as:

Vector Median filter: One of the most popular methods based on reduced ordering, used in many filtering designs, is the Vector Median Filter (VMF). The VMF output is the pixel from W for which the sum of cumulated distances to other samples is minimized. It is always one of the pixels of the filtering window, which is profitable as the filter does not introduce any new colors to the processed image. However, when all pixels of W are affected, for example by additional Gaussian noise, the output is also noisy. Numerous solutions devoted to the elimination of this undesired behavior were introduced, resulting in significantly better filtering performance

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4.3 Spatial Domain Filtering:

The spatial filtering consists of two things(1) a neighborhood and (2) a predefined operation that is performed on the image pixels encompassed by the neighborhood. A new pixel is created by filtering operation which has coordinates equal to the coordinates of the centre of the neighborhood, whose value is result of filtering operation. In this the filtered image is generated as the centre of

the filter visits each pixel in the input image. In spatial filtering a filter mask is moved from pixel to pixel in an image and at each pixel the response of filter is calculated using a predefined relationship which can be either linear or nonlinear.
Fig. 4.1 shows the concept of spatial filtering with the help of an example.

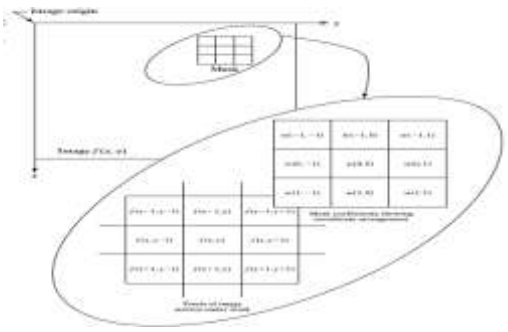

Fig.4.1 Spatial Filtering.

The image mask show above is of size 3x3. Mask must be of odd size to ensure that it has centre. Depending upon the operation spatial filtering can be of two types:

- Linear spatialfiltering
- Non-Linearspatial filtering

a) Linear Spatial Filtering

In linear filtering technique a filter mask is moved in an image from pixel to pixel. At each pixel (x,y), the response is given by sum of products of the filter coefficients and the corresponding image pixels in the area spanned by the filter mask. The Fig. 3 shows this concept, In this the result R for the linear filtering is as:

R=

$$w(-1,-1)f(x-1,y-1)+w(-1,0)f(x-1,y)+\cdots+w(0,0)f(x,y)+\cdots+w(1,0)f(x+1,y)+w(1,1)f(x+1,y+1)$$

Eq.(1.6)

The general form of linear filtering of image f of size M x N with a filter mask of size m x n is given by the following expression:

$$g(x,y) = \sum_{s=-a}^{a}$$ Eq.(1.7)

Where and . To generate a complete filtered image the above equation must be applied for x= 0,1,2,…,M-1 and y= 0,1,2,…,N-1.[29]

b) Non-linear Spatial Filtering

In this filtering technique moving of filtering mask in an image is done as in linear filtering. The filtering operation is based on the values of the pixels in the neighborhood but in this coefficients are not used in the sum-of-products manner. Noise reduction can be achieved in this with a non-linear filter, for example Median filter. Computation of non-linear filter is explained further in the section of Median filter.

V. EDGE PRESERVATION IN IMAGES

Edges are the most common features in an image, they are the local variations in an image. Edges in an image are sharp transitions in the gray level in an image. During the denoising of image it is sometimes difficult to differentiate between the edges and noise present in the image because noise is also sharp transitions in the gray level. Hence when a low pass filter is applied for the removal of noise, it blurs the sharp transitions to make the noise less visible. But with the noise it also blurred the edges in the image due to which sometimes an important information lost which is present in image edges. Hence it is important to preserve these edges during the image denoising. All the above mentioned techniques are efficient for removal of different kind of noise but none of them have provisions for the preservation of edges in images. Hence a need of different kind of filter occurs which can remove the noise as well as preserve the edges in image. Bilateral filter [7] is a such kind of filter, which is given by Tomasi and Manduchi in 1998. Bilateral filtering is explained below.

To understand the concept of bilateral filtering the concept of simple averaging or box filter and Gaussian filter should be clear. Both of these are low pass image smoothing filters. I have already explained the concept of simple Box filter in the above section of smoothing filters under the title of averaging filter. This filter smoothen the image by taking simple average of all the pixel values in the selected filter window and then replaces the centre pixel with the result. The filtering mask used for this filter is shown in the section of averaging filter.

V. CONCLUSION AND FUTURE SCOPE

This paper has introduced a new image processing method to restore the image corrupted by impulse noise, which employs the impulse noise detection, Many noise removal algorithms, such as the bilateral filtering, tend to treat impulse noise as edge pixels, and, hence, end with unsatisfactory results.

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