An Eye Tracking Interface for Image Search

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1 Introduction

Eye tracking presents an adaptive approach that can capture the user's current needs and tailor the retrieval accordingly. Applying eye tracking to image retrieval requires that new strategies be devised that can use visual and algorithmic data to obtain natural and rapid retrieval of images. Recent work showed that the eye is faster than the mouse as a source of visual input in a target image identification task [Oyekoya and Stentiford 2005]. We explore the viability of using the eye to drive an image retrieval interface. In a visual search task, users are asked to find a target image in a database and the number of steps to the target image are counted. It is reasonable to believe that users will look at the objects in which they are interested during a search [Oyekoya and Stentiford 2004] and this provides the machine with the necessary information to retrieve a succession of plausible candidate images for the user.

2 Method

Thirteen unpaid participants were presented with images in a 4 by 4 grid with target image presented in the top left corner of the display (Figure 1). Two image types (4 easy-to-find and 4 hard-to-find target images) were picked for the experiment by using a random selection strategy to explore the image database. The user is asked to search for the target image and on the basis of the gaze behaviour the machine selects the most favourable image.

Figure 1: Standard start screens for all participants

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The display change is determined by eye selection of an image, using the sum of all fixations of 80ms and above on an image position, up to a fixation threshold. Two fixation thresholds of 400ms and 800ms were employed as a factor in the experiment.

The next set of 15 images are then retrieved from the database and displayed for the next selection using a similarity model [Stentiford 2003]. 1000 images were selected from the Corel image library and a set of pre-computed network of similarity scores between image regions was generated using the model.

Participants understood that there will be a continuous change of display until they found the target but did not know what determines the display change. The display included either one or no randomly retrieved images. Participants performed 8 runs, using all image types. The maximum number of steps to target was limited to 26 runs. The random selection strategy was then explored.

3 Results

The participants using the eye tracking interface found the target in fewer steps than the automated random selection strategy ($p<0.037$) and the analysis of simple effect attributed the significant difference to the hard-to-find images. This meant that the probability of finding the hard-to-find images was significantly increased due to human cognitive abilities as opposed to the indiscriminate selection by random selection. Some did not reach the hard target after 26 successive displays, hence future work will concentrate on improving the chances of getting to the target using information extracted from the scan path.

4 Conclusions

Our experiments have shown that an eye tracking interface together with pre-computed similarity measures yield a significantly better performance than random selection using the same similarity information. A significant effect on performance was also observed with hard-to-find images. This was not seen with easy-to-find images where with the current database size a random search might be expected to perform well.

References

OYEKOYA O. K., STENTIFORD F. W. M. 2004. Exploring Human Eye Behaviour Using a Model of Visual Attention. *International Conference on Pattern Recognition*, UK.

OYEKOYA O. K., STENTIFORD F. W. M. 2005. A Performance Comparison of Eye Tracking and Mouse Interfaces in a Target Image Identification Task. *European Workshop on the Integration of Knowledge, Semantics & Digital Media Technology,* London, 30th Nov - 1st Dec, 2005.

STENTIFORD F. W. M. 2003. An attention based similarity measure with application to content based information retrieval, in *Storage and Retrieval for Media Databases 2003*, M. M. Yeung, R. W. Lienhart, C-S Li, Editors, Proc SPIE Vol. 5021, 20-24 Jan, Santa Clara.