An Approach for Color Edge Detection with Automatic Threshold Detection

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Abstract. Edge is an important feature for image segmentation and object detection. Edge detection reduces the amount of data needed to process by removing unnecessary features. Edge detection in color images is more challenging than edge detection in gray-level images. This paper proposes a method for edge detection of color images with automatic threshold detection. The proposed algorithm extracts the edge information of color images in RGB color space with fixed threshold value. The algorithm works on three channels individually and the output is fused to produce one edge map. The algorithm uses the Kuwahara filter to smoothen the image, sobel operator is used for detecting the edge. A new automatic threshold detection method based on histogram data is used for estimating the threshold value. The method is applied for large number of images and the result shows that the algorithm produces effective results when compared to some of the existing edge detection methods.

Keywords: Kuwahara filter, Sobel operator, histogram, edge thinning, threshold.

1 Introduction

An edge is the variation in the intensity and further it is an essential feature of the image processing. Efficient and accurate edge detection will directly work on the understanding of machine vision system [1]. In typical images, edges characterize object boundaries and are therefore useful for segmentation, registration and identification of objects in a scene. The research has shown that 90% of the edges are about the same in gray-value and colour images. Consequently, there are still 10% of edges have been left and may not be detected in intensity images due to change in colour. Xin et al. [1] proposed a method for edge detection of colour images which uses an improved Kuwahara filter to smoothen the images and uses adaptive threshold method. Lianaiang et al. [2] proposed a method for colour edge detection based on direction information measure used in HSV colour space. The algorithm concentrates on directional property of the edges and filter scale's effect on edge detection but it needs to convert the widely used RGB colour space to HSV colour space. Jin et al. [3] proposed the fuzzy edge detection method based on the

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morphology. Salish et al. [4] proposed a colour edge detection method using principle component analysis, but it doesn't deal with any threshold detection mechanism. Li Xue-wei et al. [5] proposed a perceptual colour edge detection algorithm, based on eye blurring technique by using 2-D Gaussian filter and it considers a constant threshold value for all kind of the images. Eswaran et al. [6] proposed a fuzzy multiscalar colour edge detection method it uses pixel enhancement before applying a constant threshold value. Jian et al. [7] proposed edge detection method using quaternion convolution masks, by neglecting the threshold detection part. Soumya et al. [8] proposed a method for detecting the edges of colour images in RGB colour space which uses average maximum colour difference for predicting the optimum threshold value.

In this paper, a synthetic method to detect the edges of the images in RGB colour space is defined using Kuwahara filter to smoothen the image and uses Sobel operator to detect the edge. A new automatic threshold detection mechanism based on histogram data is used. New set of edge thinning masks are introduced which works in four different directions used to get thin edges from thick edges.

2 Proposed Method

The proposed method involves four steps. First involves smoothening the image using improved Kuwahara filter. Sobel operator is used for edge detection. A new automatic fixed threshold detection method from histogram data is used. Edge thinning masks are applied to get the thin edges from the edges obtained by thresholding.

2.1 Image Smoothening Using Kuwahara Filter

The Kuwahara filter is a noise reduction filter that preserves edges. It works by calculating the mean and variance for four sub quadrants and chooses the mean of the region with smallest variance. Traditional Kuwahara filter uses a square shaped window, however window size varies. Computational complexity of the algorithm for each channel is high which involves 16 additions, 16 subtractions, 2 divisions and 9 multiplications at least and in order to reduce computational complexities the shape of the traditional Kuwahara filter is reduced into triangular regions[1] which is as shown in the Fig.1.In each of the triangular regions (R1, R2, R3, R4) the mean (μ) and variance (σ) is calculated according to (1) and (2) respectively.

$$\mu = 1/n \sum(x, y)\, p(x,y)\,. \tag{1}$$

$$\sigma^2 = \sqrt{\quad 1/n - 1 \sum (x, y)[p(x, y) - \mu]2\,.} \tag{2}$$