Edge Detection of Images: An Improved Approach

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Abstract— *There are several edge detection methodologies can be found in many image processing publications. But a single edge detection method is not enough to perform well in every possible image context. The purposed method describes a new framework which allows us to quantitatively combine the methods of different edge detection operators in order to provide improved results for edge detection of an image. Here, the Sobel edge detector is combined with Rothwell edge detector in order to detect the edge of an image and compared with individual edge detectors.*

Keywords— Edge Detection, Image Processing, Sobel Edge Detector, Rothwell Edge Detector

I. INTRODUCTION

Edges occur at points where there is a significant variation in the intensity values on an image. Changes in some physical and surface properties, such as illumination, geometry and reflectance can also signal an object boundary in the scene. An edge is a local property of an individual pixel and is calculated from the image function in a neighborhood of the pixel. A basic approach to edge detection is the enhancement and thresholding .If a discontinuity exceeds a threshold value, an edge is considered to be present. A great diversity of edge detectors have been devised with differences in their mathematical and algorithmic properties.

An edge detector which is able to recover reliable topological properties has been designed by Rothwell [3].It applies a dynamic threshold which varies across the image.There is certainly a great deal of variety in the applications of edge only images in higher-level visual processing, such as recognition, scene segmentation and image compression. While the human eye can easily perform the task of edge detection, it remains to be a complex task for a computer algorithm to achieve the equivalent edge detection functions due to problems caused by noise, quantization and blurring effects.

Edge enhancement operators can be gradient operators such as Sobel , Robert and Laplacian operators detect edges. Edge detection is the most common approach for detecting discontinuities that could highlight the boundaries of an object captured in a digital image. The ubiquitous interest in edge detection stems from the fact that not only it is in the forefront of image processing for object detection, but it is a fundamental operation in computer vision too.

1. SOBEL EDGE DETECTION METHOD

The Sobel operator [38] performs a 2-D spatial gradient measurement on an image and so emphasizes regions of high spatial frequency that correspond to edges. Typically it is used to find the approximate absolute gradient magnitude at each point in an input grayscale image. In theory at least, the operator consists of a pair of 3×3 convolution kernels as shown in Figure 1. One kernel is simply the other rotated by 90°. This is very similar to the Roberts Cross operator.

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

Gx

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

Gy

Fig. 1. Sobel Operator Matrix

These kernels are designed to respond maximally to edges running vertically and horizontally relative to the pixel grid, one kernel for each of the two perpendicular orientations. The kernels can be applied separately to the input image, to produce separate measurements of the gradient component in each orientation (call these *Gx* and *Gy*). These can then be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is given by:

$$\mathbf{G} = \sqrt{G_x^{\,2} + G_y^{\,2}}$$

Typically, an approximate magnitude is computed using:

$$\mathbf{G} = |\mathbf{G}_x| + |\mathbf{G}_y|$$

2. ROTHWELL EDGE DETECTION METHOD

The uniqueness of this algorithm originates in the use of a dynamic threshold which varies across the image. The purpose of this thesholding is to remove the spurious edges included in the set of potential edges generated in the previous step of the algorithm. Quadratic interpolation is applied on the image points not included in Σ_0, in order to include a part of them into the set of potential edge points . After this stage, the candidate edges have been identified and their geometrically accurate location has been estimated using sub-pixel interpolation .The image pixels will be classified as true edges according to a threshold function T(i, j), computed using morphology based distance transforms and, in particular, chamfer masks .

Rothwell [1] designed an operator capable of recovering sound topological descriptions.Gaussian smoothing is applied prior to the computation of directional derivatives. The topological description of the image will be built on a base set Σ_0, composed of pixels that exceed a pre-set threshold value t_{low} and have survived the non-maximal suppression suggested by Canny.

Two pairs of masks (A1,A2), (B1,B2) are applied to estimate the distance of a pixel to the nearest edge point. Each mask's pass over the image originates from one of its four corners. This procedure yields two array types, namely, d_i and n_i, for $i = 1. . . 4$, indicating the distance of each pixel to the nearest edge point and the strength of that edge point, respectively. We consider the above procedure for the first mask as follows:

Mask A_1 :
for i = 2 : (row − 1)
for j = 2 : (columns − 1)
$d_1(i, j) = \min (d_1(i-1, j-1) + 4, d_1(i-1, j) + 3,$
$d_1(i-1, j+1) + 4, d_1(i, j-1) + 3, d_1(i, j))$
$n_1(i, j)$ = strength of the minimum found above

The true edge identification is achieved by comparing the original image I(i, j) with the threshold function T(i, j). An edge is deemed present if it satisfies the condition:

$$I(i, j) > \alpha T(i, j)$$

where the parameter α ($0 < \alpha < 1$) serves to improve the detection, especially at points close to junctions where the edge strength weakens.

The points included in the set Σ_0 provide a reliable indication of the threshold strength at these image pixels. On the other hand, for the points outside Σ_0, the local value t of the threshold surface T(i, j) is estimated by applying linear interpolation. The edge map yielded up to this stage contains edges, two to three pixels thick. Consequently, the digital curve topology is not represented properly. The thinning process employed in the Rothwell algorithm follows the Tsao-Fu thinning method. According to that method, elements which bring a zero change in genus can be cleared.

II. EXPERIMENTAL RESULTS AND DISCUSSION

In this section, Fig. 2 represents the original image. After applying the Sobel edge detector the result image is represented in Fig. 3. Similarly, after applying Rothwell edge detector the result image is represented in Fig. 4. After applying the Sobel edge detector on the original image, the Rothwell edge detector is applied on that intermediate image and the result image is represented in Fig. 5.

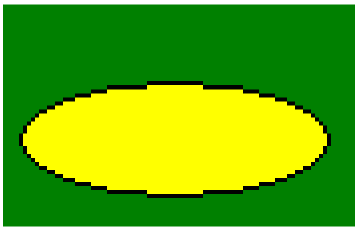

Fig. 2. Original Image

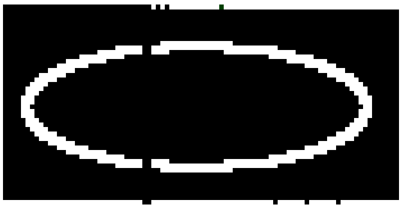

Fig. 3. Resultant Image using Sobel edge detection method

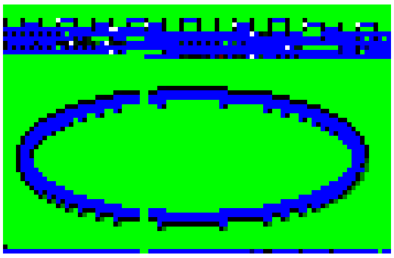

Fig. 4. Resultant Image using Rothwell edge detection method

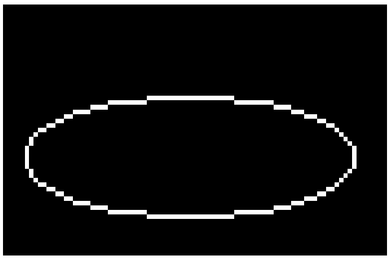

Fig. 5. Result Image using Sobel and Rothwell edge detection method

III.CONCLUSION

In this paper, an improved approach Sobel with Rothwell edge detection method is implemented to produce the edge of an image and compared with Sobel edge detector, Rothwell edge detector individually. From experimental results and discussion, it is concluded that the proposed technique provides better result for edge detection of an image.

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