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AN ANALYSIS ON PERFORMANCE EVALUATION OF IMAGE PROCESSING APPLYING CLASSICAL FILTERING TECHNIQUES

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Abstract: Image processing has two objectives: creating good visual fields and automatic detection and recognition of noise. To achieve these two objectives, imaging techniques are very important. Generally, input images corrupted by noise. Sometimes we need to enhance image for particular works. Perhaps we need to reduce noise in the image; or, certain image details need to emphasized or suppressed. To do that, filtering is a good option to choose. However, there are several kinds of filtering techniques - high pass and lowpass filtering in board. In this paper, 3 (three) kinds of low pass filters such as Mean, Median and Gaussian filter are taken in consideration for analysis. In addition, some edge detection techniques under high pass filter such as Sobel, Roberts, Prewitt operators taken into consideration for analysis to find their optimal point of application. It found out that Standard Median Filter (SMF) is good filter for SPN with less than 40% density noise, and Sobel Operator produces higher accuracy in detection of object edges. Along with other supporting tools, C# language under ASP.NET framework has used to create a program to help perform the analysis. The achieved figurative and quantitative results depicted in the results and conclusion section.

Keywords-Imaging; Image Processing; Image Filtering; High Pass; Law Pass; Edge Detection.

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I. INTRODUCTION

Some goals of filtering and enhancement include detecting, extracting, or separating signals, reducing noise, or accentuating certain features of a signal. Content-aware image retargeting has attracted many interests in recent years in the concern of image processing. The most challenging issue for this task is how to balance the tradeoff between preserving the important contents and minimizing the visual distortions on the consistency of the image structure. This paper presents the analysis of some classical image filtering techniques for smoothing image using some filtering techniques like mead, median, average, gaussian towards optimal low pass filtering.

Besides image enhancements, edge detection is also a very important issue in image processing for segmentation, registration, and identification of objects in image. Edges in an image are pixel locations with abrupt changes in gray levels. If we had a continuous image we would say that the derivative of the image f (x,y) assumes a local maximum in the direction of the edge. Therefore, one edge detection technique is to measure the gradient of f in a particular location. This paper also presents the analysis of some classical edge detection techniques like Robert, Sobel, and Prewitt operator.

II. FLOORPLAN & MATERIAL

A digital Image is composed of an array of elements called pixels. Each pixel represents a single color and value. Image also has an absolute width and height in pixels. The number of pixels packed into a unit of measure [e.g. inch] that determines the quality of the image. This value is the image resolution. Image resolution most commonly refers to the number of pixels per inch. This is called "dots per inch," or dpi. In most cases, higher resolution results in better image quality. However, the final image quality limited by the quality of image source. While image resolution can always reduce, increasing resolution will not improve image quality. The dimensions of an image are independent of its file size.

This part deals with the formation, acquisition and processing of images. Its contents can be a best represented as a diagram in Figure 1 where the evolution of the considered information (images) and the processes involved are shown.

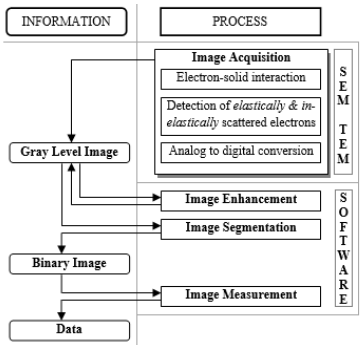

Fig. 1. Image to data conversion system diagram.

III. SYSTEM DESIGN & FILTERING

Filtering is a process that cleans up appearances and allows for selective highlighting of specific information. A number of techniques are available and the best options can depend on the image.

A. Low Pass Filter

A low-pass filter is a filter that passes low-frequency signals and attenuates (reduces the amplitude of) signals with frequencies higher than the cutoff frequency. The actual amount of attenuation for each frequency varies depending on specific filter design. It sometimes called a high-cut filter, or treble cut filter in audio applications. Any kernel (window) having all positive coefficients will act as a low-pass filter.

1/9 ×

1	1	1
1	1	1
1	1	1

A 3×3 window

Mean filter: Mean filter is the filter where the center pixel becomes the average of all neighboring pixels.

x, y	172	173	174	175	176
62	165	159	159	126	126
63	165	154	154	107	107
64	153	107	**107**	49	49
65	158	134	134	111	111
66	157	159	159	154	154

x, y	173	174	175
63	147	124	109
64	140	**117**	103
65	140	123	114

Fig. 2. Calculating the mean value of a pixel neighborhood.

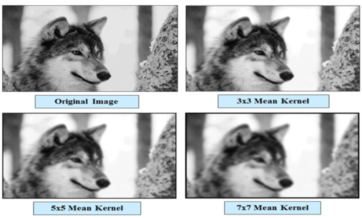

Fig. 3. Example of Mean Filter.

Gaussian Filter: The Gaussian filter is a 2-D convolution operator that used to `blur' images and remove detail and noise much like the mean filter. It is similar to the mean filter, but it uses a different kernel that represents the shape of a Gaussian (`bell-shaped') hump. The Gaussian output is a `weighted average' of each pixel's neighborhood, with the average weighted more towards the value of the central pixels.

$$g(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Fig. 4. Example of Gaussian Filtering

Median Filter: The median filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighboring pixel values, it replaces it with the median of those values. The median calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel considered with the middle pixel value. Figure 5 illustrates an example. The value of the output pixel is the value of the "median" pixel.

123	125	126	130	140
122	124	126	127	135
118	120	150	125	134
119	115	119	123	133
111	116	110	120	130

Neibouhood Values:

115, 119, 120, 123, 124, 125, 126, 127, 150

Median Value: 124

Fig. 5. Calculating the median value of a pixel neighborhood.

As can be seen, the central pixel value of 150 is rather unrepresentative of the surrounding pixels and replace with the median value: 124. A 3x3 square neighborhood used here. Larger neighborhoods will produce more severe smoothing.

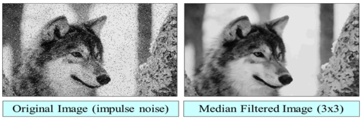

Fig. 6. Example of Median Filtering.

B. High Pass Filter (Edge Detection Filter)

High pass filter allows only high-frequency information to retain. Its main feature is a positive center coefficient and negative perimeter values. The sum of the coefficients is zero, which means that areas of constant intensity eliminated.

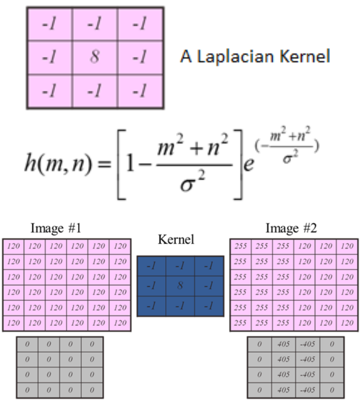

Fig. 7. High pass filter Kernel Example

A High pass filtered image can be computed as the difference between the original and the low-frequency components as the Figure 8 shows.

High pass = Original - Low pass.

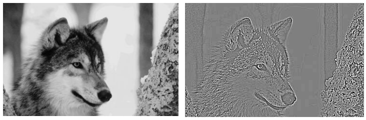

Fig. 8. Example of High Pass filter

An "edge" viewed as a one-dimensional function. Some operator is used to determine edge.

Roberts Operator: This operator (shown below) defines a kernel to implement the gradient approximation.

$$|\nabla f| \cong |z5 - z6| + |z5 - z8|$$

Sobel Operator: The Sobel Operator (shown below) both blurs and differentiates an image providing good noise-resistant edge detection.

$$|\nabla f| \cong \begin{matrix} |(z7+2*z8+z9)-(z1+2*z2+z3)|+ \\ |(z3+2*z6+z9)-(z1+2*z4+z7)| \end{matrix}$$

Pwirret Operator: According to this operator (shown below) the magnitude of the gradient can be approximated at the center of a 3x3 region as,

$$|\nabla f| \cong \begin{matrix} |(z7+z8+z9)-(z1+z2+z3)|+ \\ |(z3+z6+z9)-(z1+z4+z7)| \end{matrix}$$

IV. RESULTS

The Figure 9 shows the front page of developed program by C# under ASP.NET framework using Visual Studio 10, and the techniques used to make an analysis and find insightful results are tabulated in Table 1.

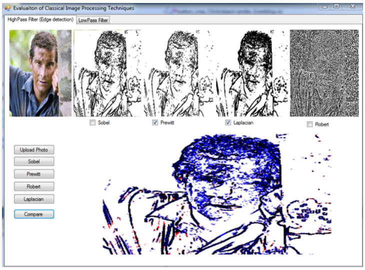

Fig. 9. Front page of the developed program to analyse the techniques.

TABLE I. TECHNIQUES USED

Techniques Name	Contains
Filtering	1. Mean, 2. Gaussian, 3. Median
Edge Detection	1. Sobel, 2. Robert, 3. Prewitt

The Figure 10-15 are representing the results of Mean Filtering, Median Filtering, Gaussian Filtering, Robert Operator, Sobel Operator, and Prewitt Operator respectively.

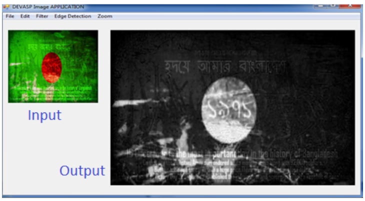

Fig. 10. Lowpass Filtering: Mean.

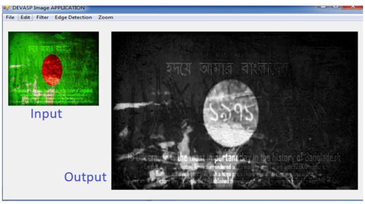

Fig. 11. Lowpass Filtering: Median.

Fig. 12. Lowpass Filtering: Gaussian Filter.

Fig. 13. Edge Detection: Robert Operator.

Fig. 14. Edge Detection: Sobel Operator.

Fig. 15. Edge Detection: Prewitt Operator.

The Table II-III represents some resolution results PSNR of the incorporated techniques for RVIN, Salt, and Pepper Noise respectively, and Table IV represents some resulted data for Robert Operator, Sobel Operator, and Prewitt Operator.

TABLE II. RESTORATION RESULT PSNR FOR RVIN

Filter Type	10%	20%	30%	40%	50%	60%
MF	28.53	28.40	28.30	28.23	28.19	28.14
GF	28.56	28.42	28.32	28.25	28.21	28.15
MF	27.67	27.55	27.51	27.47	27.45	27.44

TABLE III. RESTORATION RESULT PSNR FOR SALT AND PEPPER NOISE

Filter Type	10%	20%	30%	40%	50%	60%
MF	33.65	31.92	30.77	29.90	29.23	28.65
AWF	33.74	31.93	30.78	29.90	29.23	28.65
GF	33.78	31.95	30.79	29.91	29.24	28.67
SMF	34.29	32.57	31.33	30.39	29.61	28.94

TABLE IV. RESLTED DATA FOR SOBEL, PREWITT, AND ROBERTS

IMAGE	ENTROPY	PSNR	MSE	EXECUTION TIME
Sobel	1.2820	11.4067	4.7034 e+003	1.052911 seconds
Prewitt	1.2793	11.3929	4.7186 e+003	0.878267 seconds
Roberts	1.2306	17.1396	1.2564 e+003	0.831094 seconds

CONCLUSION

In this paper, some analysis & experiments carried out by developing a computer program for different filters. According to the data table in the result, Gaussian Filter is the best filter to remove SPN noise of image sensing. It does not leave any blurring in the image and Standard Median Filter (SMF) is good filter for SPN with less than 40% density noise. The best results of Gaussian Filter (GF), Main Filter (MF) and Standard Median Filter (SMF) respectively with small difference between them. On the other hand, this paper presents the relative performance of various edge detectors with their experimented outcome. It has observed that the Sobel Operator produces higher accuracy in detection of object edges with higher entropy PSNR, MSE and execution time compared to Roberts and Prewitt. On the other hand, Roberts Operator has the minimum entropy with PSNR, MSE and execution time compared with others.

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