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Edge Detection using Average filter & Thresholding

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Abstract
Images play an important role in the visual perception and vision is the most powerful sense among all the senses of human. Digital image processing is an important and crucial concept in computer vision for the purpose of effective image display and extraction of desired features as well as for editing and manipulating images. Edge detection is an authoritative concept in the digital image processing and is the initial step for image segmentation. Edges are detected for the purpose of creating a boundary or contour between an object and the background surface or different parts of a particular image. Detection of the edges include a number of different mathematical techniques that are used with the motive of identifying sharp discontinuities in a digital image. Edge detection is the fundamental concept used in image processing, machine and computer vision, image segmentation, and face recognition. In this paper, we are going to present an edge detection algorithm based on the average filtering of an image followed by thresholding and at last masking.

Keywords : Edge detection; Average filtering; Thresholding; Masking.

Introduction

The edge detection process gives significant information of an image while reducing the amount of data and unwanted information without disturbing and manipulating the originality of that image. The information provided is then used to detect the object or different objects of the image. The edge detection mainly is the way of determining the sharp discontinuities, caused due to the change in intensity, from an image.[1] Edge detection acts as a way of catching sharp discontinuities in a digital image and plays a crucial role in analysing images and acts as a key for solving various complex problems.[2] Fundamentally an edge can be defined as the boundary between the object and background or two different regions. And the main aim of edge detection is to mark the regions separately where the changes in the luminous intensity are sharp.[3] The edge detection process provides a base for a lot of image processing applications such as face recognition, image segmentation, identification and registration. The concept of edge is considered to be the basic feature of an image as it gives the necessary information about the objects contained within an image.[7] Edge detection is classified in three major categories. The first are the first order derivatives or gradient methods in which the images are sharpened and blurred images are enhanced while taking first derivative that helps in detecting the edges using the minimum and maximum values. The gradient methods include the Robert, Sobel and Prewitt edge detection techniques. The second one is Second order derivative, that is based on laplacian, in which it searches for zero crossing and they are used in order to highlight the edge location. The second order derivatives are using two basic approaches, Laplacian of Gaussian and Difference of Gaussian. The third one is optimal edge detection having canny edge detection as its pillar technique.[4][8] The basic steps in edge detection are; Filtering, Enhancement/Sharpening, Detection and Localization. These four steps constitutes the working of an edge detection process, where in filtering the noise is reduced, sharpening focuses on the change in local intensity of the pixels, detection works on the pixels for which is to be considered as noise and which is to be retained, and the final step localization deals with the exact location of the edges where the necessity of localization being the edge thinning and linking.[9]

Variations in intensity are the reasons for existence of edge in an image where the change in intensity are caused by geometric events i.e. because of surface, depth, color and texture discontinuities, and non geometric events i.e. because of shadows, inner reflections and illumination changes.[12] Edge detection is having a wide variety of application in the fields of image recognition, image segmentation, object recognition, automated interpretation systems and machine vision but the selection of a unique and optimum edge detection technique is a difficult target to achieve.[13] Since we have a lot of edge detection operators and even more attention is paid towards this field to develop more efficient algorithms.

Methodology Used

For successful completion of an algorithm we need to follow some sequential steps in order to get the desired result. Here, we have initially taken an input image. Then an averaging filter is applied to it in order to remove the noise and later the average filtered image is subtracted from the original image. Next step is the application of thresholding on the resultant image for detecting the true edges from the image and then the masking operation is applied to remove or reduce the unwanted non-zero pixels or white dot pixels that appear in surrounding. Following steps define the stepwise working of the complete algorithm.

1. Take a gray scale image as an input image.
2. Apply average filtering to input image.
3. Apply thresholding to the filtered image.
4. Apply masking to the resultant image.
5. Output image with the edges.

Average Filtering : The average filtering more popularly known as mean filtering is an easy and simple method for noise reduction as well as for reducing the amount of intensity variation between the adjacent pixels. The basic idea that supports the working of mean or averaging filter is that the each pixel value in the image is replaced with the average value of its neighbouring pixels. A specified size of filter is used for this purpose, based on what is required by the user or programmer according to the image size.

Thresholding : Thresholding can be referred to as a simple method where the pixel replacement is done based on a particular constant value. If the pixel intensity is less than that fixed value then each pixel in the image is replaced with a black pixel and if the intensity is greater than constant value then each value is replaced by the white pixels. The particular fixed or constant value is known as threshold. For making the thresholding operation completely automated, it is a compulsion for the computers to select the threshold value automatically.

Masking : In simple terms masking can be referred to as a filter. The masking process deals with the filtering operation being applied directly to the image. Filtered masks are also known as convolution mask. The general procedure followed by mask application is consisting of the movement of the filtered mask from point to point in the complete image. In the original image, at each pixel point, the filter response is calculated using a pre-defined relationship. The filters are categorized as two types i.e. Smoothing filters and Frequency domain filters. The filters are used for varying purposes such as blurring & noise reduction and edge detection & sharpness.

Proposed Algorithm

The stepwise algorithmic description for the method being developed is explained as follows:

1. *Input :* input image I(i,j)
2. H ← average mask (R^{nxn}, where n is odd)
3. Applying h on I
   Convolution function, Y ← h * I
4. Z ← Y-I
5. If (Z(i) > ϕ) ; Where ϕ is the threshold
   Z= 255
   else
   Z= 0
6. If (Z(i,j)=255 & v>1) ; Where v represents non-zero pixels in surroundings
   Z= 255
   else
   Z= 0
7. *Output :* edge detected output image O(i,j)

Initially we take an input image I(i,j), then the image is converted into the form of a gray scale image for the purpose of detecting the edges because edges can be detected for gray scale images only, we cannot detect the edges for RGB images.

Next step is to apply average filtering on the image with the motive of reducing the amount of intensity variation and removing noise from the image. After taking the mean filter result of the image, we

take the difference of the original image and the filtered image.

The next phase is the application of thresholding. It is applied to the image with an objective of appropriate and successful edge detection. The threshold value is user specified and if the pixel values are above the threshold the pixels are marked as edges otherwise they are rejected and marked black. The true edges are discovered in this step only.

Finally, we apply a masking operation to get the refined image with appropriate edges. The masking operation is applied to the complete image with an objective of removing the white or dot pixels. Each and every point of the image is scanned by the masking operation so that if more than one consecutive pixels are of white color they are retained as edge points and if there are dot pixels they are removed and turned black.

Experimental Results

The proposed algorithm is tested on various images to compare the experimental results. For the comparison of result we have generated three images for each particular picture. The first image showing the original input image, the second one image shows the results of edges being detected after the application of average filtering and thresholding. We have named the result as intermediate result. Finally to make the edges more accurate we have applied a masking operation to remove the dot pixels to get a refined result.

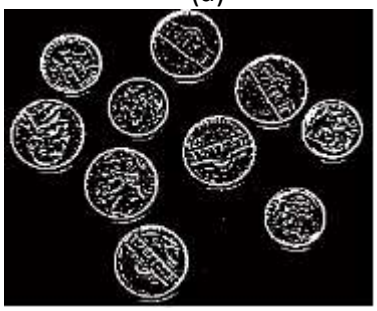
(a)

(b)

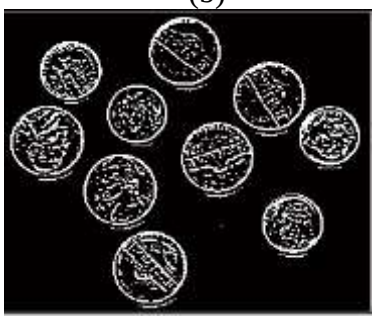
(c)

Figure 1: (a) Gray scale input image (b) Intermediate result (c) Final refined result

(a)



(b)

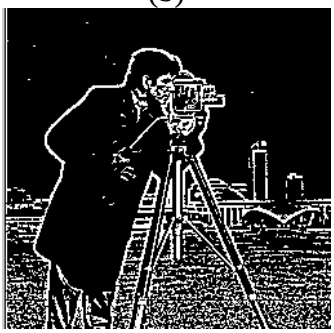


(c)

Figure 2: (a) Gray scale input image (b) Intermediate result (c) Final refined result

(a)

(b)



(c)

Figure 3: (a) Gray scale input image (b) Intermediate result (c) Final refined result

(a)

(b)

(c)

Figure 4 : (a) Gray scale input image (b) Intermediate result (c) Final refined result

Conclusion

As we know, edge detection process plays an important role in various applications so it has gained a lot of attention from the research scholars. There are a number of standard techniques used for edge detection as well as many other developed methods designed to meet a particular requirement. Here the algorithm being developed makes use of average filtering and thresholding for discovering the edges from a given input image. We have successfully developed an edge detection algorithm that works very well for the blurred images and gives even refined results with the application of masking operation. The results displayed shows a clear distinction between the resultant image after thresholding and the refined image received through masking operation that removes the dot pixels from surroundings.

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