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Color image segmentation based on three levels of texture statistical evaluation

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Abstract

In this paper a new and efficient supervised method for color image segmentation is presented. This method improves a part of the automatic extraction problem. The basic technique consists in fusing information streaming from three different sources for the same image. The first source uses information coming from only one pixel, using the Mahalanobis distance. The second uses the multidimensional distribution of the three bands in a window centered in each pixel, using the Bhattacharyya distance. And the third employs cooccurrence matrices over the texture cube built around one pixel, using the Bhattacharyya distance again. The Dempster–Shafer theory of evidence is applied in order to fuse the information from the three sources which represent different orders of statistics. This method reveals the importance of applying context and textural properties for the segmentation process. The results show the potential of the method for real images starting from the three RGB bands only.

Keywords: Color and texture segmentation; Theory of evidence; Automatic objects extraction

1. Introduction

Images segmentation represents a first step in many tasks that pattern recognition or computer vision has to deal with. There are many papers about

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segmentation of images using color, see [20] for an early survey and [6] for a more recent one. Several authors are applying different techniques for color in order to improve the final result of the segmentation, for example, Park et al. [16] presents a new algorithm based in mathematical morphology which performs a clustering in 3D color space; Zugaj and Lattuati [26] proposes the fusion of several characteristics such as region and edges; fuzzy techniques are applied in [15] and [24] and Markov random fields (MRF) are used for clustering in [11]. Of the all possibilities for studying segmentation of color images, we are going to focus in this paper on color texture, since it fits the profile for dealing with context information so important in the psychological characteristics of objects image recognition. Several authors have also studied color textures; among them Song et al. [21] who have obtained the fractal dimension of color texture with the correlation among the color bands for feature extraction. Likewise, Conci and Proenca [7] have also used color and fractal dimension for color texture segmentation. Krishnamoorthi and Bhattacharyya [12] have put forward an orthogonal polynomial basic color texture model for the unsupervised segmentation of images with interesting results. The algorithms for image segmentation using color have been used in wide range of applications such as: clothing [5]; automated surveillance [17]; images retrieval from a large database [2] and [25]; classification of weed species [3,4]. In the latter case 93% accuracy is achieved by using only saturation and hue.

In this paper color texture means using the interweaving of color information in the three bands with different order statistics and color coordinate systems. In order to obtain the greatest amount of information from the different order statistics we have relied on the theory of evidence [19]. This theory has been used as a fusion technique.

This paper is divided in several sections. Thus, Section 2 deals with different order statistics. Section 3 dwells on the relationship between the RGB and HSI systems. The theory of evidence will be introduced in Section 4 to fuse the information coming from the three sources of information in the same image. Finally, in Section 5, results with real images and evaluation of the method will be presented and culminate with some conclusions.

2. The sources

In this work only color images have been considered, on which only a process of filtering has been previously applied. This process consists on application of a median filter for smoothing the noise.

Mathematically, each image can be thought of as a set of points in a three dimensional euclidean space, where each pixel $\mathbf{x}$ is represented as a vector. Consequently, in this representation the vector's three coordinates could be its RGB or HSI corresponding values.