A Roomy Survey of Image Filtering Techniques

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Abstract— Filtering is most important and critical task to exquisite information from the noisy image and can be used in different and diverse engineering problems such as signal processing, image processing(like edge detection, object identification, brightness, contrast etc) , electronic, physics electronic, etc. Filters are used for de-blurring and smoothing in image processing and analysis,. In addition with the help of the filters some details which are clear and fair in the original image will be blurred and the ultimate final image will be enhanced. In this paper we present different types filtering techniques and have simulated some of them in Matlab.
*Keywords—*Filters, linear filters, Non-linear filters, minimum filters, maximum filters

I. INTRODUCTION

Digital images add to a great extent in fields like television, aerospace, remote sensing, ultrasound, Computed tomography scan, vision system, vision based robotic system etc. During image processing such as acquisition and transmission of images , noise is attracted by all the real world images .Various types of devices captures a various images which adds different kinds of noise in original image because of defective instruments, light levels, temperature of sensor and erroneous approaches of data capturing technique. Expelling the noise from the image and also preserving the fine details are spirit of an ideal filter [3]. Denoising of image is the most important step and it is usually done before the processing of image .It is the process of recovering a fine estimate of the initial image from a perverted image without changing the required shape and structure in the image such as edges, discontinuities and fine details [4]. Denoising is a technique of extracting the n0nessential noise from the corrupted image and reconstructing the actual image and have become more important for recovering the quality of image which is corrupted by different types of noises being added [5].Each of the noise has unique and different probability density. Different types of noises which are being added in images are Brownian noise, Gaussian noise, Rayleigh noise Uniform noise, Impulse noise (salt and pepper noise) ,Erlang noise (Gamma noise) and many other noises [6].Image filtering is performed to improve the image quality. For example smoothing an image reduces noise, blurred images can be rectified. Filtering of image is an important process done in image processing. It is performed to remove noise and blurring from an image ,edge detection etc.

II. WHY TO USE DIGITAL FILTERS?

Digital filters are required due to the fact of simplification in design, testing and implementing on a general purpose computer. Digital filters are more stable in terms of temperature and time contrasting to analog filters as they are dependent on temperature. These filters are having the ability to process signals in different manners which make them multifaceted. In comparison to analog filters ,Hardware requirements of digital filters are very simple and plain .

III. DIFFERENT TYPES OF IMAGE FILTERS

Box filter, Gaussian filter and bilateral filters are kind of well-known filters used in image processing. As we know all these filters are used for de-blurring and smoothing. In addition, with the help of these filters some facts which are clear in the original image will be blurred and the final image will be enhanced. With considering the best sigma value for bilateral filter, after comparing all these four filters we will find out that the bilateral filter is the best.

As conserving the edge is needed, we want our image to be blurred and smoothed, so bilateral filtering is very useful in such a case [1][2]. This filter has various applications in engineering and science. In this technique, colors and gray levels are joined and close values are more preferred than the far or distant ones. The main aim of the cited method is removing phantom colors in the original image which may be appeared in the edges.

Bilateral filtering is kind of de-noising methods which can preserve sharp edges and remove some colors across the edges. This filter because of weighted mean of neighborhood pixels is easy to understand. In addition, there is a distance between pixel values, so it can be adopted properly. Last but not least, this filter is non-iterative which is very simple.

Generally, filters are categorized into two parts.
• Linear filter
• Non-linear filter.

Linear filter is achieved through convolution and Fourier multiplication whereas Non-linear filter cannot be achieved through any of these. Its output is not the linear function of its input thus, its result varies in a non-intuitive manner.

There are many applications of digital filters such as digital entertainment, object recognition and remote sensing imaging etc. As the number of sensors are increased per unit area , more noise is captured by the camera along with the image.

General steps need to be followed for applying filters [7]

1. The filter matrix is moved over the image I and H (0, 0). The current image position (u, v) is moving along with the filter matrix.
2. Each filter coefficient H (i, j) is multiplied with its own corresponding image element I (u+i, v+j).
3. From the previous step, all the results are averaged, and the current location of I (u,v) is revealed.

Below equation is described from the above steps:

$I'_{u,v} \leftarrow i=1$

$j = 1$

$j=-1$

$I_{u+i, v+j} . H_{i,j}$ (1)

In the above equation, "*" represents the input location, ′ represents the output location, represents the coefficient, "u, v and i, j" represents the coefficients' location. The types of Linear filters are given below.

1. Smoothing Filter [8]
2. Box Filter
3. Gaussian Filter
4. Laplace or Mexican Hat Filter

Properties of Linear filter [7]

Linear Convolution is a unique operation that is associated with a linear filter. The below equation represents the convolution operation for the two-dimensional function of I and H.

$I' , v = \infty$

J=-∞

Iu -i ,v-j ∗H (i,j)

$I' = I * H$ (2)

The above gives the same results with the linear filter. The filter function from the linear filter is the same on both the horizontal and vertical axis. Some of the properties of the filters are:

1. Commutativity
2. Linearity
3. Associativity
4. Separability:

Non-linear Filters

Resultant images from the linear filter are associated with some problems such as image structure and edge. Such disadvantages are solved using a non-linear manner.

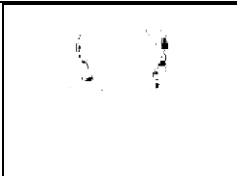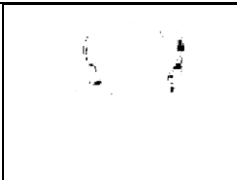Types of non-linear filters Minimum and maximum Filters
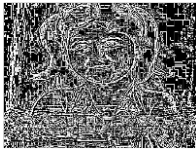
The minimum and maximum value in the moving region R is the result of the minimum and maximum filter of the original image. In equation 2: the min and max represent the moving region R.

I' u ,v ← min I u +i ,v + j‖(i,j) ∈ **R**

I' u, v ← max I u + I, v +g |(i,j) ∈ **R**   (3)

TABLE I

RESULT OF VARIOUS IMAGE FILTERS WITH MATLAB CODE

1	**LAPLACIAN** C=imread('peehu.jpg'); A=rgb2gray(C); f1=fspecial('laplacian'); cf1=filter2(f1,A); imshow(cf1);	
2	**GAUSSIAN** C=imread('peehu.jpg'); A=rgb2gray(C); f1=fspecial('gaussian'); cf1=filter2(f1,A); imshow(cf1);	
3	**Edge sharpening (low pass filter)** C=imread('peehu.jpg'); A=rgb2gray(C); f=fspecial('average');	
4	**Nonlinear maximum filter** max=nlfilter(A,[3,3],'max(x(:))'); imshow(cmax); figure,imshow(cmax)	

5	Non – linear minimum filter
	C=imread('Butterfly.jpg');
	A=rgb2gray(C);
	cmin=nlfilter(A,[3,3],'min(x(:))');
	figure,imshow(cmin);	

IV. CONCLUSION

This paper provides an overview of the functionality of various Filtering techniques . Each filtering technique have its own advantages and disadvantages in various fields. Linear and non-linear filtering techniques are discussed in this paper can be implemented in MATLAB. Image filtering techniques remove noise from images so image processing algorithm can work effectively. Hence image filtering is preprocessing step in most image processing algorithm.

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