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Optimizing multi-graph learning based salient object detection

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Abstract

In this paper, we propose a novel bottom-up saliency detection algorithm to effectively detect salient objects. Different from most existing methods that are not robust to complex scenes, we utilize multi-graph learning to take various scenes into consideration. First, multiple features are used to represent superpixels, and then measured by multiple distance metrics to construct multiple graphs. The motivation is to take advantage of their complementary information to cope with different environments. Second, fixation and boundary cues are respectively used as foreground and background seeds. The fixation is effective for crowded backgrounds because of the observation that regions within eye fixations are very likely the image foreground. Third, we integrate the multiple graphs and seeds into a regularized and optimized multi-graph based learning framework to effectively generate foreground-based and background-based saliency maps. Finally, we integrate these two saliency maps to obtain a more smooth and accurate saliency map. Extensive experiments are conducted on five benchmark datasets. Experimental results show that the proposed bottom-up saliency detection method yields comparable or better results against the state-of-the-art methods, and is robust to both cluttered and clean scenes.

Keywords: Salient object detection, Multi-graph learning, Superpixel, Fixation and boundary cues.

1. Introduction

The goal of salient object detection is to detect the most salient regions and then segment entire salient objects out. It has recently attracted more attention in computer vision community as it can be used as an important preprocessing step before further processing. Consequently, the applications of salient object detection have flourished in numerous areas, including recognition [1], [2], image retrieval [3], image retargeting [4], GPS location estimation [5], and human-robot interaction [6], [7]. In general, saliency detection methods can be divided into two categories, i.e., bottom-up and top-down. Bottom-up methods are data-driven, while top-down methods are goal-driven. Compared with top-down models, bottom-up models have attracted more interest from researchers due to their simple mechanisms. In this paper, we focus on the bottom-up salient object detection tasks.

In the past decades, a lot of bottom-up saliency detection approaches have been proposed for detecting salient objects in images. Itti et al. [8] proposed one of the earliest models. Their model combined bottom-up visual features of color, intensity, and orientation based on center-surround mechanisms to construct a saliency map. Liu et al. [9] integrated a set of novel features with a conditional random field learning to generate a binary saliency result. Achanta et al. [10] performed saliency estimation by using the color contrast of each pixel in the entire image. These bottom-up methods use pixel as the basic units, which are time-consuming and easily affected by small-scale noise in an image. A reasonable solution is to exploit the superpixel-based scheme that abstracts the image by clustering pixels with similar properties into perceptually homogeneous regions. Yang et al. [11] used boundary superpixels as seeds to detect salient regions in images through graph-based manifold learning. Wang et al. [12] selected background and foreground seeds successively from compact superpixels, and then integrated background and foreground saliency maps to generate the final saliency map. It is known to be useful for eliminating background noise and reducing computation by treating each superpixel as a processing unit.

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