# ANALYSIS BASED ON STATISTICS AND HISTOGRAM OF EDGE DETECTION TECHNIQUES

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**ABSTRACT**

*Paper is concerned with the study of various edge detection techniques on various images to detect edges and extract its data statistics. Edge detection is a name for set of mathematical methods which aim at identifying point in digital image at which image brightness changes sharply or more formally has discontinuities. Edge detection refers to the process of identifying and locating stridently discontinuities in an image. Hence edge detection is vital step in image analysis and it is the key of solving many difficult problems. In this paper we show the performance analysis of Canny and Marr Hildreth edge detection techniques.*

***Keywords: Edge Thinning, Convolution, Gradient***

## I. INTRODUCTION

Digital image processing is meant for dealing out digital computer. It is the make use of of computer algorithm to perform image processing on digital images. It is a technology extensively used for digital image operations resembling feature extraction, pattern recognition, segmentation, image morphology etc. Edge detection is a well-developed field on its own surrounded by image processing. Edge detection is essentially image segmentation technique, divide spatial domain, on which the image is distinct, into meaningful parts or regions [13].

Edge detection is a decisive step in the computer vision and object recognition, because the most fundamental trait for image recognition is the edges of an image [12]. Detection of edges for an image may assist for image segmentation, data compression, and also support for image reconstruction and so on. Edge detection is a vital tool in image processing, machine vision and computer vision, mostly in the areas of feature detection and feature extraction. Edges are major local changes of strength in an image.

Edge detection (1) Produce a line depiction of a sight from an image of that scene, (2)Important features can be mine from the edges of an image (e.g., corners, lines, curves), (3)These features are used by higher-level computer vision algorithms (e.g., recognition).

Edges typically happen on the boundary between two different regions in an image. The purpose of edge detection is significantly reducing the amount of data in an image and preserves the structural properties for further image processing. The edge in a grey level image is a local feature that, within a neighborhood separates regions in each of which the gray level is more or less uniform with in different values on the two sides of the edge. For a noisy image edges detection is difficult as both edge and noise contains high frequency filling which results in blurred and distorted result [4].

Edge detection is one of the most frequently used operations in image analysis. If the edges of images could be recognized exactly, all of the objects can be located efficiently and performance can be measured easily [10].

The quality of image is affected when there is a jump in intensity from one pixel to another. Thus important objective is to detect an edge while preserving the important structural properties of an image. In order to analyze various edge detection techniques, comparative analysis of these techniques based on certain parameters like type of edge, edge localization, environment, cost, role etc. are discussed.

Edge detection converts a 2D image into a set of curves, Extracts most important features of the scene, more condensed than pixels.

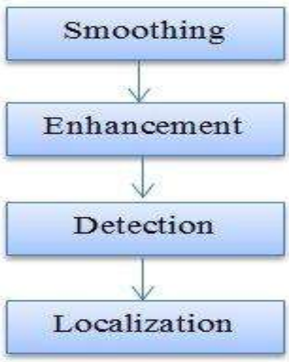


**Fig. 1. Steps of Edge Detector**

## II. LITERATURE REVIEW

Edge detection makes use of differential operators to detect changes in the grey levels gradients. Different approaches have been deployed to detect the edges of the picture: Gradient based operator and Laplacian based operator. The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image. The Laplacian method looking for zero crossings in the second derivative of the image to find edges.

### 2.1 Gradient based operator

Gradient based operator consists of Sobel, Prewitt, Robert's cross, and Canny edge detection techniques. The Sobel operator, sometimes entitled Sobel Filter, that is used in image processing and computer vision, for the most part inside edge detection algorithms, and creates an image which emphasize edges and transitions.

Sobel method is practical to detection an edge. The Sobel edge detector uses two covers with 3x3 sizes, one estimating the gradient in the x-direction and the other estimating the gradient in the y-direction. The cover is slid over the image, using a square of pixels at a time. The algorithm estimates the gradient of the intensity of the image at all point, and then provides the direction to the growth of the image intensity at all point from light to dark. Edges areas represent strong intensity contrasts which are darker or brighter [5].

The maximum value of two convolutions will be referred as output value of the exchanging point. Sobel operator is easy to accomplish in space, has a smoothing effect on the noise, is nearly affected by noise, can provide more accurate edge direction information but it will also detect many false edges with coarse edge width [3].

| | | |
|---|---|---|
| -1 | -2 | -1 |
| 0 | 0 | 0 |
| 1 | 2 | 1 |

| | | |
|---|---|---|
| -2 | 0 | 2 |
| -2 | 0 | 2 |
| -1 | 2 | 1 |

**Fig. 2. Sobel Operator**

Prewitt operator edge detection masks are the one of the oldest and best implicit methods of detecting edges in images.

The Prewitt operator is used in image processing, mostly within edge detection techniques. Technically, I is a discrete differentiation operator, estimate the gradient of the image intensity function. At all points, the result of the Prewitt operator is either the consistent gradient vector or the custom of this vector. The Prewitt operator is depends upon convolving the image with a small, discrete and integer valued filter in parallel and perpendicular directions and is therefore relatively inexpensive in terms of computations.

The Prewitt edge detector is a suitable way to estimate the magnitude and alignment of an edge. Though differential gradient edge detection needs a rather time consuming calculation to estimate the coordination from the magnitudes in the x- and y-directions, the Prewitt edge detection gain the orientation directly from the kernel with the maximum response [10].

Robert's edge detection method is one of the oldest methods and is used often in hardware implementations where simplicity and speed are dominant factors. Robert's edge detection operator is based on the principle that difference on any pair of mutually perpendicular direction can be used to calculate the gradient [10].

The Robert's cross operator is used in image processing and computer vision for edge detection. It was one of the first detectors of edge and was initially proposed by Lawrence Roberts in 1963. As a differential operator, the thought behind the Roberts cross operator is to approximate the gradient of an image through discrete differentiation which is achieved by computing the sum of the squares of the differences between diagonally adjacent pixels.

## 2.2 Laplacian Based operator

LOG (Laplacian of Gaussian) operator find the optimal filter of edge detection by ratio of the signal to noise of image. Firstly, a Gaussian function is worn to low-pass smoothingly filter image; then high-pass filter the Laplacian operator, according to the second derivative of zero to identify the edges.

It wishes to build a morphing algorithm which operates on features extracted from target images manually. It can be a good beginning to find the edges in the target images. Here, we have accomplished this by implementing a Laplacian Edge Detector [15].

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Gaussian (Gobar Filter) for edge detection is based on frequency and orientation representations. Gabor filters are similar to those of the human perception system that is related to particularly appropriate for texture representation and discrimination. 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave. Gabor filters are linked to Gabor wavelets. They can be designed for a number of dilations and rotations [3].

The rest of the paper is organized as follows. The Canny edge detection is discussed in Section III. Section IV provides the detailed description of Marr Hildreth detection. Section V presents the experimental results of our method with comparisons to other methods. Conclusions are strained in Section VI.

## III. CANNY EDGE DETECTION

Canny Edge detection is commonly used in image processing and computer vision.

The Canny operator was designed to be an optimal edge detector. It takes as key a gray scale image, and produces as output an image screening the positions of tracked intensity discontinuities.

The Canny operator works in a multi-stage process. First of each part of the image is smoothed by Gaussian convolution. after that a simple 2-D first derivative operator (somewhat like the Roberts Cross) is useful to the smoothed image to highlight regions of the image with high first spatial derivatives. Edges provide rise to ridges in the gradient magnitude image. The algorithm then tracks all along the top of these ridges and sets to zero all pixels that are not actually on the ridge top so as to give a thin line in the output, a process well-known as non-maximal suppression. The tracking process exhibit hysteresis controlled by two thresholds: $T1$ and $T2$ , with $T1 > T2$. Tracking can single begin at a point on a ridge higher than $T1$. Tracking then continues in both directions out from that point until the height of the ridge falls below $T2$. This hysteresis helps to make sure that noisy edges are not broken up into multiple edge fragments.

The Smoothing is computed as I[i,j] to denote the image. G[i,j,_] has to be a Gaussian smoothing filter where _ is the spread of the Gaussian and controls the degree of smoothing. The result of convolution of I[i,j] with G[i,j, _] gives an array of smoothed data as:

$$S[i, j] = G[i, j, \_] * I[i, j]$$

One problem with the basic Canny operator is to do with Y-junctions *i.e.* places where three ridges assemble in the gradient magnitude image. Such junctions can take place where an edge is partially occluded by another object. The tracker will indulgence two of the ridges as a single line segment, and the third one as a line that approaches, except doesn't quite join to, that line segment. The Canny edge detection algorithm is recognized to many as the optimal edge detector. Canny's intention were to develop the many edge detectors previously out at the time he started his work. He was extremely successful in achieving his goal and his thoughts and methods can be found in his paper, "A Computational Approach to Edge Detection". In his paper, he follow a list of evaluate to improve modern methods of edge detection. The first and most evident is low error rate. It is main that edges occurring in images should not be missed and that there be no responses to non-edges. The second criterion is that the edge points be well localized. In further words, the distance between the edge pixels as set up by the detector and the actual edge is to be at a minimum. A third criterion is to have just one response to a single edge. This was implemented because the first 2 were not substantial sufficient to completely eliminate the opportunity of multiple responses to an edge.

The Canny algorithm is adaptable to various environments. Its parameters permit it to be tailored to recognition of edges of differing characteristics depending on the particular requirements of a given completion. In Canny's original paper, the derivation of the optimal filter led to a Finite Impulse Response filter, which can be slow to calculate in the spatial domain if the amount of smoothing required is important (the filter will have a large spatial support in that case). For this reason, it is often suggested to use Rachid Deriche's infinite impulse response form of Canny's filter (the Canny–Deriche detector), which is recursive, and which can be computed in a undersized, fixed amount of time for any preferred amount of smoothing. The second form is appropriate for real time implementations in FPGAs or DSPs, or very fast embedded PCs. In this situation, however, the regular recursiveimplementation of the Canny operator does not give a good approximation of rotational symmetry and therefore give a bias towards horizontal and vertical edges [8].

The Process of Canny edge detection algorithm can be broken down to 5 different steps. (1)Apply Gaussian filter to smooth the image in order to remove the noise, (2)Find the intensity gradients of the image, (3)Apply non-maximum suppression to get rid of spurious response to edge detection, (4)Apply double threshold to determine potential edges, (5)Track edge by hysteresis: Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

## IV. MARR HILDRETH

Marr-Hildreth use the Gaussian smoothing operator to obtain better the reply to noise, which is differentiated by the Laplacian of Gaussian is called the LoG operator.

The Marr-Hildreth edge detection method operates by convolving the image with the Laplacian of Gaussian. Laplacian of Gaussian (LoG) is a second derivative of a Gaussian filter. Later than reading the book, the LoG can be broken up into two terms. First, smooth the image with a Gaussian filter, and second, convolve the image with a Laplacian mask. The Laplacian mask I used was in use from the book exposed below. I used the 3x3 mask with a value of 8 in the middle surrounded by -1.

| | | |
|---|---|---|
| −1 | −1 | −1 |
| −1 | 8 | −1 |
| −1 | −1 | −1 |

**Fig. 3. Laplacian Mask**

The derivative operators presented so far are not very useful because they are extremely sensitive to noise. To strain the noise before enhancement, Marr and Hildreth proposed a Gaussian Filter, joint with the Laplacian for edge detection. Is is the Laplacian of Gaussian (LoG). The primary characteristics of LoG edge detector are: • The smooth filter is Gaussian, in order to remove high frequency noise. • The enhancement step is the Laplacian. • The detection criteria is the presence of the zero crossing in the 2nd derivative, combined with a corresponding large peak in the 1st derivative. Here, single the zero crossings whose equivalent 1st derivative is above a specified threshold are considered. • The edge location can be estimated with sub-pixel resolution by interpolation.

## V. EXPERIMENTAL RESULTS

As edge detection is a fundamental step in computer vision, it is required to point out the true edges to get the best results from the matching process. That is why it is important to prefer edge detectors.]

**Fig 4. Original Image**

### 5.1 Canny Edge Detection

Here we show the edge detected, graphical representation and data statistics obtained from Canny Edge Detection method.

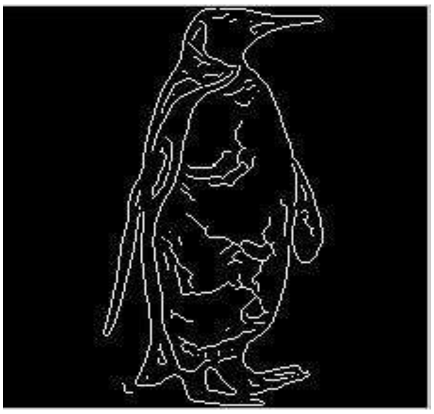


**Fig 5. Canny Edge Detected Image**

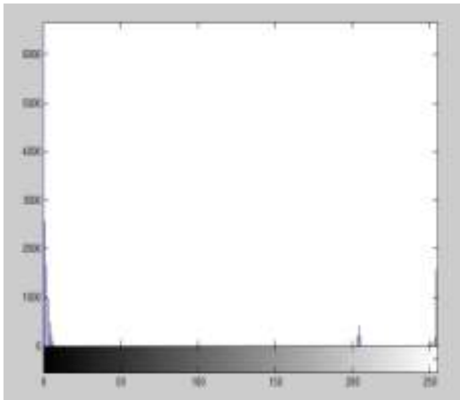
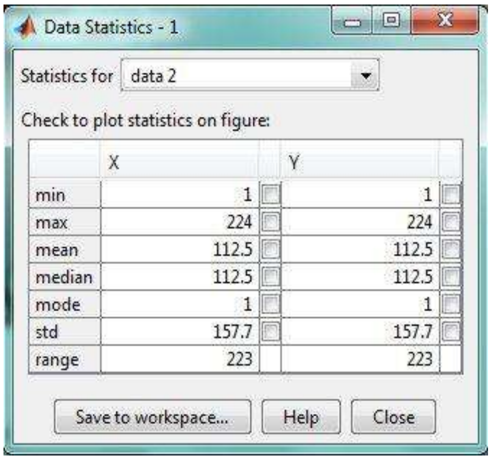


**Fig 6. Canny Edge Detected Graph**



Data Statistics - 1

Statistics for data 2

Check to plot statistics on figure:

| | X | Y |
|---|---|---|
| min | 1 | 1 |
| max | 224 | 224 |
| mean | 112.5 | 112.5 |
| median | 112.5 | 112.5 |
| mode | 1 | 1 |
| std | 157.7 | 157.7 |
| range | 223 | 223 |

Save to workspace... Help Close

**Fig 7. Canny edge Detection Data Statistics**

### 5.2 Marr Hildreth Edge Detection

Here we show the edge detected, graphical representation and data statistics obtained from Marr Hildreth Edge Detection method.

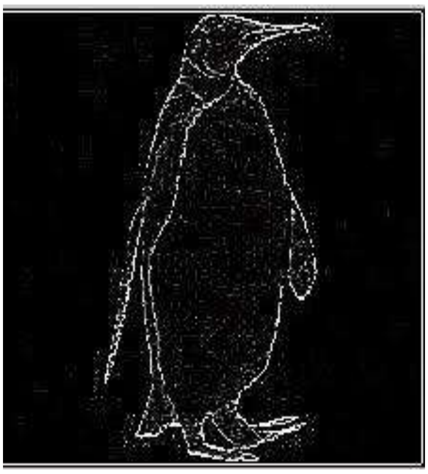


**Fig 8. Marr Hildreth Edge Detected**

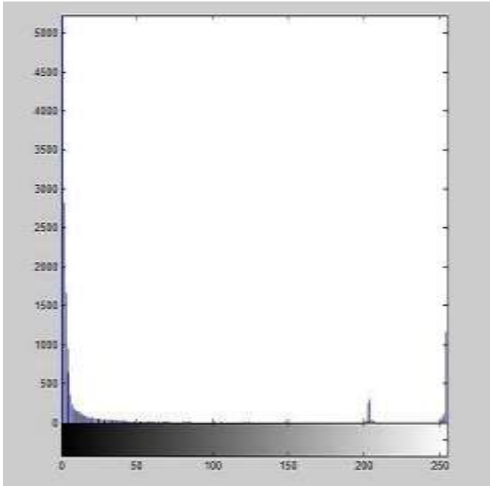



**Fig 9. Marr Hildreth Edge Detected Graph**

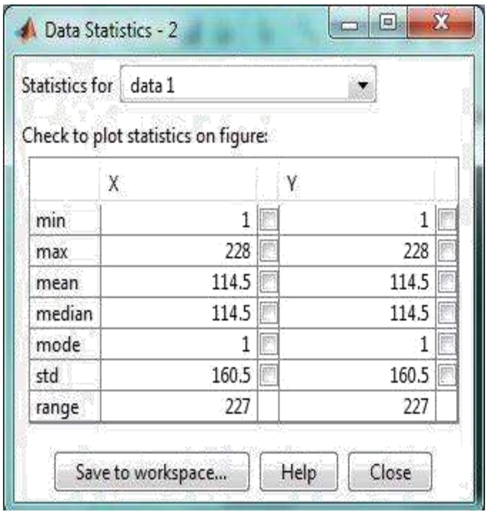



**Fig 10. Marr Hildreth Edge Detection Data Statistics**

## VI. CONCLUSION AND FUTURE WORK

It is important to know the differences between edge detection techniques because edge detection is the very early stage in object recognition. For recalling most of the information of the image, representing an image by its edge has the advantage as it reduces the amount of data required to be stored. In this paper, we show the relative performance of different edge detection techniques is done with an image. We observe that Canny edge detection technique produces almost no discontinuities in detection of edges as compared to Marr Hildreth edge detection techniques as shown in figure 5-10 respectively.. In future, we can use fuzzy edge detection technique to resolve the disadvantages in Canny edge detection algorithm.

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