Image Segmentation Using Various Edge Detection Techniques

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Abstract – Edge detection is a vital step in image analysis. Edges are the outside limit of an object, area, or surface which helps with segmentation and object recognition. Edge detection is fundamental tool in image processing, particularly in the areas of feature detection and feature extraction. The discontinuous in brightness can be detected and used for image segmentation. There are probably more algorithms in a literature of enhancing and detecting edges than any other single subject. In this paper, the main is to study most commonly used edge techniques for image segmentation.

Index Terms – Image segmentation, edge detection, digital image processing.

1. INTRODUCTION

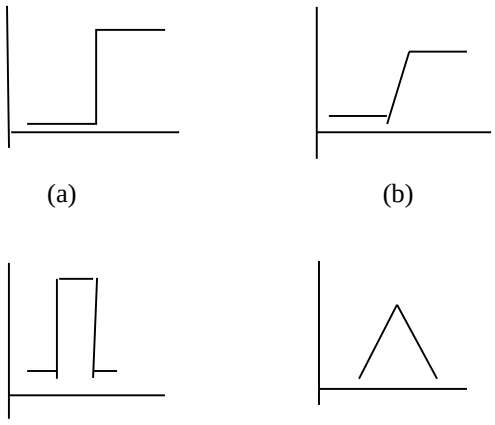
Edge of image is one of the fundamental tool used in most image processing applications to obtain information from the frames as a precursor step to future extraction and object segmentation. It is the first step of image analysis and understanding. Edge detection is a process of locating an edge of an image. Detection of edges in an image is a very important step towards understanding image features. Edges consists of meaningful features and contain significant information. It significantly reduce the image size and filters out information that may be regarded as less relevant, thus preserving the important structural properties of an image. Most images contain some amount of redundancies that can sometimes be removed when edges are detected and replaced during reconstruction. The effectiveness of many image processing depends on the perfection of detecting meaningful edges. This is where edge detection comes into play. The goal of the edge detection is (i) produce a line drawing of a scene from an image of that scene, (ii) important features can be extracted from the edges of an image (e.g. corners, lines, curves), (iii) these features are used by higher level computer vision algorithms (e.g. recognition). Also, edge detection is one of the ways of making images not take up too much space in the computer memory. Since edges often occur at image location representing object boundaries, edge detection is extensively used in image segmentation when images are divided into areas corresponding to different objects. These features are used by advanced computer vision algorithms. Edge detection is an active area of research as it facilitates higher level image analysis. Every year new edge detection algorithms are published. This paper discusses various techniques for edge detection.

2. IMAGE SEGMENTATION

Usually image segmentation is an initial and vital step in image analysis. Inputs generally are images. Outputs are attributes extracted from those images (edges contours, identity of individual object). In computer vision, image segmentation is the process of partitioning a digital image into multiple segments(sets of pixels, also known as super pixels). The purpose of image segmentation is to partition an image into meaningful regions with respect to a particular application. Segmentation is based on measurements taken from the image and might be gray level, color, texture, depth or motion. Edge detection is one of the frequently used techniques in digital image processing.

2.1 Types of Edges

(a) Step Edge (b) Ramp Edge
(c) Line Edge (d) Roof Edge



1. Step Edge: The intensity of the image changes from value of one side of the discontinuity to different value on the opposite side.
2. Ramp Edge: A step edge where the intensity change is not instantaneous but occur over a finite distance.
3. Ridge Edge: The image intensity abruptly changes value but then returns to the stating value within some short distance (generated usually by lines).
4. Roof Edge: A ridge edge where the intensity change is not instantaneous but occur over finite distance (generated usually by intersection of surfaces).

2.2. Steps of edge detection

(1) Smoothening: Suppress as much noise as possible, without destroying the true edges.

(2) Enhancement: Apply a filter to enhance the equality of the edges in the image (Sharpening).

(3) Detection: Determine which edge pixels should be discarded as noise and which should be retained (usually, thresholding provides the criterian used for detection).

(4) Localization: Determine the exact location of the image. Edge thinning and linking are usually done in this step.

3. EDGE DETECTION TECHNIQUES

The various Edge Detection Techniques are: (a) Gradient Based :- (1) Roberts Edge Detection, (2)Sobel Edge Detection, (3)Prewitt edge detection (b) (b) Gaussian Based:- (4) LoG Edge Detection, (5) Canny Edge Detection.

1**.** Roberts Edge Detection **:** The Roberts operator performs a simple,2-D spatial gradient on an image. The regions of high spatial frequency edges are highlighted.. The input to the operator is a grayscale image. The values at each point in the output is estimated by calculating the sum of squares of the differences between diagonally adjacent pixels.

-1	0
0	+1

G_x

0	-1
+1	0

G_y

2**.** Sobel Edge Detection ***:*** The absolute gradient magnitude at each point (where input is in grayscale image) can be estimated using this method. In conjecture at least the operator consists of pair of 3x3 complication kernels as given under table. One kernel is simply the other rotated by 90 degrees.

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

G_x

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

G_y

3. Prewitt Edge Detection ***:*** To estimate the edge detection using magnitude and orientation, prewitt is a correct way. In this case, edge detector is estimated in the 3x3 neighborhood for eight directions. All the eight convolution masks are calculated.

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

G_x

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

G_y

4. LoG Edge Detection***:*** It is a second order derivative and it has two effects, it smoothes the image and when computed yields a double edge image. Locating edges consists of finding the zero crossing between the double edges. The implementation through the mask is given below.

1	1	1
1	-8	1
1	1	1

G_x

-1	2	-1
2	-4	2
-1	2	-1

G_y

5. Canny Edge Detection: The Canny edge detection is one of the standard edge detection techniques. To find edges by separating noise from the image, first step is to find the edges of image. Canny method is a better method without disturbing the features of the edges in the image afterwards applying the tendency to find the edges and the serious value for threshold.

4. ADVANTAGES AND DISADVANTAGES OF EDGE DETECTOR

As edge detection is a fundamental step in computer vision, it is important to classify the true edges to get the best results from the matching process. So it is necessary to choose edge detectors that fits best to the application.

Operator	Advantages	Disadvantages
Robert, Sobel, Prewitt	Simplicity,	Inaccurate,

	Detection of edges and their orientations	Sensitive to noise
LoG	Test wide area around the pixel, Find the correct places of edges	Difficulties at the corners and curves where the gray level intensity function varies
Gaussian Operators like Canny	Use probability for finding error rate, Localization and response , Improved signal to noise ratio, Better detection specially in noise conditions	Complex computations and time consuming, False zero crossing

5. LITERATURE SURVEY

C.Nagaraju et.al(2011)[1] proposed a novel edge detection algorithm based on multi structure elements morphology of eight different directions and then the final edge results are obtained by using synthetic weighted method. The proposed algorithm is more efficient than conventional mathematical morphological edge detection algorithms and differential edge detection operators. G.T. Shrivakshan[1] Dr.C. Chandrasekar [2],(2012) [3]deals with the observation of shark fish classification through image processing using various filters and is implemented using MATLAB. M.Sridevi and C.Mala (2012)[10] compared the different segmentation algorithms and implemented in MATLAB and concluded the result that the required segment can be obtained based on proper mask and threshold values. Er.Komal Sharma, Er.Navneet Kaur(2013)[13] deals with the process of those regions in the image where there is an abrupt change in the brightness of the image using various edge detection methods. Kiranjeet Kaur, Sheenam Malhotra(2013)[14] represented methods for edge segmentation of satellite images which described the different types of Fuzzy Logic using edge detection. And also described CBIR technique and Bacterial foraging optimization technique. Thabit Sultan Mohammed[1], Wisam F. AI-Azzo[2] and Khalid Mohammed (2013)[15]In this simulation system, a user friendly GUI is developed and two alternative methods for image acquisition are implemented. Amit Chaudhary1,Tarun Gulati2 (2013)[18] Concluded that Sobel edge detection algorithm performs better than Laplacian algorithm; however, the false edges are high in both cases for blurred or low resolution images. Therefore, a new algorithm and set of filters(kernels) is proposed and its result are compared with the Sobel and Laplacian filters for three images and from the results obtained it is found that the proposed algorithm performs better than the above mentioned filters. M.Davoodianidaliki a,*,A.Abedini b,M. Shankavi a(2013)[19] uses traditional edge detection operators like Sobel and Canny as input to ACO and turns the overall process adaptive to application. Karishma Bhardwaj* and Palvinder Singh Mann**(2013)[22]presented an Adaptive Neuro Fuzzy Inference System (ANFIS) based edge detection technique and the proposed technique detects the edges from the digital images using ANFIS based edge detector and then it is compared with popular edge detectors Sobel and Roberts on the basis of performance metrics PSNR (Peak Signal to Noise Ratio) and MSE (Mean Square Error). Girish Sahu1, Anand Swaroop Khare2, A.K.Singh3(2014)[23] shows the comparison of edge detection techniques under different conditions proposed novel method based on the denoised images. Zhenfeng Shao1, Weixun Zhou1*, Qimin Cheng2 (2014) [24]discussed low-level features yields unsatisfactory retrieval results in remote sensing image retrieval because of the existence of the semantic gap. In order to improve the result, visual attention model is used to extract salient objects from image according to their saliency. Then color and texture features are extracted from salient objects and taken as feature vectors for image retrieval and concluded experimental results improves retrieval results and obtains higher precision. Srinivas.B.L.1 Hemalatha2, Jeevan.K.A3(2014)[25]discussed that the edge detection Is a fundamental tool for image segmentation which separates an image into its component regions or objects from the background.

6. CONCLUSION

In this paper many edge detection methods like Sobel operator technique, Roberts technique, Prewitt technique, Canny technique are discussed. Among the above mentioned techniques, many experimental methods concluded that the result obtain using canny operator gives the better result. Choosing a suitable method for edge detection is based on the some environmental conditions. Each technique have its own advantages and disadvantages. This paper will be helpful for the researchers in understanding the concept of edge detection who are new in this field.

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