



## A Review : Comparative Study of Edge Detection Techniques

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**Abstract:** This article defines research about edge detection systems with their functions, pros and cons. For this purpose we will compare existing edge detection procedures lying under the 3 categories a) 1st order derivative/gradient methods (sobel, prewitt's, robert's operator) b) 2nd order derivatives / zero crossing (laplacian of gaussian, difference of gaussian) and c) optimal methods (canny operator). Comparison is finished on the foundation of side detected pictures with their PSNR (peak signal to noise ration) and MSE (mean square error) values for exclusive strategies.

**Keywords:** edge detection (ED); sobel; prewitt; roberts; canny; log;zerocrossing; PSNR; MSE

### 1. INTRODUCTION

Digital image Processing (DIP) includes the alteration of digital information for get better the picture elements with the aid of pc. Processing of images helps in increasing the sharpness, clarity and extra features of interest. DIP is mainly divided into 5 groups. They're [1]:

- **Visualization** - realize the objects which are hidden or invisible
- **Image sharpening and restoration** – Enhancement of picture
- **Image retrieval** – Finding related picture
- **Measurement of pattern** – Object detection and Identification
- **Image Recognition** – Differentiate the objects in a Picture.

In any image the point at which intensity of pixel changes is Edge. So, the ED is a mathematical method to find those points in images where brightness, sharpness and continuity changes. Now a day this method is very helpful in many fields. As it is basically a topic of DIP, in this its applications are widely discusses. ED leads to accurate output of methods like image segmentation and object detection.

ED is important technique used in different application of DIP such as pattern recognition, analysis of medical images and PC vision [1]. Using ED process we can simply know the shapes and locations of the object. To distinguish different objects and/or separate them from the background in a scene is carried out by a variety of ED techniques. In image processing, ED is used to filter out less foremost valuable understanding while maintaining the elemental properties of a picture [2]. It makes use of some steps such as feature extraction, registration, interpretation and image segmentation for drastically reduces the quantity of data. The edges of the image's objects may also be recognized with the aid of residences similar to field, perimeter, and kind. An object between boundary and historical past of a picture is known as facet [3]. Monochromatic pictures simplify the operations akin to classification and pattern recognition. Digital Morphology is a part of image processing that tackles filtering of images and analysis of structural elements. To appreciate the shape of an picture, a suite of mathematical operators are applied. Texture is

repetition of identical patterns in a small area [4]. The well know approach to identify different textures is to apply a unique gray level or color to each pixel belonging to same texture.

### 2. EDGE DETECTION STEPS

Image processing and pc vision tasks rely on the excellence of detecting meaningful edges. Side detection is more challenging main issue in low level image processing or color pictures considering the fact that of its multi-dimensional nature. There are most likely four steps similar to Filtering, Enhancement, Detection and localization which can be used for facet detection and picture segmentation. The outline of these steps is given below:

#### A. Filtering

Image got by a camera or other imaging procedure are not suitable to use it directly due to the fact that it usually is corrupted by means of random editions in intensity, editions in illumination, or negative distinction. These random editions in intensity values are known as noise. If a picture has ample noise it is not able to be differentiate edges of dissimilar importance. There are various kinds of noise, such as Salt and Pepper Noise (SPN), Impulse Noise Gaussian, but the most widely studied "SPN" noise. [5].

#### B. Enhancement

Enhancement manner enlarge or improvement in quality, worth, or extent. The main objective of development techniques is to generate a picture which is better and more appropriate than the actual image for an exact application [5].

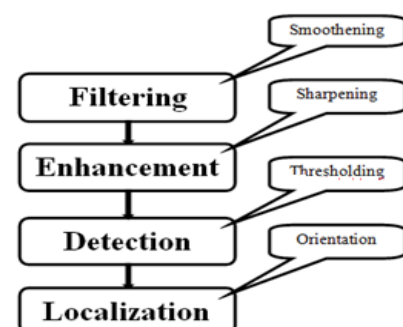


Fig. 1 Steps of Edge-detection

### C. Detection

Detection means the action or process of identifying the presence of something hidden. Essential perform of detection is to examine which edge pixels will must be discarded as noise and which must be retained (more often than not, thresholding presents the criterion used for detection).

### D. Localization

Main Objective of localization is to determine the exact location of an edge (sub-pixel resolution might be required for some applications, that is, Estimate the area of an aspect to higher than the spacing among pixels). Area thinning and linking are normally required in this step.

## 3. EXISTING TECHNIQUES

In this section, edge detection techniques are reviewed and focus has been made on detecting the edges of the digital images. In usual images, edges signify object boundaries and precious for segmentation, registration, identification of objects and filters out capabilities as a way to much less crucial and in distinction of maintaining the principal properties of a picture. There are more than a few common procedures used for edges detection in distinct point of view. Laplacian Roberts, Sobel and gradient are the methods which are widely used [4]. Linear operators can notice edges by means of using masks that characterize the excellent edge steps in quite a lot of instructional materials each for intensity and color. They used an identical system for detecting strains and curves. These techniques will also be grouped into 3 modules:

- Gradient (estimate of the 1<sup>st</sup> derivative)
- Laplacian (Zero crossing detectors)
- Image approximation algorithms

**Table 1 Existing Edge Detection Approaches**

Edge Detection Categories	Existing Approaches
1 <sup>st</sup> Order Derivative or Gradient method	Sobel, Prewitt, and Roberts Operator
2 <sup>nd</sup> Order Derivative or Zero Crossing	LOG, Difference of Gaussian
Optimal method	Canny method

## 4. RELATED WORK

Lots of work towards detecting edges in an image have been done in past. This section presents a brief survey of existing approaches, their advantages and limitations.

Palvi Rani [6] presented a hybrid approach for edge detection that performs edge detection in two phases. In first segment, for picture smoothing canny filter is applied and in 2nd phase neural network is used to observe exact edges. NN is a wonderful tool for ED as it is a non-linear network with built-in threshold capability. NN can be informed with again propagation procedure utilizing few training patterns

but the main and difficult section is to establish the right and correct instruction set.

R.Shenbagavalli [7] proposed a technique of edge detection for satellite images using fuzzy logic concept. Fuzzy logic is helpful to find and mark all the boundaries associated with a picture by inspection the relative pixel values. Scanning of an image utilizing the windowing method takes place which is subjected to a set of fuzzy circumstances for the contrast of pixel values with near about pixels to check the pixel magnitude gradient in the window. Later with the completion of testing of fuzzy circumstances the appropriate values are allotted to the pixels in the window below testing to deliver an image highlighted with all the associated boundaries.

In [8] Osama Basil Gazi proposes a new method for edge detection in satellite images founded on cellular neural networks (CNN). CNN based edge detector is used conjunction with image improvement and noise elimination method, in order to transport accurate edge recognition results, compared to state of the art approaches. Thus, considering the got results, a comparison with optimal canny edge detector is achieved. The proposed image processing chain supplies more expertise regarding edges than canny edge detector. The offered method objects to retain salient info, due to its significance in all satellite picture processing applications.

edge detectors founded on gradient inspiration are proposed by means of Roberts [9], Prewitt and Sobel [10] which exhibit the influence of those filters on the sensing pictures. These techniques have some limitations such as in determining the actual location of the edge, slope turn over's point, is difficult. A more effective operator is the Laplacian, which uses the 2nd by-product in opting for the edge [10].















Soft Computing founded strategies comparable to fuzzy logic reasoning are used in digital pictures without deciding on the edge value is proposed by way of Alshennawy et al [11], Aborisade et al [12] and Begol et al [13]. One more process established on again Propagation Neural network is proposed through Hamed Mehrara et al [14].

Hybrid procedure founded on ANFIS i.e. Adaptive neuro-fuzzy inference system for ED by using making use of ANFIS operator to optimize by means of coaching utilizing artificial picture is proposed by using Lei Zhang et al [15].

## 5. EXPERIMENTAL ANALYSIS

This section represents analysis of experiments done on various ED techniques. The experiments had been conducted using MATLAB. Matlab is a data visualization and analysis tool. The tool has been designed with powerful support for matrix and matrices operations. Along with this, the tool has outstanding graphics capabilities, and its own powerful programming language. The reason behind the success of the Matlab is a tool having sets of programs termed as Matlab programs (called as toolboxes) designed to support a specific task. The particular toolbox of our interest is image processing toolbox [16].

**Table 2 PSNR & MSE Values for Various Edge Detection Techniques**

Techniques	Input Image 	Input Image 	PSNR (Image 1)	PSNR (Image 2)	MSE (Image1)	MSE (Image2)
Sobel Operator			5.1975	3.7358	1.9501e+ 04	2.7791e+ 04
Prewitt's Operator			5.1971	3.7361	1.9501e+ 04	2.7791e+ 04
Robert's Operator			5.1870	3.7214	1.9502e+ 04	2.7794e+ 04
Canny Operator			5.2508	3.8187	1.9485e+ 04	2.7774e+ 04
log			5.2634	3.8175	1.9495e+ 04	2.7780e+ 04
Zerocross			5.2634	3.8175	1.9495e+ 04	2.7780e+ 04

As we already know that we are comparing the different Edge detection techniques in terms of MSE & PSNR. MSE & PSNR of each technique are shown via Table1.

The PSNR is defined as the ratio of maximum possible power and Occurring noise that affect the representation of input image. Usually, PSNR is expressed as decibel scale.

Commonly, PSNR is being used by the researchers as the measure of quality reconstruction of an image. In this case, original data is used as the Signal and occurring error as the noise. Maximum value of PSNR leads to high quality of image.

The PSNR is defined using the MSE and matching distortion matrix. The PSNR. [17] Is-

$$\text{PSNR} = 10 \cdot \log_{10} \left( \frac{\text{MAX}_f^2}{\text{MSE}} \right) = 20 \cdot \log_{10} \left( \frac{\text{MAX}_f}{\sqrt{\text{MSE}}} \right)$$

Here in the formula above, Max is maximum pixel value of image when pixel is represented by using 8 bits per sample.

For the realistic purposes, mean square Error, MSE permits researchers to examine the “true” pixel values of normal knowledge with the degraded picture. As understood via the name, MSE represents the ordinary of squares of the “errors” among the genuine picture and the noisy picture. The error can be calculated as the amount by which the values of the original image differ from the degraded image [18].

$$\text{MSE}(x) = \frac{1}{N} \|x - x^{\wedge}\|^2 = \frac{1}{N} \sum_{i=1}^N (x - x^{\wedge})^2$$

Minimal value of MSE leads to the greater the best of picture.

The thought is that the larger the PSNR, the easier degraded picture has been reconstructed to match the normal picture and the simpler reconstructive algorithm. This would occur because we wish to minimize the MSE between images with respect the maximum signal value of the image.

For this analysis we have taken two input images: cameraman image (input image1) and girl image (input image2). And their respective PSNR & MSE values for each technique states that 2nd order derivatives i.e. log, zerocrossing and canny operator (Optimal operator) performs enhanced the first order derivatives such as sobel, prewitt and robert's operator because of their maximum PSNR and minimum MSE correspondingly.

## 6. CONCLUSION

In this paper we compare dissimilar edge detection operators and the experimental tests have been conducted by using MATLAB. The first order derivatives do not provide the better results as compare to the 2<sup>nd</sup> order derivative filters. The log, zerocrossing and canny operator presented the better results for both, Visual Perception and Edge Quantity. The consequence of 2nd order derivatives are hearty and accomplish the high improvement level. The achieved edge distinguished picture is utilized for the further phases of the article acknowledgment process. As the future work we can get better the quality of image by designing a new filter over the limitations so that the image can be enhanced by its resolution by reducing the noise.

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