Using Eye-Tracking for the Evaluation of Interactive Information Retrieval

Thomas Beckers and Dennis Korbar

Universität Duisburg-Essen
Department of Computer Science and Applied Cognitive Science
Information Engineering
Duisburg, Germany
{tbeckers,korbar}@is.inf.uni-due.de

Abstract. In this paper we present the INEX 2010 Interactive Track experiments that have been performed with eye-tracking in addition to the other collected data (system logs and questionnaires). We present our tool *AOILog* for recording Areas of Interest (AOI) data for dynamic user interfaces. Finally, we show how these eye-tracking and AOI data could be used for further analysis of the user interaction with the search system.

1 Introduction

In this year's run of the Interactive Track (iTrack) we wanted to investigate how users interact with an integrated interactive search system. The working tasks do not only rely on the classical topic aspect but also on other aspects such as book reviews or structure information. In addition to the standard experiments (see [1] for more detailed explanations of the experiment design and the data collection) in the 2010 run of the iTrack, we additionally used an eye-tracking system to record the user's gaze data while interacting with the search system.

Our main research goals are to check the assumptions of interactive IR models and to find out how users interact with an integrated search system.

2 System Description

The search system (see Figure 1) was developed at the University of Duisburg-Essen. It is based on the digital library system *ezDL*[1]. Pharo et al. provide a more detailed explanation (see [1]).

The **search tool** offers a Google-like search field as well as advanced search fields for title, author, year, abstract and reviews (depends on the system version, see [1]). A combo box allows the user to search also in reviews with the Google-like search field. Below this query panel the user can select fields for the sorting of the results. Furthermore, the user can choose the display style of the result

[1] Live system: http://www.ezdl.de/
Developer site: http://www.is.inf.uni-due.de/projects/ezdl/

S. Geva et al. (Eds.): INEX 2010, LNCS 6932, pp. 236–240, 2011.

list. The lower half of the search tool contains the result list and the result page navigation buttons.

A double-click on a result item shows book details in the **detail tool**. Users can indicate the relevance of an examined book as either *relevant*, *partially relevant*, or *not relevant*, by clicking markers at the bottom of the tool. A second tab shows reviews of the selected book. Initially the title, author, rating, date and the utility rating of the review is shown. By clicking on a review, the actual review text is added to the review.

Users can mark any book as part of the answer to the search task by moving it to the **basket tool**. This can be performed either via drag-and-drop or by clicking the *add to basket* button next to the relevance buttons.

A history of performed search queries is provided by the **query history tool**. Finally, the **task tool** shows the current working task.

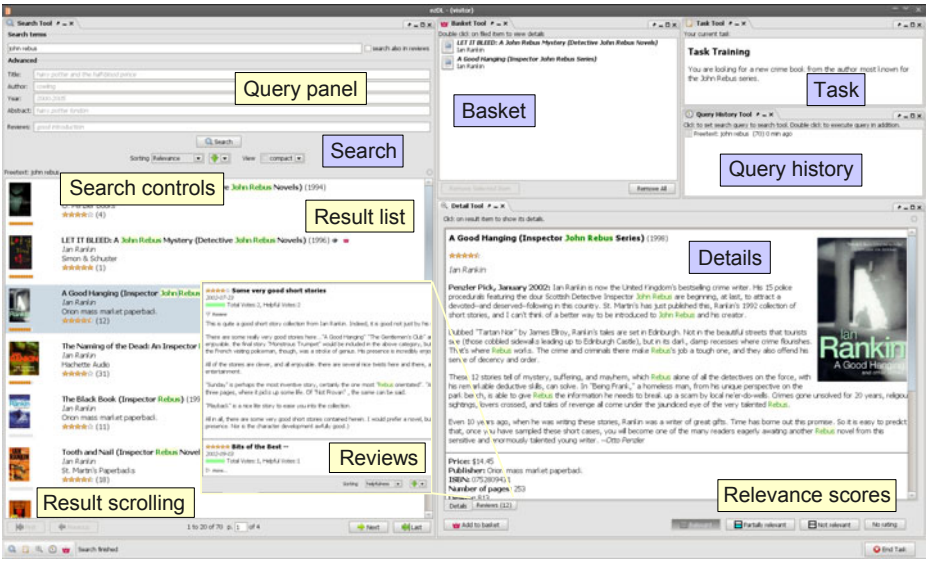

Fig. 1. The search system interface (blue boxes: tools mentioned in the description in section 2)

3 Eye-Tracking for Interactive Information Retrieval Systems

In addition to the questionnaires and system log data we also used an eye-tracking system[2] to record the user's eye gaze data.

The search system provides a multi-panel layout that presents a lot of information to the user. The user does not need to explicitly interact with the system

[2] SMI RED: `http://www.smivision.com/en/gaze-and-eye-tracking-systems/products/red-red250-red-500.html`

to get certain information. Thus, system logs and questionnaires are not sufficient since they can only capture explicit interaction of the user with the search system (e.g. clicking on a button or selecting a tab).

For analysing the eye-tracking data, the user interface of the system (see Figure 1) was divided into so called Areas of Interests (AOIs) (see Figure 2). AOIs define larger and logically connected gaze areas. These areas are used to capture not only fixations, but also more peripheral perceptions. Since some of the tools in the search system are on top of other tools and the position of user interface components changes dynamically, it is necessary to record the visibility information of tools to create dynamic AOIs automatically. The manual creation of AOIs would take too much time, thus it is generally not applicable in practice, especially when trying to analyze very dynamic components.

Biedert et al. capture gaze data for elements in HTML pages to provide gaze-aware text in web browsers [2]. For the *ezDL* desktop client a browser-based solution would not be applicable. We developed a framework called *AOILog* which automatically keeps track of position, visibility and size of registered Java Swing components, thus enabling us to consider even small and very dynamic areas of interest, such as result items in a scrollable list widget. Also included in the AOILog framework is a small converter application which will convert our AOI XML format into the proprietary SMI AOI format. This will enable us to use the recorded data in the statistical analysis software *BeGaze* which is part of SMI's software suite. In order to use our framework with eye tracking devices by other manufacturers, one only has to implement an appropriate converter, the logging functionality on Java Swing based applications can be used out of the box.

Figure 2 shows the AOIs of the search interface. We defined the following AOIs:

- tools (search, details, task, query history)
- query panel and query fields
- search controls and result scrolling
- result list
- parts of the details
- reviews and review sorting

With these dynamic AOIs it will be possible for future analyses to investigate the use of tools and book details as well as reviews in general by the users.

4 A Model for Interactive Information Retrieval

In 2010 we started a new project called HIIR (Highly Interactive Information Retrieval)[3] aiming to create an interactive information retrieval system based on efficient retrieval algorithms combined with a theoretic model for interactive IR, the IIR-PRP (Interactive Information Retrieval Probability Ranking Principle)[3]. The IIR-PRP tries to offer decision lists and information based on

[3] `http://www.is.inf.uni-due.de/projects/hiir/index.html.en`

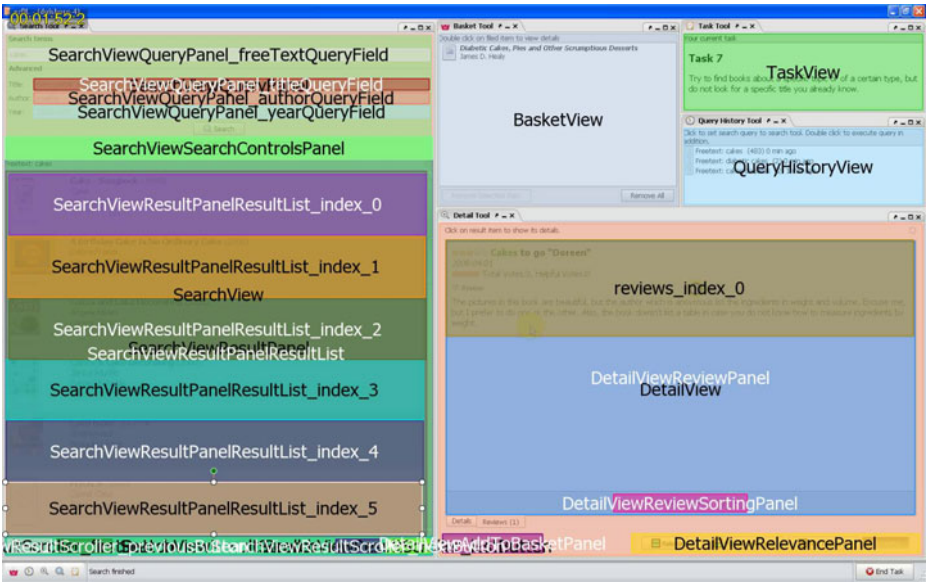

Fig. 2. Areas of Interest (screenshot from BeGaze analysis software)

a cost/benefit ratio. The basic idea is that users move from situation to situation. In every situation a list of choices is presented to the user, s/he then decides about each of these choices sequentially. Upon the first positive decision the user will move to a new situation.

In order to use the IIR-PRP as a model to implement interactive IR systems, its assumptions have to be confirmed. Furthermore we will have to measure some of its constants in order to be able to apply the model's ranking method. As we stated above, the IIR-PRP tries to sort available choices by use of a cost/benefit ratio. In order to apply the model to interactive IR systems we first have to measure the user's effort for evaluating certain types of choices. By use of traditional evaluation methods, we would not be able to measure the time a user spends on evaluating a certain choice as there are always multiple choices available. By logging the time between two choices we would not be able to determine how much of this time has been spend to evaluate each of the available choices. Using an eye-tracker in conjunction with the AOI logging framework described above will enable us to measure the time a user spends on evaluating the offered choices. We will be able to measure exactly how much time a user spends gazing upon a certain available choice.

Its implementation in the current INEX 2010 iTrack search system will provide us with a first indication about the validity of the IIR-PRP's assumption concerning user behaviour while scanning a list of choices. In addition we might be able to determine if there is a connection between a result item's textual length and the effort to evaluate that item. We will also try to analyze the effort to evaluate other objects provided by the search system (e.g. review items). This

might enable us to create a first measurement to calculate the expected effort for a given choice.

5 User Study @ iTrack 2010

For the 2010 run of the iTrack we recruited 24 participants for experiments with the additional eye-tracking support. The participation was compensated with an Amazon 12 EUR voucher. The experiments have been performed in our eye-tracking laboratory from November 2010 until December 2010. We plan to perform the analysis of the experiments later this year.

6 Conclusion and Outlook

We presented how eye-tracking data can be used for evaluation of interactive information retrieval systems.

We plan to analyze the collected data (questionnaires, system logs and eye-tracking data) to find out how users interact with interactive search systems. Our framework *AOILog* will be extended and included into *ezDL*. Furthermore it is planned to develop tools to make the analysis of the eye-tracking data and the linkage to the system logs easier.

References

1. Pharo, N., Beckers, T., Nordlie, R., Fuhr, N.: The INEX 2010 Interactive Track: An overview. In: Geva, S., et al. (eds.) INEX 2010. LNCS, vol. 6932, pp. 227–235. Springer, Heidelberg (2010)
2. Biedert, R., Buscher, G., Schwarz, S., Möller, M., Dengel, A., Lottermann, T.: The Text 2.0 framework - writing web-based gaze-controlled realtime applications quickly and easily. In: Proceedings of the International Workshop on Eye Gaze in Intelligent Human Machine Interaction, EGIHMI (2010)
3. Fuhr, N.: A probability ranking principle for interactive information retrieval. Information Retrieval 11(3), 251–265 (2008)