ISSN: 2455 - 9172

EIJO Journal of Engineering, Technology And Innovative Research (EIJO–JETIR)

Einstein International Journal Organization (EIJO)

Available Online at: www.eijo.in

Volume – 3, Issue – 6, November – December -2018 , Page No. : 01 - 07

Comparative Study Between Canny and Sobel Edge Detection Techniques

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Abstract

Image Processing is a method to perform working or an action on an image to intensify and upgrade it or to bring out some useful information. It is a type of signal processing in which input is an image and output may be image or features relating with that image. Nowadays, image processing is becoming a promptly growing technology. Image Processing is also used as a technology in core research area. It's upper hand is able to be seen in the application such as face detection, speech recognition, speech processing, video compression and audio compression etc,. This paper encourages the comparison between edge detection technique which is a advanced computer technology being used in a variety of applications that identifies human faces in digital images. Edge Detection includes a variety of mathematical methods that aims at identifying points in a digital image at which the image brightness sharply changes or have discontinuities. The point at which image brightness changes sharply are typically organized into a set of curved line segments called edges[4]. Edge Detection is the fundamental tool in image processing, machine vision and computer vision. In this paper, the comparison of two edge detection algorithms will be done namely, Canny edge detection and Sobel edge detection to extract edges from facial images.

Keywords: Edge detection, Object detection and recognition, Image Segmentation, Canny Operator, Sobel Operator.

Introduction

Image Processing is a method of converting an image into digital form and perform some operations on it, in order to get an intensify image or to bring out some useful information from it. Image Processing has been evolved basically for two purposes. The first purpose is for the interpretation of images by human and second is for data storage, analysis and transfer. Image segmentation is the process of dividing an image into different parts or into multiple segments (sets of pixels). Image segmentation is done in many ways. Some of them are using region based segmentation (similarity detection), histogram based method and the edge detection algorithm (dissimilarity detection)[1]. The structure of human faces reveal similarities with minor differences from individual. In face detection, for an input image firstly the positions are detected keeping it independent of conditions such as illumination, focus, size of the faces, poses, alignment, etc,[6]. The biggest issue in face recognition is to set angles and poses in addition with facial expressions, variations in colour, texture and lighting conditions. Face detection is a feature based approach in which face geometry is taken which includes face shape and other facial features like mouth, eyes, nose etc [5].

Based on certain aspects and parameters, an efficient edge detector is used for image recognition:

1) **Good Localization**: The location of the edge detected must be as close as possible to the correct position called edge localization accuracy.

2) **Good detection**: There are false and true edges which are detected in the edge detection technique. False edge should be minimum in number. The detection of edges brings about the threshold operation. The threshold leads to less false edges, but also reduces the number of true edges[6].

3) **Orientation sensitivity**: Orientation is used to connect edges segments, reject noise and suppress non maximum edge magnitude.

4) **Noise sensitivity**: The edge detector should either reduce or remove noise to some acceptable extent.

5) **Speed and Efficiency**: The algorithm used should be fast to implement in image processing system. An algorithm that allows recursive implementation improves efficiency [6].

Edge Detection Technique

Edge Detection means extraction of information about the image. It is a main tool in pattern recognition, image segmentation, scene analysis and target tracking[3]. Edge detection is mainly the measurement detection and location of the changes in image gray. The most basic feature of an image is the image gray. The current image edge detection methods are mainly differential operator technique & high pass filtration. Basically, the edge detector is a high pass filter, which is applied to extract the edges from images. The widely used operators are Sobel, Prewitts, Roberts and Laplacian are sensitive to noises and their anti –noise performances are poor. Log and canny edge detection operators which have been proposed, use Gaussian function to smooth or do convolution to the original image, but computation are very large[3].

1) Sobel Edge Detection

Sobel operator measures a 2-dimensional spatial gradient on an image and gives more attention on regions of high spatial gradient corresponding to edges. It is used for finding gradient magnitude at each point in gray scale image. Sobel edge detection technique brings out all of the edges in an image, regardless of direction. Sobel operator is advantageous as it provides both differencing and smoothing effect. It is implemented as the sum of two directional edges enhancement operation and the resulting image appears as an unidirectional outline of objects in original images. Constant brightness regions becomes black, while changing brightness regions becomes highlighted. Sobel operator is applied to an uncompressed graymap or to each color channel of apixmap that is in memory, loaded from a JPG, PNG etc. In Sobel edge detection method derivative are implemented in digital form because derivatives enhance noise and the smoothing effect is the attracting feature of Sobel operator.

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

Gy

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

Gx

Figure1: Sobel convolution kernels (3×3 mask)[2]

Sobel algorithms work using a mathematical procedure called convolution, which simply means “take the pixels of interest”, and multiply each transform value time with the neighbour over which the sliding transform lies and sum all of them including the pixels of interest. The implementation of Sobel method for edge detection, which is based on 3 by 3 array that is moved over the image. The Sobel convolution kernels are designed to respond to edges vertically and horizontally. These masks are each convolved with the image. It calculates horizontal and vertical gradient (Gx and Gy),

then combines together to find the magnitude of the gradient at each point and the orientation of that gradient. These numbers are used to compute the edge magnitude which given by:

$$|G| = \sqrt{(Gx2 + Gy2)}$$

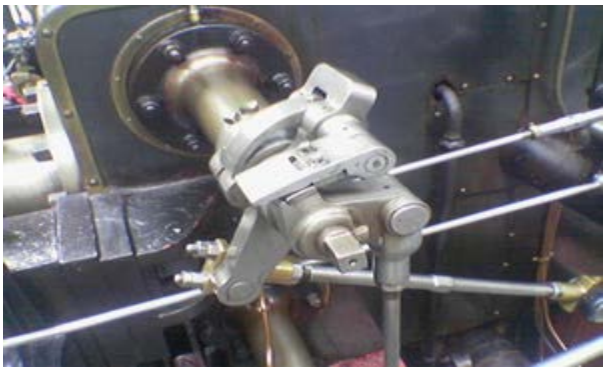


Figure 2: Colour image.

Figure 3: Image after applying Sobel edge detector

2) Canny Edge Detection

Canny edge detector uses multi-stage algorithm to detect a wide range of images. Canny is used for object recognition and pattern matching purposes where it is necessary to retain the features when in case of noisy images. System requiring accurate results and need to preserve maximum possible features can use canny operator.

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

Figure 4: Canny Implementation

The input image is converted into gray scale by modifying the variations and brightness, this is done to remove noise from the input image. The removal of noise makes the location and detection of edges efficient. Generally, a Gaussian filter is used for noise removal because the Gaussian filter accomplishes two points, first one that it manages to control the details of the input image and second it suppresses the noise. Mostly, the image is smoothed using a two-dimensional Gaussian filter but these filters are sometimes costlier. So in the place of two two-dimensional Gaussian filter, two one dimensional filters are used, one in x-direction and other one in y-direction. Edges should be marked where the gradient of image has large magnitudes[6] . Each pixel measures the intensity of a gradient image measures the change in intensity of that same

point in the original image, in a given direction. To attain the full range of direction, gradient images in the x and y directions are computed.The final image should have thin edges but the image magnitude originated results in thick edges. Non-Maximum suppression is applied for the same reason to make the edges thin. When edge points are marked in image, it gives rise to ridges in gradient magnitude image. The algorithm then tracks the ridge top & sets all pixels to zero that are not actually ridge top so as to give a thin line in the output, a process known as non maximal suppression. If ridge pixels are then threshold by so called hysteresis thresholding which uses two thresholds T1 and T2 with T1<T2. The value more than the threshold T2 is called strong edge pixels. Ridge pixel with values between T1& T2 are called weak pixels[1].

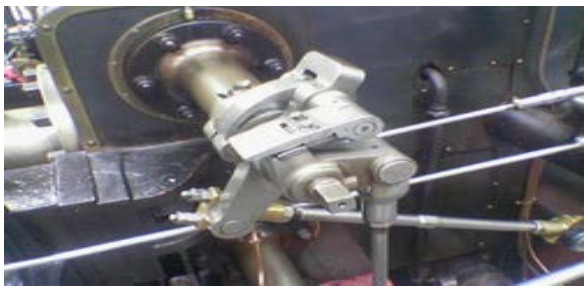


Figure5: Colour image

Figure6: Image after applying Canny edge detector

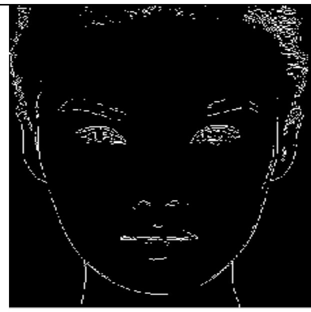
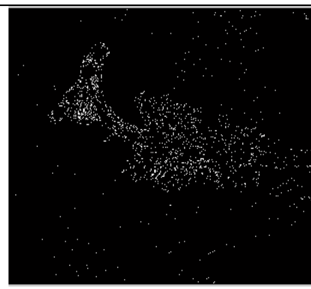
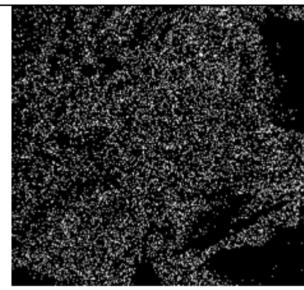
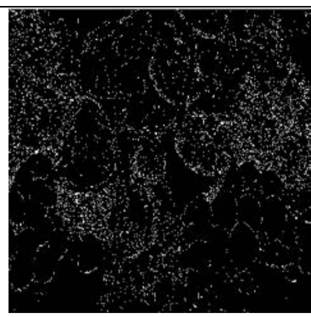
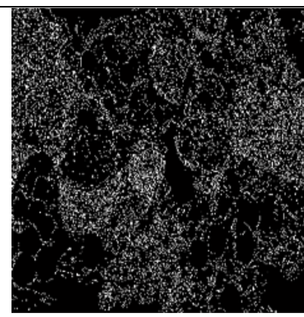
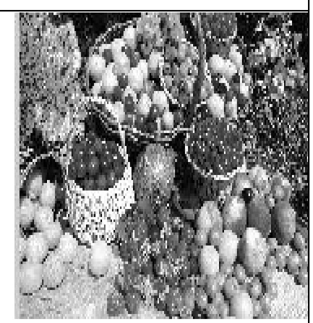
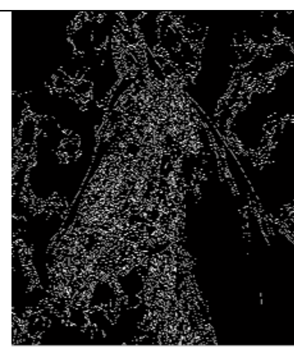
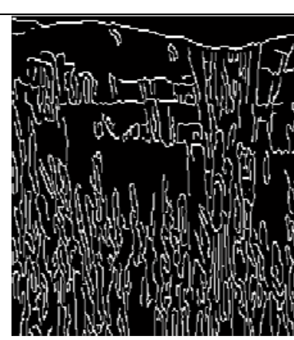
In Canny edge detection Gaussian Filter is applied to smoothen the image. As given below:

$$\text{Gaussian Mask}=1/159 \begin{bmatrix} 2 & 4 & 5 & 4 & 2 \\ 4 & 9 & 12 & 9 & 4 \\ 5 & 12 & 15 & 12 & 5 \\ 4 & 9 & 12 & 9 & 4 \\ 2 & 4 & 5 & 4 & 2 \end{bmatrix}$$

Gaussian can be calculated by using the following formula:

$$g(x, y) = e^{\wedge}(-(x2+y2)/2\sigma2)$$

Where, x and y represent the coordinate distance from the center pixel (x, y). It is seen obvious that all such values are in the form of fractions. In order to perform mathematical operation on fractions, a floating point number system is required[1]. **Table1**: Difference between Canny and Sobel Edge Detection operator:

Original Image	Sobel Image	Canny Image	Threshold Image
			
			
			
			
			

Result Analysis

Table 2: Comparison of Canny and Sobel edge detection

Parameter	**Sobel**	**Canny**
Computation	Simple and time consuming	Complex and time consuming
Signal to noise ratio	Low	High
Appearance of image	Less efficient	More efficient
Number of objects in image	Suitable for simple images	Suitable for simple as well as complex images.
Application	Massive data communication and data transfer	Medical field for X-Ray diagnosis and object recognition.
Strength	It is simple and detects edges.	Removes noise through smoothing effect. Good localization and response. Unsusceptible to noisy environment.
Weakness	Inaccurate and sensitive to noise.	Time consuming.

Conclusion

This paper gives a comparison between Sobel and Canny edge detection methods. Each operator is useful in its own domain but the parameters like accuracy, complexity and efficiency creates a difference between these two. Basically, Sobel edge detector is used for high data transfer as Sobel gives fast performance results and its computation is also high. Canny on the other hand, is most useful for object recognition and pattern matching where it is necessary to retain features even in case of noisy images.

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