Comparative Performance Analysis of Various Digital Image Edge Detection Techniques

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Abstract – Edge detection is a segmentation technique that correctly detects the presence of an image and outline. Edges contain critical information that can be extracted using edge detectors. This paper will compare various digital image edge detection techniques such as sobel, prewitt, Laplacian, and canny edge detectors. Edges are the pixels that connect two regions.

Keywords- Edge, edge detection, operators, comparison

I. INTRODUCTION

Images are the very important part in our life. An image contain various information in digital image processing, this information can be extract, most of the information are present at the boundaries, these boundaries are nothing but the pixels. Variations in pixel intensity provide help to extract edges from an image. To extract the information from an image different age detector techniques such as prewitt, sobel, Laplacian and canny are applied .These methods follows various parameter to refine the ages as well as reducing the noise from an image .There are three main steps to detect edges from an image, through the edge detection techniques, namely smoothening, enhancement, detection and localization.
Smoothening-suppress noise
Enhancement -sharpening the image
Detection -find pixel intensity values in terms of pixels
Localization- exact location of an image.
In other words steps may be analyze, detect edges/easy object and define map, of an image contains important information. This paper provides the comparison between different edge detection techniques for an image (grey image).

II-OPERATORS FOR EDGE DETECTION

Various edge detectors techniques or methods are there like gradient edge detector and Laplacian of Gaussian etc. gradient is the first derivative based while Laplacian is based on second derivative.

A. Methods based on First Derivative

First derivative based edge detectors are explained briefly

1) Sobel Operator
It is almost commonly used edge detection techniques based on convolving image with integer valued filter. It is inexpensive and provides edge response with reduced noise.

$$G_X = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \quad \text{..... (1)}$$

$$G_Y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \quad \text{..... (2)}$$

Gradient magnitude is as

$$|G(x,y)| \approx \max\left(|G_x|, |G_y|\right) \quad \text{..... (3)}$$

Its results are better than the other operators.
2) Prewitt Operator
It is used to detect vertical and horizontal edges of an image. Prewitt Operator Kernel matrix given below:

$$G_X = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix} \quad \text{..... (4)}$$

$$G_Y = \begin{bmatrix} -1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix} \quad \text{..... (5)}$$

This performs well for noisy images.
3*) Robert Operator*
In Robert edge detection, vertical and horizontal edges are removed individually and then come together for the resulting edge detection. The Roberts edge detector uses the following masks to digitally approach the first derivatives as differences between adjacent pixels.

$$G_X = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}, \quad G_Y = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \quad \text{..... (6)}$$

B. Second Derivative based Methods

In this section, some well-known edge detectors based on second derivative are briefly explained.
1) LOG operator
It is based on second order derivative and find out the edges at the zero crossing. it works in frequency domain.

Log Operator is defined as follows.

$$\log(x,y) = \frac{1}{\pi\sigma^4}\left(\frac{2(x^2+y^2)}{\sigma^2} - 1\right)e^{\frac{x^2+y^2}{2\sigma^2}} \quad \text{..... (7)}$$

Convolution matrix is as follows,

$$G_X = \begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix} \quad \text{..... (8)}$$

$$G_Y = \begin{bmatrix} -1 & -1 & 1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix} \quad \text{..... (9)}$$

2) Canny Operator

It is most popular and strictly defined method provides stable detection. It is calculus of variation which satisfies following requirement.

- It detects the edge with accuracy or with low error rate.
- It localized accurately on the centre of the edge.
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III. PROPOSED METHODOLOGY DURING THE RESEARCH WORK.

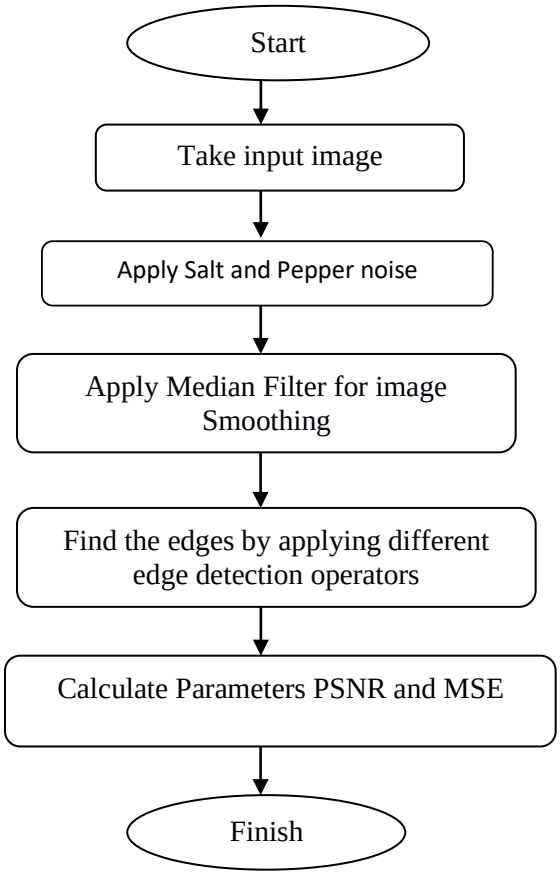

Figure1: Proposed methodology during the research work

IV. RESULTS AND DISCUSSION

In this paper we are providing visual representation of various edge detection techniques for a grey image. However it doesn't prevent from the noise but represent the visual comparison of methods for the same image.

Figure 2: Original Grey Test Image

Figure 3: Image with Salt and Pepper noise

Figure 3: Median filtered image

Figure 4: Visual results on Sobel operator

Figure 5: Visual results on prewitt operator

Figure 6: Visual results on Robert operator

Figure 7: Visual results on LOG operator

Figure 8: Visual results on Canny operator

FILTER	NOISE	DENOISING FILTER	M.S.E.	P.S.N.R.
Sobel Edge Detector	Salt and Pepper (2%)	Median	12602.4339	7.1263
Prewitt Edge Detector	Salt and Pepper (2%)	Median	12602.5006	7.1262
Roberts Edge Detector	Salt and Pepper (2%)	Median	12601.71	7.1265
Log Edge Detector	Salt and Pepper (2%)	Median	12597.678	7.1279
Canny Edge Detector	Salt and Pepper (2%)	Median	12593.4717	7.1293

Table: Comparative analysis of different edge detectors

V.CONCLUSION

Edge detection is considered as one of the critical part in image processing. All the image processing techniques are based on edge detection. Some methods deal with noise in effective way efficiently however lack in accuracy and vice versa. In this research paper Canny edge Detector performs well against Salt and Pepper noise Since it provides less value of MSE and high value of PSNR comparatively other edge detection methods. So, for future work a hybrid algorithm can be developed by combining the two or more may be an addition to a technique which can be efficient and perform better for aforementioned issues.

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