OpenDS: An Open Source Implementation of Discriminant Saliency on Center-surround Hypothesis

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***Abstract*—Most existing saliency detection models tend to target the high contrast in colors, intensity and orientation channels. However, it doesn't accurately represent the visual focus of human. The saliency map most likely turns out to be a highlighted contour map of the image itself, rather than the actual focus point or region that people look at. In order to quantitatively predict human eye fixation on natural scenes, a research paper proposes saliency detection based on discriminant hypothesis. The discriminant saliency hypothesis is developed on top of the classical assumption that bottom-up saliency is a center-surround process. The methodology consists of two stages of detection, involving discriminant saliency detection, and leveraging natural image statistics to finally distinguish the target pop-out.**

***Index Terms*—saliency, bottom-up, itti-koch, discriminant hypothesis, center-surround map**

I. Introduction

In computer vision, saliency is defined as standout part(s) of the image with distinct properties that draw eye fixation, which is the attention of the viewers. There are primary 2 saliency cues: *bottom-up* - fast, stimulus-driven mechanism, and *top-down* - slower, goal-driven mechanism [1]. Bottom-up saliency is more common in development as people tend to do it naturally without following certain tasks. Bottom-up is also highly desired because it allows us to understand what typically catches our attention, what visual features falls into the retina and so on...

The original research paper is called *"On the plausibility of the **discriminant center-surround hypothesis** for visual saliency"* by Dashan Gao. **Discriminant analysis** concerns with classifying set of observed data into predefined classes, giving minimum probability of expected error. The analysis requires a discriminant function. The **center-surround** hypothesis suggests bottom-up saliency as a center-surround process that derives optimal saliency architecture. In this architecture, saliency is detected from discriminating between the centre area of interest (*the center*) and the neighbourhood surrounding it (*the surround*) [2]. Optimal saliency detectors can serve psychophysics predictions of human saliency such as eye fixation prediction on natural scenes, background subtraction on high dynamic scenes and motion-based saliency in the presence of ego-motion [3].

This is an Engineering project which aims to reproduce the discriminant saliency model in Python 3 code with the help of open-source libraries such as OpenCV and Numpy.

A project proposal based on "On the plausibility of the discriminant center-surround hypothesis for visual saliency" by Dashan Gao; Vijay Mahadevan and Nuno Vasconcelos in 2008.

II. Methodology and Implementation

The general architecture of image processing mainly follows the Itti-Koch-Niebur (IKN) model [6].

For static imagery, the process consists of 2 main stages. First stage is feature decomposition, using wavelet or Gabor decomposition to process into intensity map, and 4 color channels. The second stage is saliency detection which involves the center-surround classification (with provided formula for calculation) [7]. It also combines with Gabor or wavelet coefficients to reduce complexity of high dimensional image. One concern was to make sure OpenCV is able to handle the RGBY color channels and taken in account for visual angle (pixels/degrees).

III. Results and Validation

The project final step would be to apply the implemented model to a set of input images, which is preferably close to the research's original test set. Previously, the researchers relied on classical experiments in visual attention which were both qualitative and quantitative. For simple target pop-out test, some example images were provided directly in the research paper. And to generate progressive/dependency graph between saliency versus image feature, more static and motion data will be needed.

Due to the lack of test data sources, the project will simulate input images with similar features in such a way that if the model is computed correctly, the outcome should mimic the same behavior as the research results. Essentially it's possible to use previous psychophysics results as a benchmark to evaluate the model. For more reliable online test set on saliency detection, some test input will be retrieved at the Toronto Dataset.

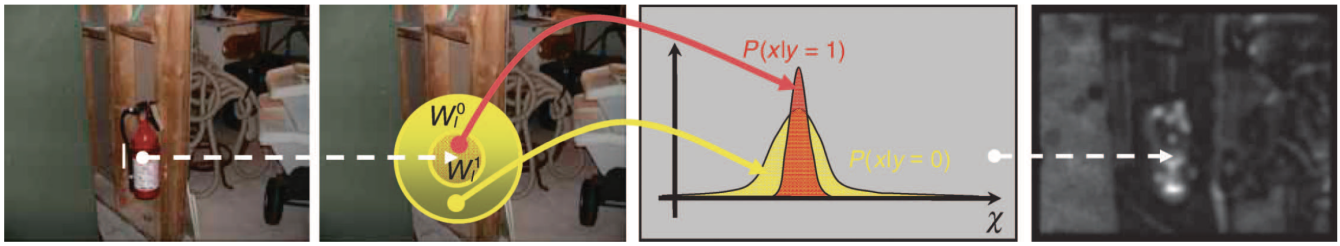

Fig. 1. Illustration of discriminant center-surround saliency

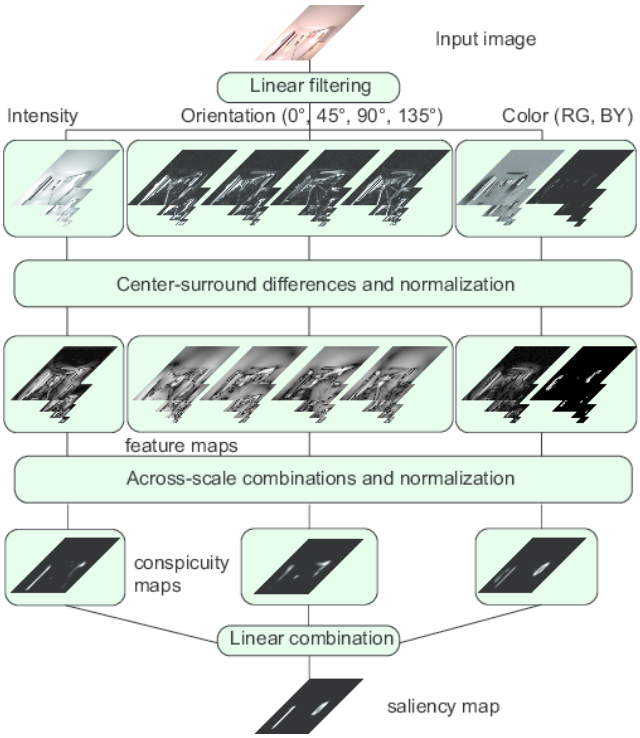

Fig. 2. Itti-Koch model with center surround map computation

Neil Bruce, John K. Tsotsos. Attention based on information maximization.120 color images of outdoor and indoor scenes (size: 681 x 511px). Observers: 20 undergrads, grads. A large portion of images here do not contain particular regions of interest. Eye tracker: ERICA workstation including a Hitachi CCD camera with an IR emitting LED.

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