

## A Comparison between Enhanced Edge Detectors

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### 1. Introduction

Edge detection is a fundamental tool in computer vision. It is often used in image processing and feature extraction. Enhancing the edge detector can affect the overall result of the system. Many edge detectors have been proposed, such as Sobel edge detector which is one of the commonly used edge detectors.<sup>[1]</sup> It computes the gradient for intensity changes at each point in the image. It is also known to be good for noise suppression. Robert cross edge detector was introduced by Lawrence Robert in 1965 and it is considered as one of the oldest edge detectors that uses 2D filters.<sup>[2]</sup> Canny edge detector was created by John F. Canny in 1986.<sup>[3]</sup> It uses multi stage algorithm and hysteresis threshold. It is complex to implement and requires execution time. However, it gives a better result compared with other edge detectors. The laplacian of Gaussian (LoG) highlights the regions of rapid intensity changes at each point in the image.<sup>[4]</sup> The image is usually smoothed before applying LoG because it detects the noise along the edge in the image. Prewitt edge detector is similar to Sobel edge detector.<sup>[5]</sup> It is simpler to implement however, it is very sensitive to noise. Recently few researches have been using Gabor filters as an edge detectors.<sup>[6][7]</sup> Gabor filters are band pass filters with tunable frequency, orientation and bandwidth.<sup>[8]</sup> The edge can be detected in the image if it's filtered with Gabor bank of different orientation and frequency. In this paper 24 Gabor filter bank are used and designed with 6 different orientation (0, 30, 60, 90,120 and 150) and 4 different scales.

Some researchers compared the performance of different edge detector such as; in<sup>[9]</sup> they compared Prewitt, Sobel, LoG, Canny, and Susan edge detector. In<sup>[10]</sup> they compared Sobel Roberts cross, Canny, LoG and Prewitt edge detector. However, none of the researches compared the enhanced edge detectors or the usage of Gabor filter as an edge detector.

This Paper presents a comparison between commonly used edge detectors such as Canny, Sobel, Prewitt, Roberts cross, Laplacian of Gaussian, and the usage of Gabor filter as an edge detector. A morphological edge enhancement method is used as a post process to enhance the results of these edge detectors. Pratt's figure of merit is used as an evaluation method.

### 2. Edge enhancement

There are 3 major errors in edge detection. 1. Missing valid edge points 2. Failure to localize edge points and 3.

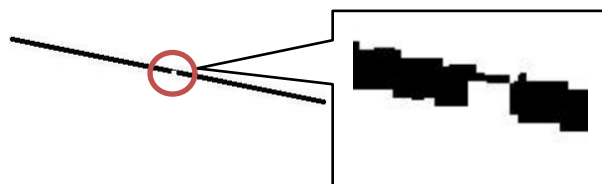
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Classifying noise fluctuation as edge point<sup>[11]</sup>. Morphological operation is often used to enhance the edge detectors. The method used in this paper is as follows:

- 1- An edge detector is applied on the image.
- 2- The short lines are segmented and the start and end of each line is located.
- 3- A circular blob is placed at the end and beginning of each line segment.
- 4- The radius of the circular blob is half the size of the gap between the line segments.
- 5- When the size of the blobs is close to the size of the gap the two blobs will overlap and will connect the edges together
- 6- A thinning operation is applied on the circular blob to create a line as shown in figure 1.
- 7- The result of the edge filling is combined with the result of the edge detector to create the enhanced edge image.
- 8- The enhanced edge image is then used for the comparison

The result of the edge filling using different edge detector is shown in figure 2.



**Figure 1.** Edge enhancement result. The short line segments are connected after the thinning operation

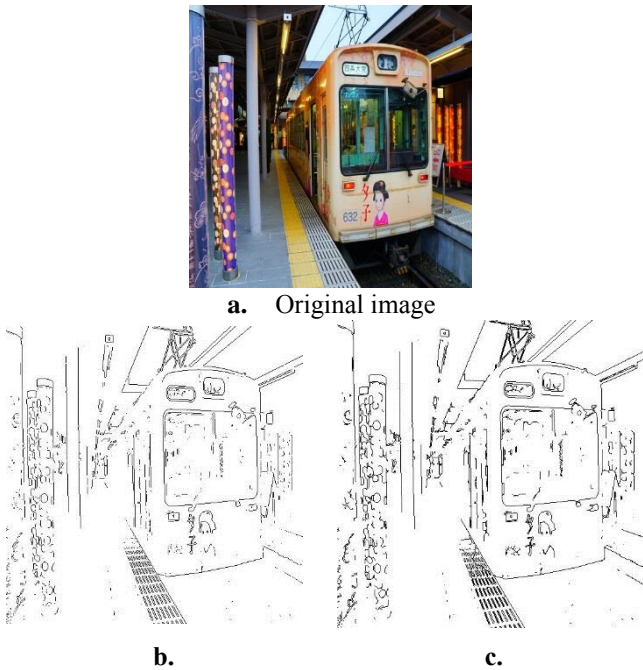
### 3. Comparison criteria and results

After the enhancement method was applied on different edge detector, an evaluation method is needed to check the improvements. Pratt's figure of merit (PFOM)<sup>[11]</sup> evaluates the results of the enhanced edge detectors. The following equation is used for the evaluation:

$$P = \frac{1}{\max\{I_1, I_A\}} \sum_{i=1}^{I_A} \frac{1}{1+ad^2} \quad (1)$$

Where  $I_1$  is the number of original edge pixels and  $I_A$  is the number of detected edge pixels.  $d$  is the distance of the original edge point to the detected edge point. The scaling constant  $a$  is set to a value of  $1/9$ .

An image of a square shape is used for testing as shown in figure 3. Different types of edge detectors were applied along with the enhancement method. The gap size was chosen randomly. The result of Pratt's figure of merit values is shown in table 1.



**Figure 2.** Sobel edge detection result. **b.** before applying edge enhancement method. **c.** after applying the enhancement method



**Figure 3.** The Test image.

Operator	Gap size						
	0	3	5	11	25	33	83
Prewitt	0.5756	0.6001	0.6191	0.6739	0.8474	<b>0.8479</b>	
Sobel	0.5752	0.5920	0.6089	0.6657	0.7794	<b>0.8475</b>	
LoG	0.5700	0.5707	0.5707	0.6039	0.7480	<b>0.8012</b>	
Canny	0.6486	0.6486	0.6486	0.6486	0.6486	0.6486	<b>0.9468</b>
Roberts	0.7790	0.7818	0.7863	0.7891	0.8465	<b>0.9581</b>	
Gabor	<b>1</b>	1	1	0.9998	0.9976	0.9953	

As shown in table 1 some edge detectors like Prewitt, Sobel, LoG, Canny and Roberts got improved after the enhancement method with gap size of 33 and 83 for Canny. However, Gabor filter result got worse after applying the enhancement method. This is because of the characteristic of Gabor filter as it can detect all the edges in different orientation and scales.

#### 4. Conclusion

In this paper we compared common edge detectors as long as the usages of Gabor filter as an edge detector. Pratt's figure of merit was used to evaluate the results of edge detectors after applying enhancements method. Results were improved in all the edge detectors except for Gabor filter. These results can affect the result of image classification process which will be done in our future work.

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