Aastha Chaudhary
CECS 553 – Machine Vision

Homework Assignment – 3

Image Segmentation & Edge Detection Methods

Introduction

An image is the visual representation of things and can be widely expressed in the form of the electronic information. Image segmentation is a very important part of image processing having applications in a wide variety of fields like healthcare industry where we find the application of image segmentation in locating tumors, measuring tissue volumes etc. It is further used in Machine Vision field and also for recognition tasks like face recognition, Iris recognition etc. Image segmentation is the process of extracting meaningful contents of a given image so as to get some information about the properties of the image. Image denoising is also done sometimes so as to remove the background noises from the image so as to extract all the information about it which is mainly done with the help of the filtering algorithms. The edge detection method is a part of image segmentation which further uses various methods in order to identify the edges of the applied image which describes the shape and the size of the image further.

The various Edge detecting algorithms detect the edges by applying convolution on the binary image. So in order to begin with the detection of the edges of the image we need to convert the rgb equivalent image to gray scale and then to a binary image. The basic steps of edge detection process are as follows-

- Filtering – This method is used for removing the unwanted background noises which are accompanying the image without spoiling the true edges of the image.
- Sharpening – The strength of the corresponding pixels can be increased by increasing the intensity of the pixels so as to identify the edges properly.
- Localization – This method helps in detecting accurate locations of edges in an image.

The different edge detection methods include Sobel, Prewitt, Roberts, Canny methods. The Sobel and Prewitt methods have a 3 * 3 matrix as a kernel for obtaining the gradient magnitude of the image while Roberts method uses a pair of 2 * 2 convolution kernels of the operator. [1]

Roberts Method

The Roberts Method seems to be the most fastest convolution method. It was proposed by Lawrence Roberts in 1965 and was the first edge detection technique used. It is a 2-D spatial gradient measurement where the mode of input and output is the gray scaled image. The figure represents a pair of 2 * 2 convolution kernels of the operator.

1	0
0	-1

Gx

0	1
-1	0

Gy

Figure 1- Roberts Operator Masks [1]

Using Convolution masks, the gradient magnitude becomes-

G[f[i.j]] =|Gx| + |Gy|

Or

|G|=sqrt(Gx*Gx + Gy*Gy)

Canny's Method

Canny's edge detecting algorithm seems to be very popular edge detection method which is used as a pre-processing step in many computer vision algorithms. The algorithm processes an image in a couple of steps which includes smoothing and filtering of the image followed by non-maxima suppression of the image and then a connected component analysis stage to identify the edges.

Canny's edge detector approximates the operator that optimizes the product of signal-to-noise ratio and localization. It is generally the first derivative of the gaussian.

A few of the criteria's being followed by the canny method which were being mentioned in his paper are as mentioned here. One of them is the low error rate, it is important to make sure that the edges which are present in the image should not be missed and we need to ignore the places where don't have any edges. The second criteria is that the edge points should be well localized i.e. the edge points should be at that location only where the detector has identified them. There should be minimal distance between both of them.[2]

Steps followed by the Canny's method are-

- The first thing the algorithm do is to remove the noise which are present in the background of the image before trying to locate the edges.
- Once the image is smoothened, then the strength of the edges i.e. the gradient is identified by applying sobel operator to the image in x and y directions. The masks of the sobel operator are as follows-

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

Gx

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

Gy

Figure 2- Sobel Operator Masks [2]

The magnitude of the edge strength is calculated by-

|G|=|Gx| + |Gy|

- The next step is to identify the direction of the edge using the gradient obtained in the previous step.
- The next steps is to relate the edge direction with the pixels which are present in the image.
- Then non maximum suppression is applied which suppresses the pixels which are not to be considered as a part of the edge.
- Finally, hysteresis is used to eliminate the invalid pixels which were considered as edges i.e. fluctuating above and below threshold.[2]

Difference of Gaussians (DoG)

The difference of Gaussians features enhancement algorithm which enhances the features of an image by subtracting the blur image from the original image. The leftover image is less blur and hence enhance the spatial features of the Gray scale image. Blurring an image using Gaussian filter suppresses only the high-level spatial features. Subtracting one image from another preserves

some of the spatial information which lies in the acceptable frequency range. The difference of Gaussian is also known as spatial band pass filter. [3]

Laplacian of Gaussian (LoG)

The Laplacian is the 2-D measure of the 2nd derivative of the image. The Laplacian of an image highlights the regions of rapid intensity change and is therefore often used in edge detection. The Laplacian is generally applied on the image after the smoothing or filtering of the image is done so that the background noises are removed from the image.

The discrete convolution kernel's which are mostly used by the Laplacian filter are as follows-

1	1	1
1	-8	1
1	1	1

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

Figure 3 – Commonly Used Approximations for the Laplacian Filter [2]

As we are dealing with the second order differentiation of the image, we need to remove all the high frequency noise which are accompanying the image which is mostly done as a pre-processing step prior to the filtering.

Experimental Evaluation

Figure 4 – Original Image

Figure 5- Sobel Filter Image

Figure 6- Perwitt Filter Image

Figure 7 – Roberts Filter Image

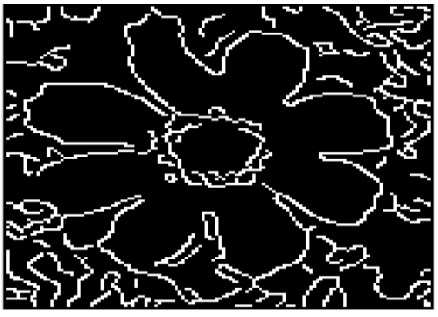

Figure 8 – Canny's Filter Image

References

1. P. Sujatha, K. K. Sudha (2015) , " Performance Analysis of Different Edge Detection Techniques for Image Segmentation " , International Journal of Science and Technology Volume 8(14)
2. Raman Maini, Dr. Himanshu Aggarwal , " Study and Comparision of Various Image Edge Detection Techniques " , International Journal of Image Processing Volume 3(1)
3. https://en.wikipedia.org/wiki/Difference_of_Gaussians
4. G. T. Shrivakshan, Dr. C. Chandrasekar , " A comparison of various Edge Detection Techniques used in Image Processing " , International Journal of Computer Science Issues, Volume 9(5)