Chapter 15
Ant–Inspired Visual Saliency Detection in Image

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ABSTRACT
Visual saliency detection aims to produce saliency map of images via simulating the behavior of the human visual system (HVS). An ant-inspired approach is proposed in this chapter. The proposed approach is inspired by the ant’s behavior to find the most saliency regions in image, by depositing the pheromone information (through ant’s movements) on the image to measure its saliency. Furthermore, the ant’s movements are steered by the local phase coherence of the image. Experimental results are presented to demonstrate the superior performance of the proposed approach.

INTRODUCTION
Visual saliency detection has been of great research interest in recent years, since it is potential for a wide range of applications, such as object detection, content-based image retrieval and perceptual image compression. Human perceptual attention usually tends to firstly pick attended regions, which correspond to prominent objects in an image, rather than the whole image (Jams, 1890; Itti, 2000). Visual saliency detection aims to simulate the behavior of the human visual system (HVS) by automatically producing saliency maps of the image. Much research has been done on modeling visual attention; they can be classified into the following two categories: bottom-up and top-down. The first approach is an image-driven approach to select visual information based on saliency in the image itself, while the second one is a goal-driven approach based on both a user-defined task and the image itself.

This chapter is focused on the first kind of approach. In general, it uses certain means of determining local contrast of image regions with their surroundings using one or more of the features of color, intensity, and orientation. Usually, separate feature maps are created for each of the features used and then combined to obtain the final saliency.
map. Itti (1998) introduced a biologically-inspired saliency model. They proposed to use a set of feature maps from three complementary channels as intensity, color, and orientation. The normalized feature maps from each channel were then sent into a Winner-Take-All competition to select the most conspicuous image locations as attended points (i.e., the overall saliency map). Ma (2003) proposed a local contrast-based saliency model, which is obtained from summing up differences of image pixels with their respective surrounding pixels in a small neighborhood. A fuzzy-growing method then segments salient regions from the saliency map. Hu (2004) proposed to produce saliency maps by thresholding the color, intensity, and orientation maps using histogram entropy thresholding analysis instead of a scale space approach. They then use a spatial compactness measure, computed as the area of the convex hull encompassing the salient region, and saliency density, which is a function of the magnitudes of saliency values in the saliency feature maps, to weigh the individual saliency maps before combining them. Wu (2009) proposed to determine the saliency map using low-level features, including luminance, color and region information, then thresholding these feature maps using a just noticeable difference (JND) model and integrating them to a final saliency map.

The major challenges in visual saliency detection are (i) image features extracted and (ii) mechanisms of saliency measure. To tackle the above challenge, a new bottom-up approach, called an ant-inspired visual saliency detection approach, is proposed in this chapter. The proposed visual saliency detection approach exploits the ant colony optimization (ACO) (Dorigo, 2004; Dorigo, 2006) technique to establish a pheromone information matrix that represents the saliency information presented at each pixel position of the image. The proposed approach is inspired by the natural collective foraging behavior of ant species, which guides ants on short paths to their food sources, since ants can deposit pheromone on the ground in order to mark some favorable path that should be followed by other members of the colony. The pheromone information matrix is estimated via the movements of a number of ants which are dispatched to move on the image. Furthermore, the ant’s movement is steered by the local feature coherence (Morrone, 1988; Kovesi, 1999) of the image, which is able to provide a perceptual image representation that is fairly consistent to the human visual system.

This chapter is organized as follows. Section 2 provides a brief introduction to ant colony optimization. Section 3 presents the proposed approach, followed by the experimental results presented in Section 4. Furthermore, Section 5 provides some insightful comments to point out several promising research directions for future research. Finally, Section 6 concludes this chapter.

ANT COLONY OPTIMIZATION

Ant colony optimization (ACO) is a nature-inspired optimization algorithm (Dorigo, 2004; Dorigo, 2006) motivated by the natural collective behavior of real-world ant colonies. The major collective behavior is the foraging behavior that guides ants on short paths to their food sources. More specifically, it is achieved by a deposited and accumulated chemical substance called pheromone by the passing ant which moves towards the food. In its searching the ant uses its own knowledge of where the smell of the food comes from (called heuristic information) and the other ants’ decision of the path toward the food (called pheromone information). After it decides its own path, it confirms the path by depositing its own pheromone making the pheromone trail denser and more probable to be chosen by other ants. This is a learning mechanism ants possess besides their own recognition of the path. Despite that ACO has been widely applied to tackle numerous optimization problems, its application in image processing is quite a few (Tian 2008).
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