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A Survey on Content Based Image Retrieval Based On Edge Detection

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Abstract—Content-based image retrieval (CBIR) work includes image representation, selection, and matching. An image contains different Information of picture, such as object's color, texture, shape, size, but intolerance of the objects from their background is the first analysis task that should be performed. The contour of an object can be extracted, by detect the object's edges formation, and this provides the constitutional importance of edge detection in computer vision and image processing and analysis. Edge detection process has its uses in wide range of applications such as recognition of images, compression, image enhancement, morphing, restoration, registration, retrieval, hiding, and etc. The papers purpose is to provide comparison on existing methods such as Sobel operator technique, Prewitt technique, Canny edge detector, Marr Hildrith Edge Detector, Laplacian technique and Edge Maximization Technique (EMT), Roberts Cross Edge Detector, And highlight the best method to retrieve similar query image from a large database.

Keywords: Content based image retrieval (CBIR); Edge detection; Sobel operator technique; Roberts Cross Edge Detector; Prewitt technique; Laplacian technique Maximization Technique (EMT).

I.

II. INTRODUCTION

Automatic information retrieval from huge databases is increased due to the recent advances in computer technology and revolution in the way information is processed. In particular, content-based retrieval has received considerable attention and consequently improving the technology for content-based querying systems becomes more challenging. [1]There are four important feature components for content-based image retrieval: color, texture, shape, and spatial relationship. Along With these features additionally shape contains the most attractive visual information for human perception. An important step before shape extraction is edge point detection. Many edge detection methods have been proposed [2-4][5]. Z. Hou [2] uses a one-way design detector to determine existence of an edge point. J. Weickert [4] uses a partial differential and morphology method to formulate an optimization problem. M. Kass [6] has proposed an active contour model to surround the contour points. They overcome the problem of multiple objects. Most of these research results show that they are robust but inefficient, because of the long processing time. Another important issue next to edge detection is shape representation. A good shape representation method should be invariant to translation, rotation and scaling. F. Mahmoudi [1] uses an edge orientation autocorrelogram to represent an object to tolerate imperfect edge point detection. T. Bernier [7] records contour points of an object with their distances and angles relative to the center point of the object to form a shape representation, which is invariant to rotation, translation and scaling, but yields a poor result when edge detection is incomplete. H. Nishida [8] proposed a representation that tolerates deformation of contour points. J. Zhang [9] uses a shape spaces method to deal with both the noise and occlusion problems. Methods in [8] and [9] both provide effective representations in practice, but the former is generally very expensive in terms of computational time, and the feature adopted by the latter is very sensitive to noise.

The remainder of this paper is organized as follows. Section II details the Edge detection III details the technique of Edge detection. Section IV details the Advantages and disadvantages of edge detectors And conclusion is given in section V.

II. EDGE DETECTION

EDGE DETECTION is a terminology that refers to finding edges in an image. It is meet in the areas of feature selection and feature extraction in Computer Technology. An edge detector accepts an image and produces an edge map. The edge map includes explicit information about the position and strength of the edges and their orientation. In point of technical view, the edge detection methods can be grouped into two categories: search-based and zero-crossing based. The search-based methods spot the edges by a measure of edge strength, such as magnitude of an image intensity function, and then searching for local maxima in a direction that matches with the edge profile, such as the gradient direction. The first-order derivative is regularly used to express the gradient. The zero-crossing based methods search for zero crossings in a second-order derivative expression computed from the image in order to find edges, such as the Laplacian expression. [10] In point of theoretical view, the edge detection methods are categorized into contextual and non-contextual approaches. The non-contextual methods work autonomously without any prior knowledge about the picture and the edges. They are stretchy in the logic that they are not limited to specific images. However, they are based on local processing focused on the area of neighbouring pixels. The contextual methods are guided by a priori knowledge about the edges or the scene. They perform exactly only in a exact context. It is clear that independent detectors are appropriate for general-purpose applications. However, contextual detectors are modified to applications that always include images with same scenes or objects. Structurally, the edge detection methods incorporate three operations: smoothing, differentiation and labeling. Differentiation consists in evaluating the desired derivatives of the image. Smoothing lies in reducing noise. Labeling involves localizing edges and increasing the signal-to-noise ratio of the detected edges by suppressing bogus edges. Differentiation and Smoothing of an image are realized only by filtering the image with the differentiation of the smoothing filter. In this regards, the terms filter and detector are often used synonymously [11].

III. EDGE DETECTION METHODOLOGY

Edge detection makes use of differential operators to detect changes in the gradients of the greylevels. It is divided into two main categories:

A. First Order Edge Detection Or Gradient Based Edge Operator:

First-order derivatives detect the edges possibly and enhance the brightness. Gradient operators are used to estimate image gradients from the input image and to smoothen the image. [12] There are various ways to compute first order edge detectors they are One dimensional forward differences, Roberts cross gradient operators, One dimensional central differences, Prewitt operators, Sobel operators etc,.. First-order derivatives in image processing are implemented using the magnitude of the gradient

$$\nabla f = grad(f) = \begin{bmatrix} g_x \\ g_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix}$$

The magnitude (length) of vector is

$$M(x,y) = mag(\nabla f) = \sqrt{g_x^2 + g_y^2} \approx |g_x| + |g_y|$$

B. Classical operators:

Classical operators includes Prewitt, Robert, Sobel, are easy to operate but highly sensitive to noise.

C. Sobel operator:

The Sobel operator is based on convolving the image with a discrete, diminutive, and numeral valued filter in horizontal and vertical direction and is therefore relatively inexpensive in terms of calculation. It is relatively simple, for the images with high frequencies. [12]The operator uses two 3×3 kernels which are convolved with the original image to calculate approximations of the derivatives –such as horizontal changes, and vertical. If we define **A** as the source image, and $\mathbf{G}_x$ and $\mathbf{G}_y$ are two images which contain the horizontal and vertical derivatives, the calculations are given below:

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

Gx

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

Gy

A disadvantage of the Sobel edge detector is that the response to a step edge is present over pixels width, reliant on the particular position of the pixel grid. This need the use of post-processing in the form of edge ``thinning" and ``thresholding" in order to reduce the computational complexity of further processing.

D. Robert Operator

The Roberts Cross operator performs a trouble-free, quick to process, 2-D spatial gradient measurement on an image [12]. It thus highlights regions of high spatial frequency which often correspond to edges. In its most frequent usage, grayscale image is the input to this operator. Magnitude of the spatial gradient for the input image is represented by pixel values at each point in the output .In speculation, the operator consists of a pair of 2×2 convolution kernels .One kernel is simply the other rotated by 90°.This is very similar to the sobel.

+1	0
0	-1

Gx

0	+1
-1	0

Gy

Compute the Gradient magnitude using approximations of partial derivatives. optimizes the trade-off between noise filtering and edge localization

At each point convolve with

$$G_x = \begin{bmatrix} -1 & 1 \\ -1 & 1 \end{bmatrix} \qquad G_y = \begin{bmatrix} 1 & 1 \\ -1 & -1 \end{bmatrix}$$

E. Prewitt operator

Prewitt operator is similar to the Sobel operator and is used for detecting vertical and horizontal edges in images. the operator calculates the *gradient* of image at each point, giving the direction of the largest promising increase from light to dark and then rate of change in that direction.[12][13]The result therefore shows how "abruptly" or "smoothly" the image changes at that point and therefore how likely it is that part of the image represents an *edge*, as well their oriented.

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

0°

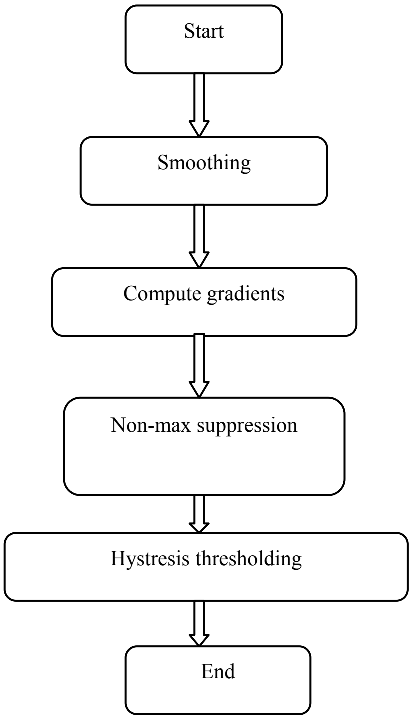
+1	+1	+1
-1	-2	+1
-1	-1	+1

45°

Stages of the canny algorithm

Canny edge detection is carried out by following steps:

- To clear any speckles and to free the image from noise gaussian blur is applied.
- Gradients' intensity and direction is obtained.
- Non-maximum repression determines if the pixel is a better candidate for an edge than its neighbours.



Flow chart of canny edge detection algorithm

F. *Canny Edge Detector*

The **Canny edge detector** is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images. It was developed by John F. Canny in 1986.[12-15] It is an optimal edge detection technique as provide detection of edge perfectly, response is clear and good localization of the image. It is widely used in image processing techniques with further improvements.

- Hystheresis thresholding finds where edges begins and ends

G. Second Order Edge Detector

The Laplacian filter is second order derivative edge detector, and it is stout to the selection of threshold. The edge detection is sensitive to noise so denoising is necessary before the Laplacian filter.[12] The combination of Gaussian filter and Laplacian filter is called Laplacian of Gaussian (LOG), and simplification of LOG, is specific Difference of Gaussian (DOG).

Properties of the Laplacian

- It is an isotropic operator.
- It is cheaper to implement (one mask only).
- Edge information is not provided clearly.
- It is more sensitive to noise (differentiates twice).

IV. Advantages And Disadvantages Of Edgedetectors

As edge detection is a fundamental step in processing, it is essential to identify the precise edges and to get the finest results from the similar process. So as to is important to choose edge detectors that fit to the application. In this respect, some advantages and disadvantages of algorithms [12, 1-4] are analyzed and their context of our classification as follows:

A. Classical (Sobel, Prewitt, Roberts):

Advantages:

- Simple.
- Detection of orientations and edges are quite easy.

Disdvantages:

- Sensitive to noise.
- Inaccurate.

B. Laplacian of Gaussian (LoG):

Adantages:

- Finding the correct places of edges.
- Testing wider area around the pixel.

Disadvantages:

- Not working well in corners, curves and where the gray level intensity function varies.
- Orientation of edge is not detected because of using the Laplacian filter.

C. Gaussian operators (Canny):

Advantages:

- Probability for finding error rate is high.
- Localization and response.
- Improving signal to noise ratio.
- Detection of edges is perfect, especially in noise conditions.

Disadvantages:

- Complex Computations.
- False zero crossing.
- Time consuming.

V. Conclusion

In this paper we have studied and evaluate different techniques in edge detection. From that canny edge detector gives enhanced result as compared to others detectors. It is less responsive to noise, adaptive in nature, resolved the problem of lines, provides localization in better way and detects sharp edges when compared to others. It is consider to be a best edge detection technique hence lot of work and improvement on this algorithm has been done and further improvements are possible in future as an improved canny algorithm can detect edges in color image without converting in gray image, improved canny algorithm for automatic extraction of moving object in the image guidance. It finds practical application in Runway Detection and Tracking for Unmanned Aerial Vehicle, in brain MRI image, cable insulation layer measurement, Real-time facial expression recognition, edge detection of river regime, Automatic Multiple Faces Tracking and Detection. Canny edge detection technique is used in license plate reorganization system which is an important part of intelligent traffic system (ITS), finds practical application in traffic management, public safety and military department. It also finds application in medical field as in ultrasound, x –rays etc.

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