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A new algorithm of image segmentation using curve fitting based higher order polynomial smoothing

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ABSTRACT

Image segmentation plays an efficient role in image analysis which discriminates the objects from its background in pixel level. In accordance with the application, image segmentation is widely spread over various fields. The motivation of this paper is to focus on the application of statistical analysis in image segmentation. In this paper, we have incorporated curve fitting technique on an image to acquire the segmented image thereby extracting information from the images. By using higher order polynomial smoothing curve, appropriate result is obtained from detection of the object. Furthermore, we have calculated the image quality metrics which is a method of statistical analysis to get the quality measures and performance analysis of images. Extensive experiments show that the proposed approach outperforms the existing approaches namely histogram based segmentation, edge detection based segmentation, Ostu's segmentation and Watershed segmentation. The outcome is derived by applying the proposed algorithm and results obtained are appreciable.

1. Introduction

Image Segmentation is the process of partitioning a digital image into multiple regions or sets of pixel [1–3] and is basically used to locate objects and their boundaries. The concept behind segmentation is to simplify the representation of an image into something that is more meaningful and easier to analyse. The segmentation algorithms can be divided into two broad categories based on the two important properties, namely, (1) Discontinuity and (2) Similarity. These two important properties are derived by gray level. Over the years segmentation is applied for various computer vision applications namely feature extraction, identification, image registration etc.

In this paper, we have introduced image segmentation technique using smoothing polynomial curve fitting technique considering the higher order polynomial distribution. By using the curve fitting process, we can construct an exact fitting curve where the data point can be constructed using mathematical function which also known as smooth function. In the context of data fitting, these curves are used for visualization of data. Here the data is nothing but considering the pixels. There are different orders of polynomial equation. Considering the higher order polynomial equation applied on an image provides more appropriate and promising results. Smoothing technique is much more prominent for denoising the outcome segmented images. Furthermore, several image quality assessment indices are applied for the performance analysis of the outcome derived by applying the proposed algorithm. There are two different approaches for image quality measurement

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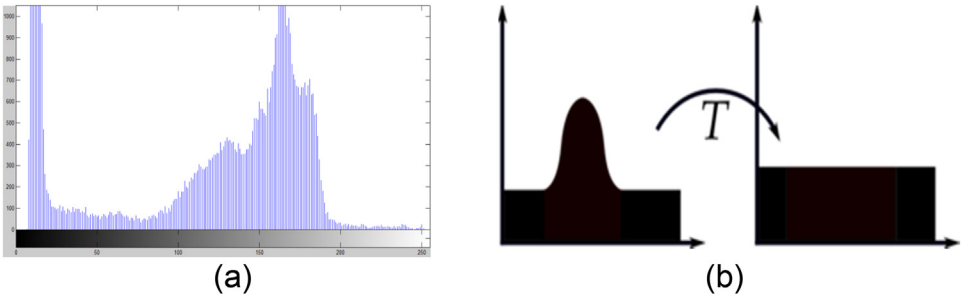

Fig. 1. (a) Image histogram (b) histogram equalization.

or metrics analysis. They are (1) Subjective approaches and (2) Objective approaches. When a human expert provides their decision about the quality of an image it is known as subjective measurements and when the measurement can be done using mathematical calculations it is known as objective measurements. Calculating the parameters using objective approaches on outcome segmented images by the proposed segmentation method, furnishes appreciable results when compared to other existing segmentation methods.

The rest of the paper is organized as follows. Section 2 presents the description related to work. In Section 3, the proposed method is presented. Experimentation and Results are explained in Section 4 while, Section 5 concludes the work.

2. Preliminaries

2.1. Image histogram and histogram equalization

An "image histogram" is a type of histogram that acts as a graphical representation of the tonal distribution in a digital image. It plots the number of pixels for each tonal value. By looking at the histogram for a specific image, a viewer will be able to judge the entire tonal distribution at a glance, as shown in Fig. 1. HE (Histogram Equalization) is a method of contrast adjustment which uses the image's histogram in image processing [4,15].

2.2. Polynomial curve fitting

The first degree polynomial equation is represented as:

$$n = mc + a \tag{1}$$

In Eq. (1), slope is m. With distinct 'c' coordinates, the 1st degree polynomial equation provides an exact fit over any two different points. If we increase the order of the above equation, the 2nd degree polynomial equation can be represented as:

$$n = mc^2 + ac + b \tag{2}$$

In Eq. (2), m,a and b are three different points to fit a curve. If we increase the order of the above equation, the 3rd degree polynomial equation can be denoted as:

$$n = mc^3 + ac^2 + bc + d \tag{3}$$

In the above equation, m, a, b and d are the four different points which exact fit. When we fit a curve, the important constraints to be taken care are point, angle and curvature. For the end condition, curvature and angle are considered as two important constraints. Other condition is known as identical end condition. For this condition an identical condition is taken for the smoothness of the curve. Three different degree equations are used for different conditions wherein Eq. (1) is to be fit for an angle and single point. In the same way Eq. (3) which represents 3rd order equation, derives the fit for angle, curvature and two different points.

2.3. Smoothing

Image smoothing is the most important step in digital image processing. Smoothing technique provides the different data set which helps to evaluate the quality of an image [5,6]. Histogram is one of the processes among many, which is used in smoothing an image.

Smoothing technique can be explained by relating it with a curve fitting technique using the following different methods: