

Effects of Interior Bezels of Tiled Large High-Resolution Displays on Saliency Prediction and Human Eye Movement Behavior

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Abstract

We present the results of two studies to quantify the effects of bezels LHRDs on human eye movements and on saliency algorithm predictions. Subjects observe natural images on two different display systems, with and without interior bezels. Our results indicate that: (i) the effect of interior bezels on the subjects' gaze decreases after a short period of time. While eye movement patterns of images presented on LHRDs vary, eye movement patterns of images presented on a single-screen display without interior bezels focus on the most salient locations in the images. (ii) The interior bezels of tiled displays affect the results of saliency prediction algorithms.

Categories and Subject Descriptors (according to ACM CCS): Information Interfaces and Presentation [H5.2]: User-centered design—

1. Introduction

Large high-resolution displays (LHRD) are widely used in various application domains, such as automotive design, geospatial imaging, scientific visualization, telepresence, and astronomy [NSS*06]. With a larger capacity for visual information, these display environments provide users with a significantly larger display surface area compared with desk-top displays.

However, it has been recognized that tiled-display systems bring a new set of interaction challenges, from fundamental selection, manipulation to task management [NSS*06]. Several studies investigated the effects of interior bezels on tiled displays [BhBB10], but the effects of interior bezels on human eye movements during free viewing, and on saliency algorithms predictions, have not been studied yet.

Here we present the results of two studies to quantify the effects of interior bezels in LHRDs on human eye movements and on image saliency algorithms.

2. Influence of Interior Bezels on Human Eye Movements

We conducted a user study in order to explore the effects of interior bezels on human eye movements when performing a free viewing task with: (i) A tiled LHRD comprising 24 LCD panels with a resolution of 1900×1200 pixels each, with a combined resolution of approximately 55 megapixels. The width of a pair of interior bezels from two neighboring panels is 4.8 cm. (ii) a DLP TV with a 67 inch screen diagonal and Full HD resolution of 1920×1080 pixels.

2.1. Eye Tracking Experiment

We selected 20 images from the Microsoft Salient Object Dataset and from the York University Eye Fixation Dataset. Each image was presented to eight subjects. We split the subjects into two groups. The stimuli presented to the second group was similar to what presented to the first group but with different presentations order. Each subject performed two experiments, with the presentation order of the experiments counter-balanced across the participants. Throughout the experiments, the subjects' right eye position was recorded using an iView X HED 4 Eye Tracking System (SMI).

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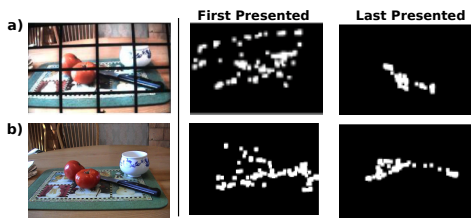


Figure 1: The distribution of eye movements of individual subjects, on images presented in different presentation orders on a) the tiled LHRD and on b) the single DLP display.

2.2. Results

We performed the two-sample t-test between the distribution of eye movements on the LHRD and the single DLP display, across all images and subjects, using a significance level of 0.05. We observed no significant difference between eye movements and displays types. We also carried out a qualitative analysis (see Figure 1). We found that the distribution of eye movements of users on the LHRD doesn't differ from that on the single display. Also we can see that the distribution of eye movements for images presented on the LHRD in varying presentation order is different (see Figure 1(a)). While the eye movement patterns of images presented to the subjects at the beginning of the experiment are distributed across the whole scene, the eye movement patterns of images presented after a while are focused on the most salient locations in the image.

3. Influence of Interior Bezels on Visual Saliency Models Predictions

The objective of this analysis is to investigate how interior bezels affect saliency algorithms performances. We compared how well the classic Itti and Koch [IKN98], GBVS [HKP07] and Torralba [Tor03] saliency models perform when we have the bezels of tiled displays in the image compared to when they are not there.

3.1. Comparing Visual Saliency Models Predictions

Using each model, we generated a saliency map for each image in our test images. In Figure 2 we can see that the bezels of the LHRD affect the predictions of saliency algorithms, and this influence differs according to the contrast properties of the images. A two-sample t-test revealed a significant difference between the three model predictions ($p < 0.05$). Also we can see that the performance of visual saliency models is better for the images on the single-panel DLP display compared with the LHRD (see in Figure 3).

4. Conclusions

Our experiments have shown that there is no significant difference between the distribution of eye movements on the

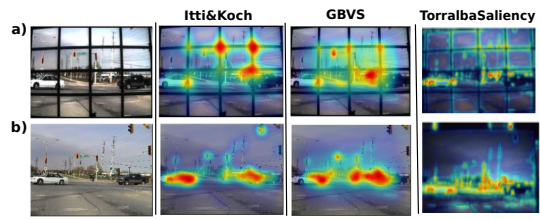


Figure 2: Sample saliency heat maps predicted by Itti and Koch, GBVS and Torralba saliency models, superimposed on images from a) the tiled LHRD and b) the single DLP display.

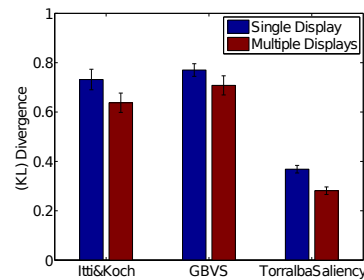


Figure 3: The performance of the three saliency models on the single DLP display and on the multiple LHRD.

LHRD and on a single-panel display. After a brief exposure time, viewers adapt to the interior bezels, so the effect of interior bezels vanish over time. The distribution of eye movements for images presented with varying presentation order are differing significantly. The presence of interior bezels also affects the performance of saliency prediction algorithms.

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