Color Image Edge Detection using Gradient Operator

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Abstract

The digital image is stored in 2 dimensional matrix of size m rows and n columns (m x n.). Whenever the intensity values of this matrix is ranging from 0 to 255 for 8-bit image then it is called gray-scale image. And when the contents of the image will be stored in m x n x 3 matrix then it is called color image. Here three (3) is used to indicate the corresponding values of R, G and B. In this research paper the use of Gradient operator for color image edge detection will study. Here the gradient operator will apply on RGB images to compute the gradient of each components of color image to determine the magnitude and the direction of any intensity value

Keywords:- Gradient, Sobel, Roberts, Prewitt

1. INTRODUCTION

The edges of color image have characterized the boundaries and regions of the image. Edges in images are areas with strong intensity contrasts – a jump in intensity from one pixel to the next. Process of Edge detection significantly reduces the amount of data and filter out the unwanted information while preserving important structural properties in an image. [1]

In general the edge detection techniques are grouped into two categories: [2]

- Gradient
- Laplacian

The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image. Whereas the Laplacian method searches for zero crossing in the second derivative of the image to find edges The digital image is stored in 2 - D matrix of size m rows and n columns (m x n), when the intensity values of this matrix is ranging from 0 to 255 for 8 bit image then it is called gray-scale image. And the contents of the image will store in m x n x 3 matrix then it is called color image. Here 3 are used to indicate the corresponding values of R, G and B. Here the gradient operator will apply on RGB images to compute the gradient of each components of color image to determine the magnitude and the direction of any intensity value.

2. COLOR IMAGE SEGMENTATION

Segmentation subdivides an image into its constituent regions or objects. The level to which the subdivision is carried depends on the problem being solved. That is, segmentation should stop when the objects of interest in an application have been isolated. Image segmentation algorithms generally are based on one of two basic properties of intensity values:

1. Discontinuity
2. Similarity

In the first category, the approach is to partition an image based on abrupt intensity changes, such as edges in an image. In the second category, the approaches are based on partitioning an image into regions that are similar according to a set of predefined criteria

There are three basic discontinuities types in a digital image: [3]

- Points
- Lines
- Edges

3. GRADIENT

First-order derivatives of a digital image are based on various approximations of the 2-D gradient. The gradient of an image *f*(x, y) at location (x, y) is defined as a vector.

$$\nabla f = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix} \qquad 3.1$$

An important quantity in edge detection is the magnitude of this vector, denoted, where

$$\nabla f = mag(\nabla) = \left[G_x^2 \quad G_y^2 \right]^{1/2} \qquad 3.2$$

This quantity gives the maximum rate of increase of *f*(x, y) per unit distance in the direction of**.** It is a common practice to refer to also as the gradient. The direction of the gradient vector also is an important quantity. Let represent the direction angle of the vector at (x, y). Then from vector analysis,

$$\propto (x,y) = Tan^{-2} \left(\frac{G_x}{G_y} \right) \qquad 3.3$$

Computation of the gradient of an image is based on obtaining the partial derivatives and at every pixel location. Let the 3 x 3 area shown in Fig. 3.1 (a) represent the gray levels in a neighborhood of an image. [4,5] One of the simplest ways to implement a first-order partial derivative at point z5 is to use the following Roberts cross-gradient operators:

$$G_x = (z_9 - z_5) \quad 3.4$$

And

$$G_y = (z_8 - z_6) \quad 3.5$$

These derivatives can be implemented for an entire image by using the masks shown in Fig. 3.1 (b). Masks of size 2 x 2 are awkward to implement because they do not have a clear center. An approach using masks of size 3 x 3 is given by

$$G_x = (z_7 + z_8 + z_9) - (z_1 + z_2 + z_3) \quad 3.6$$

And

$$G_y = (z_3 + z_6 + z_9) - (z_1 + z_4 + z_7) \quad 3.7$$

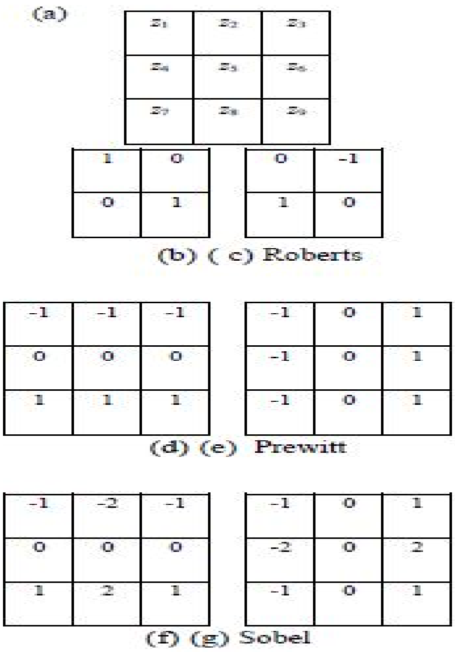


Fig. 3.1 A 3 x 3 region of an image (the z's are gray-level values) and various masks used to compute the gradient at point labeled z_5.

4. EDGE DETECTION USING GRADIENT

a. Sobel Edge Detector

The Sobel edge detector uses the masks shown in Fig. 4.1 to approximate digitally the first derivatives G_x and G_y and finds edges using the Sobel approximation to the derivatives.[6]

G_x

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

G_y

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

Fig. 4.1

4.2 Robert Edge Detector

The Roberts edge detector uses the masks in Fig. 4.2 to approximate digitally the first derivatives G_x and G_y.

G_x

−1	0
0	1

G_y

0	-1
1	0

Fig. 4.2

4.3 Prewitt Edge Detector

The Prewitt edge detector uses the masks in Fig. 4.3 to approximate digitally the first derivatives G_x and G_y.

G_x

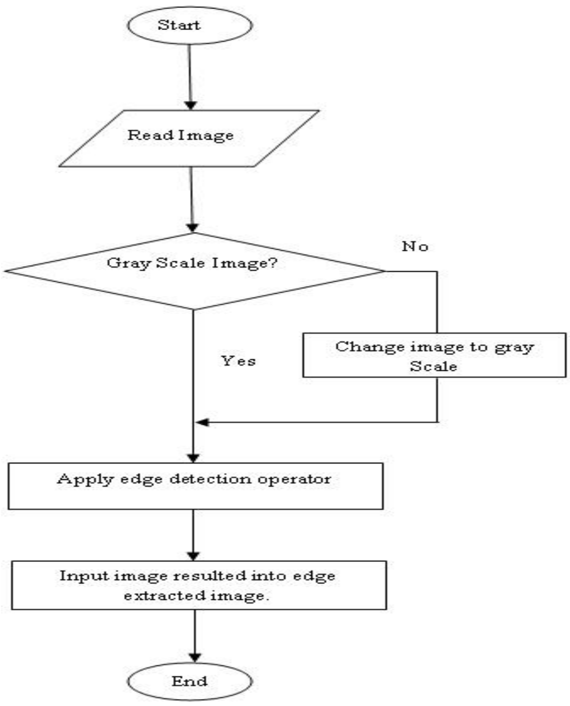
-1	-1	-1
0	0	0
1	1	1

G_y

-1	0	1
-1	0	1
-1	0	1

Fig. 4.3

5. FLOW CHART



6. EXPERIMENTAL ANALYSIS

In this research paper the effect of gradient operators like Sobel, Prewitt and Roberts have applied on around 50 different color images, out of them few selected images are given in the paper. Experimental images have got from different sources like database of DIP book website.

On each image all three operators has applied and their comparative study is performed [7]. As per specification given in point 4, related to Sobel, Prewitt and Roberts are found in output images which are shown in Fig's. It is found that according to the approximation to the derivative of Sobel, Prewitt and Roberts mask, it returns edges for the point where gradient is maximum.

(a) Original Image (b) Roberts (c) Prewitt (d) Sobel

7. CONCLUSION

The objective of the research paper was to study the use of gradient operators like Roberts, Prewitt and Sobel for color image edge detection. This objective is fulfill through the experiments perform on around 50 different color images [8, 9]. The comparative output of each operator is given through Fig. The weight values of mask are used to achieve some smoothing of edges of images by giving more stress on central point. The Prewitt and Sobel operators have given more prominent enhance edges. Among these two masks the Sobel mask has slightly superior noise suppression characteristics which are important with derivative features. Another fact found in result is that the Prewitt and Sobel mask gives isotropic results only for vertical and horizontal directional edges.

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