

A Salient Object-Based Image Retrieval Using Shape and Color Features

Shuxian Huang, Wenbing Chen

Nanjing University of Information Science and Technology, Nanjing 210044, China

(Received January 17 2018, accepted July 05 2018)

Abstract. In this paper, a salient object-based image retrieval method (SOBIR) is presented, which linearly combines the shape and colour features of the salient objects contained in target and candidate images respectively to carry out content-based image retrieval (CBIR). The framework of the proposed method is carried out as follows: first, the mean shift and region growing algorithms are used to segment an input image into many regions; secondly, based on these regional contrasts the saliency map, the binary image, and the salient object image are extracted respectively; thirdly, the shape representation of the salient object is extracted from the binary image using an improved polar Fourier Descriptor method, meanwhile the salient object contained in the input image is converted into a representation of its histogram in the $L^*a^*b^*$ colour space; Finally, the similarity between the two salient objects contained in the target and candidate images is defined by linearly combining both the shape and colour representations. Experimental results show that, compared to the latest two CBIR methods, the proposed SOBIR method exhibits an excellent performance in precision, recall, flexibility and efficiency.

Keywords: Image retrieval; salient object; region; shape; object detection; similarity measure.

1 Introduction

Colour is intuitive, stable, simple and popular feature to represent, analyze and recognize an image. Since Swain and Ballard [1] proposed the histogram intersection method used for image retrieval, a variety of histogram-based image retrieval methods have been continuously proposed [2, 3, 4, 5, 6, 7]. However, Figure 1 shows that a white cup and a white dish can not be correctly identified using single colour feature. Therefore, with using the histogram-based method, it seems to be difficult to correctly distinguish the two salient objects like visual perception. To solve the issue, we present a SOBIR method combining colour and shape features, intuitively which should be more exact and efficient than simply using colour feature. As Figure 2 shows the framework of the proposed method.

A simple iterative procedure referred to as the mean shift (MS) method [11, 12], which shifts each data point to the average of data points in its neighborhood, is generalized and used to smooth and cluster or segment an image. Subsequently the MS method has been widely used to smooth and segment an image [13, 14, 15, 16, 17] since it is simple, highly efficient and has no parameters. In more recent years, image segmentation methods are still being developed rapidly. Gong et.al.[18] proposes a fuzzy c-means clustering and kernel metric-based image segmentation method, which uses an improved fuzzy C-means algorithm with a tradeoff weighted fuzzy factor and kernel metric to segment an image. Although this method exhibits a better performance, one main drawback is that an input image has to be segmented into $c(c \geq 2)$ classes beforehand.



Figure 1: Two salient objects contained in the two images seem to be difficult to be identified by simply using the histogram-based CBIR. (a) and (c) are two original images; (b) and (d) are the two salient objects extracted from the corresponding original image respectively.

For salient object detection and extraction, in recent years a few popular methods have been proposed, such as methods based on low-level features of luminance and colour [8] and based on frequency-tuned salient region [9]. The regional contrast-based saliency extraction method [10], simultaneously evaluates global contrast differences and spatial coherence and yields full resolution saliency maps. However, within this prominent method, there exist two shortages: the first is a slow speed due to computing global contrast between regions; the second is its effectiveness, which is suppressed for saliency detection and extraction since the contribution of colour similarity between involved two regions to saliency has not been highlighted. Therefore, We investigate deeply the method proposed in [9] and use MS and region growing (MSRG) to partition an image into many regions rapidly instead of Graph-cut.

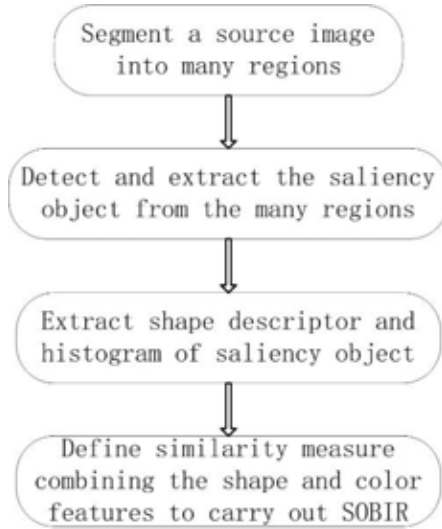


Figure 2: A salient object-based image retrieval framework.

Various shape descriptors exist in many literatures[21, 22], these descriptors are broadly categorized into two groups: contour-based and region-based shape descriptors. Zhang and Lu [21] proposed a region-based Fourier shape descriptor, referred to as GFD, and confirmed its advantage over other relevant shape descriptors. However, since there exists a high computational complexity with GFD, in this paper an improved GFD, referred to as PFD, is presented and used as shape descriptor.

Overall, in this paper, we show a new perspective, which carries out CBIR with using two salient objects contained in the target and candidate images respectively. The scheme is organized as follows:

- As Figure 3 shows, the MSRG is used to detect and extract the salient object and yield one binary image as Figure 3(c), and one salient object image as Figure 3(d).
- Against the binary image as Figure 3(c), we use PFD to extract the shape descriptor of the salient object; against the salient object image as Figure 3(d) we use the $10 \times 3 \times 3$ quantization histogram of $L^*a^*b^*$ colour space as its colour descriptor.



Figure 3: An example using MSRG to detect and extract. (a) The original image; (b) the segmented image; (c) the binary image; (d) the salient object image.

We define a similarity measure based on the linear combination of shape and colour features between the target and candidate salient objects.

- The candidate images are ranked in ascending order by their similarity measures.

The rest of the paper is organized as follows. In Section 2, image segmentation and salient object extraction are described. In Section 3, extraction and representation of the salient object are discussed. A similarity measure between two salient objects is defined in Section 4. In Section 5, evaluation and experiment comparisons are conducted.

2. Image segmentation and salient object extraction

The general process of the MS filtering and segmenting is shown in [11]. The MS filtering algorithm is used to quantize the colour space so that the smoothed image is formed by some homogeneous colour regions. Afterward, based on the smoothed image, we use the region growing algorithm to over-segment the smoothed image into such regions that $I_s = \bigcup_i R_i$, and, $R_i \cap R_j = \emptyset$ while $i \neq j$.

2.1. Mean shift filtering