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Saliency detection by exploiting multi-features of color contrast and color distribution[☆]

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ABSTRACT

Automatic salient object detection from a cluttered image using the object prior information related to the image enhances the accuracy of object detection which is very useful for many computer vision applications. In this work, we introduce a new bottom-up approach for salient object detection by incorporating the multi-features of color contrast with background connectivity weight and color distribution. Firstly, we extract coarse saliency map by using a color contrast with background connectivity weight and the color distribution. Secondly, we improve the coarse saliency map result through a multi-features global optimization energy function. This energy function is used to fuse several low-level measures, to evenly highlight the salient object and suppress the background efficiently. Extensive experiments on the benchmark datasets have been performed to demonstrate that the proposed model outperforms against the existed state-of-the-art methods with the higher values of precision and recall.

1. Introduction

The human cortical cells are very sensitive to contrast and hastily capture salient object in a messy image through only selecting the important visual information. This type of capability is also engaged in computer visualization system to deal with the data handling problems. Many saliency detection techniques have been designed to check the attention mechanism of human visual system. Salient object detection is extensively utilized in several computer vision applications such as: image segmentation, object detection, image re-targeting, salient region detection, adaptive image display, and advertising design.

The saliency detection schemes designed to deal with the human visual information are generally separated into two classes: the bottom-up saliency detection techniques and the top-down saliency detection techniques. The bottom-up saliency detection techniques are data-driven and non-task-driven. These designed techniques only simulate and pay more attention to the salient areas in the images. While the other class of saliency detection is top-down, which is task driven and designed to work according to the human visual information system with supervised learning.

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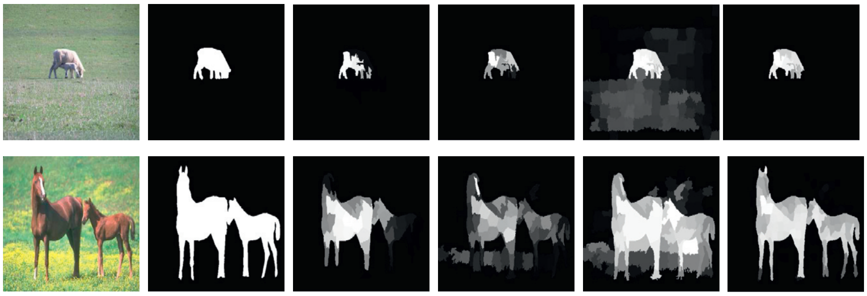

Fig. 1. The comparison results of previously proposed contrast based methods on CSSD dataset [4]. The images are arranged in the order from left to right: (a) original image, (b) ground truth, (c) MR [5], (d) SF [3], (e) GS [6], and (f) the proposed model saliency map without refinement.

The majority of contrast-based techniques use more color information for their saliency computation. Zhai et al., [1] utilize the entire image color histograms for the region based saliency computation. In [2], a fast frequency-domain algorithm is proposed that utilizes the low-level characteristics of colors and luminance to compute their saliency maps. Saliency Filters (SF) [3] firstly, computes two color contrast measures like uniqueness and spatial distribution. Then by utilizing these two contrast measures a precise saliency map is derived. A common problem in the above-discussed methods is that they cannot distinguish between the similar features of the foreground and the background regions. So, they cannot properly highlight the salient part of the image. Some of them are equipped to tackle with the smooth background, however, sometime it is invalid to deal with the smooth background.

Consequently, in the work presented in this paper, we estimate a new multi-features color contrast with background connectivity weight and a color distribution prior which are more accurate to extract salient objects. We employ the background connectivity with outer boundary information followed by a spatially weighted contrast to find out the color contrast prior with background connectivity weight. In contrast with most presented center based schemes, we utilize the object-biased prior to enhance the foci of attention. We improve the coarse saliency map results through a global optimization energy function. This energy function is used to fuse several low-level measures, to evenly highlight the salient object and to suppress the background efficiently. Our saliency detection algorithm works in two steps. In the first step, we utilize the color contrast with background measure and color distribution to calculate the initial salient region maps. Then, we use the object-biased prior to highlight the initial contrast map and to achieve the enhance saliency map. Lastly, we engaged the energy function to refine the previous saliency maps by assigning the high values to the flat salient object regions. The framework of the proposed model is elaborated in Fig. 2.

The rest of this paper is structured as follows. We discuss the current literature about the saliency detection in the Section 2. In Section 3, particulars of the presented algorithm are illustrated to show how the improvements are achieved from pixel to region level saliency. In Section 4, the experimental results and comparisons are discussed to validate the proposed scheme. Finally, the conclusion is drawn in Section 5.

2. Related work and background

In addition to the contrast prior, more than a few recent methods utilize a boundary prior [6–8] to improve their saliency maps. However, these methods are not accurate for measuring saliency, when the objects are located near the image boundaries. To estimate the fine saliency results a global optimization formulation is discussed in [8]. The authors utilize an energy cost function directly to prominent the achieved saliency results. They assign the higher values to the background constraints and the lower values to the foreground constraints to get the smooth and uniform saliency results. However, some background pixels are attached to the foreground and the size of the salient object does not remain significant.

To better suppress the background and to effectively highlight the saliency map an energy smoothness function is defined in [9]. They define a global optimization function through that they refine the initial saliency map results. According to that function, the greater the value of the initial saliency maps of a pixel, the greater the probability that it belongs to the foreground. However, they over smoothed the salient objects and the extracted saliency maps edges are not clearly observable. All of the above-mentioned issues like object attenuation and over smoothing are clearly described in Fig. 1.

A Regional Contrast (RC) method is defined in [10], to calculate the pixel-wise full resolution saliency map which is simply based on the color separation. The authors select the histogram-based method to get the fast and efficient results. After that, they employ a smoothing procedure to overcome the problem of quantization artifacts. Initially, in RC's maps, the spatial relation is integrated to get the region based contrast. Then the saliency value is computed by using the global contrast score and the spatial distance of a region from another region. However, this proposed technique is only for the natural images those are sub-optimal for computing salient regions of highly textured images.