ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 11, November 2013

A Performance Based Study of Edge Detection Techniques for 2D Images under Normal and Noisy Conditions

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Abstract: This paper proposes the adaptation and optimization of four edge detector algorithms used for feature set extraction in 2D images. The paper compares the performance of Sobel, Canny, Roberts and Prewitt edge detectors and proposed better solution for feature extraction in image processing. It has been shown that the Canny edge detection algorithm performs best among Sobel, Roberts and Prewitt edge detection under normal and noisy conditions, but with compromise of time. This work is implemented using MATLAB 7.10.0.

Keywords: Edge detection, Canny, Roberts, Sobel,Prewitt.

I. INTRODUCTION

Edge detection is a very important area in the field of Image processing. Edges define the boundaries between regions in an image, which helps with segmentation and object recognition.

Edges are significant local changes of intensity in an image. Edges typically occur on the boundary between two different regions in an image.

The main problem is that different edge detectors work differently. some takes more time with respect to other, while some finds more edges(works deeply) with respect to other. The detection of edges in an image depends upon illumination, blur, noise, intensity, objects.

The actual difference in working of various edge detectors can be analyzed by using these different algorithms in a same program or system. We tested four edge detectors that use different methods for detecting edges and compared their results for a variety of images to determine which detector works better for different images. This data could then be used to create a multi-edge-detector system.

II. EDGE DETECTION TECHNIQUES

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A. Sobel

It performs 2-D spatial gradient measurement on an image. The operator consists of a pair of 3×3 convolution mask. One mask is simply the other rotated by 90°.

+1	+2	+1
0	0	0
-1	-2	-1

Gx

-1	0	+1
-2	0	+2
-1	0	+1

Gy

These masks are designed to respond maximally to edges running vertically and horizontally relative to the pixel grid, one for each of the two perpendicular orientations. The masks can be applied separately to the input image, to produce separate measurements of the gradient. The magnitude of gradient is given by:

$$|G| = \sqrt{Gx^2 + Gy^2}$$

The direction of gradient is given by:

$$\theta = \arctan(Gy/Gx)$$

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The edge pixel, E(m, n), is then given by:
E(m, n) = |G(m, n) *Gx| + |G(m, n) *Gy|
where G(m, n) are the pixels from the input image, G.

B. Canny

This method was proposed by John F. Canny in 1986. Even though this method is quite old but is still used because of its precision in edge detection. The main advantage of this method is elimination of multiple responses to a single edge. It also having good localization property, means the detected edges are much closer to the real edges. The response of this detector is also good, as the original edge does not result in more than one detected edge. The gradient magnitude and direction is calculated by using first order finite differences.

C. Robert's Cross Operator

The Roberts Cross operator performs a simple, quick to compute, 2-D spatial gradient measurement on an image. Pixel values at each point in the output represent the input image at that point. The operator consists of a pair of 2×2 convolution kernels as shown. One kernel is simply the other rotated by 90°. This is very similar to the Sobel operator.

+1	0
0	-1

Gx

0	+1
-1	0

Gy

D. Prewitt's Operator

Prewitt operator is similar to the Sobel operator and is used for detecting vertical and horizontal edges in images.

-1	0	+1
-1	0	+1
-1	0	+1

Gx

+1	+1	+1
0	0	0
-1	-1	-1

Gy

III. IMPLEMENTTION AND RESULTS

Fig 1. Input Image

Fig 2.Resut of Sobel

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Fig 3. Result of Canny

Fig 4 Result of Roberts

Fig 5. Result of Prewitt

From the above pictorial descriptions it is clear that Canny works best among all the four edge detectors. Moreover it is clear that the Canny edge detecting algorithm is more precise because the edges that were not shown by the other detectors, are easily detected by Canny detector. The only disadvantage of Canny is that it takes more time as compared to Sobel.

A. Analysis On Noisy Image

We added salt and pepper noise to the image and when it is passed through the detectors, the results are

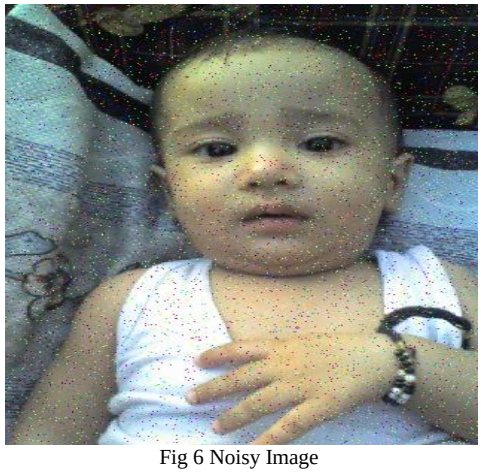

Fig 6 Noisy Image

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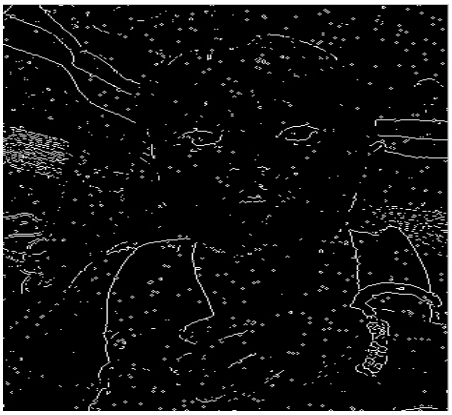

Fig 7 Result of Sobel

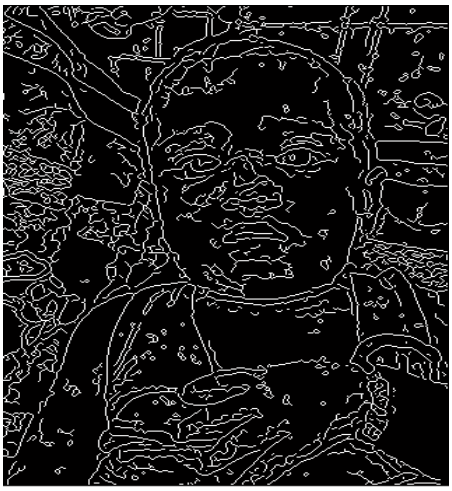

Fig 8. Result of Canny

Fig 9. Result of Roberts

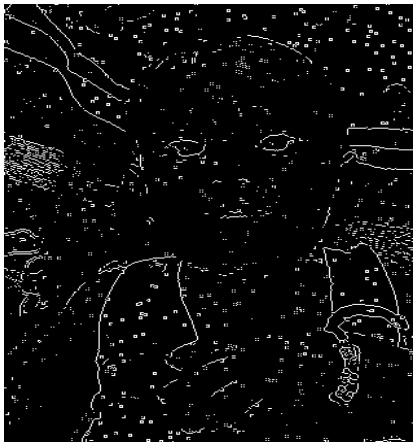

Fig 10. Result of Prewitt

B. Analysis On the Basis Of Speed

The speed of canny is slow because of its deep processing.

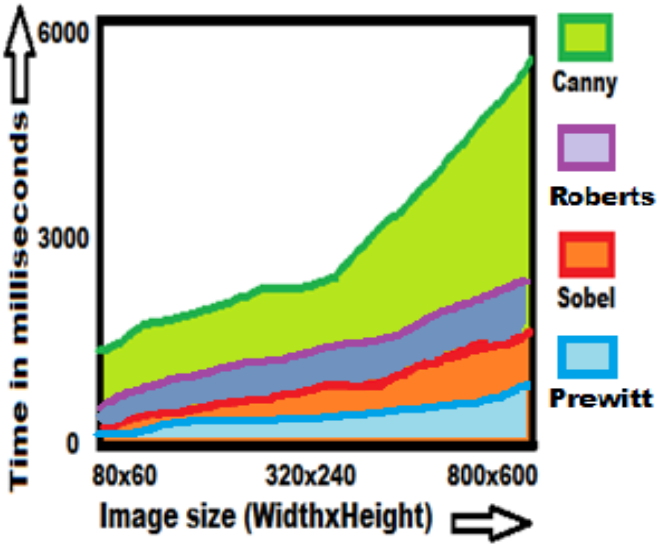

Fig 11. Speed Comparison

IV. CONCLUSIONS

The edge detection holds a big importance in image retrieval, image recognition and in segmentation. Sobel, Roberts, Prewitt edge detectors are fast in processing but are less precise. Canny's method produces single pixel thick, continuous edges and is precise, but also is bit slower in processing as compared to its competitors. The major requirement by a user is a system that gives good result even in the presence of noise and canny proves to be the best as shown by the results and fulfils the noise rejection requirement by a user.

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