TwisterSearch: A distributed user interface for collaborative Web search

Roman Rädle, Hans-Christian Jetter, Harald Reiterer
Human-Computer Interaction Group, University of Konstanz
{roman.raedle,hans-christian.jetter,harald.reiterer}@uni-konstanz.de

ABSTRACT
Although Web search is typically regarded as a solitary activity, collaborative search approaches are becoming an increasingly relevant topic for HCI and distributed user interfaces (DUIs). Today's collaborative search systems lack comprehensive search support that also involves pre- or post-search activities such as preparation or sensemaking. We believe that post-WIMP DUIs can help to better support social search and have identified four design goals that are critical for their successful design. In consequence, we present TwisterSearch, an interactive DUI prototype that meets our four design goals.

Author Keywords
Post-WIMP, distributed user interfaces; surface computing.

INTRODUCTION
In the recent years, research in HCI has increasingly focused on collaborative search [1,7,8]. Collaborative search approaches can support activities and decision making such as travel planning, purchasing products or literature search and could become important tools for users' information practice in future. Consequentially, Morris identified a great need for better tool support for collaborative Web search [6].

We believe that distributed user interfaces (DUI) are particularly appropriate for supporting collaborative Web search, especially when assisting users in the three search phases *before search*, *during search*, and *after search* as they were identified by Evans and Chi in their canonical model of social search based on everyday searches [2].

While most present-day systems for collaborative Web search focus on the *during search* phase, they lack support for other phases that are more collaborative and are often distributed in nature and require a division of labor. For example, a survey conducted by Morris showed that 22.0% of the respondents cooperated by brainstorming or suggesting keywords to each other for generation and refinement purposes before search [6] – a process that is currently unsupported.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.
CHI'12, May 5–10, 2012, Austin, Texas, USA.
Copyright 2012 ACM 978-1-4503-1015-4/12/05...$10.00.

Furthermore, we believe that DUIs based on post-desktop computing systems such as tabletops and tablets are important for a natural collaboration and for supporting different working styles. For example, Jetter et al. provide collaborative faceted search and flexible working styles using a hybrid visual-tangible user interface on a tabletop that users perceived as fun to use and that was equally effective as traditional Web interfaces [5].

Figure 1. TwisterSearch: a post-WIMP DUI supporting collaborative Web search.

Our goal is to achieve a similar result for collaborative Web search based on a Microsoft Surface tabletop, Apple iPad tablets, and Anoto digital pen & paper. In the following, we first propose design goals for systems supporting collaborative Web search based on the canonical model of social search by Evans and Chi [2] and implications for design of Morris [6]. Then we present TwisterSearch[1] (see Figure 1), an interactive prototype that we designed and implemented to meet these design goals and describe its interaction design using a scenario. We conclude with a brief summary and our planned study design as future work.

DESIGN GOALS
We have formulated four design goals (DG1-4) based on the canonical model of social search by Evans and Chi [2] and design indications given by Morris [6]: 1. *Strategic Planning and Coordination*, 2. *Amplify Collaboration*, 3. *Intensify Discussion and Simplify User Input*, and 4. *Traceability*. We consider all of the four DGs as critical for the successful design of a post-WIMP DUI for collaborative

[1] TwisterSearch Video – http://youtu.be/lLLWV6Nx91s

Web search. Therefore, our prototype TwisterSearch was designed and implemented with regard to these DGs.

DG1: Strategic Planning and Coordination

Morris describes two search strategies that occur in cooperative search tasks: *divide-and-conquer* and *brute force* [6]. The first is a coordinated division of labor whereas the latter is uncoordinated and tends to evoke "Google races" or "competitions". These races possibly duplicate search results and thus increase search effort. Therefore, we argue to provide tool support for explicit coordination and planning of an ongoing search towards a structured-search. Users should be supported in pre-search activities (e.g. *context framing* and *requirement refinement*) and post-search activities (e.g. *organize and distribute search results*). Thereby, *context framing* defines and shares the boundaries of an intended future search task and establishes information needs and motives among the group members. *Requirement refinement* is a stepwise concretization of an information need by consulting other sources such as colleagues. Later structuring and distribution of search results takes place in 72.0% of the reported search experiences and is a pre-condition for embedding search into real world activities and decision making [2].

DG2: Amplify Collaboration

Evans and Chi categorized *during search* into three different behaviors: *navigational*, *transactional*, and *informational* search [2]. Based on their survey, the latter accounts for more than a half (59.3%) of the search intentions and includes various steps from information foraging to sensemaking. The *informational* search behavior, furthermore, features both solitary tasks (e.g. read and extract information) as well as information exchange with others. A Web search system, therefore, should best offer a smooth transition between loosely-coupled parallel work and tightly-coupled collaboration similar to Jetter et al. [5].

DG3: Intensify Discussion and Simplify User Input

Conventional WIMP interfaces with their single point-of-action are inappropriate for creating shareable user interfaces for co-located collaborative work. In these cases, simultaneous user input is indispensable. In contrast, Geyer et al. show the feasibility of a post-WIMP tabletop and tangible user interface combined with digital pen & paper for creative group work [3]. Furthermore, touch interfaces such as tabletops allow users to communicate more efficiently with the help of deictic references to create a joint reference and substantiate arguments. Although touch input is the dominant input on tabletops, a study conducted by Morris et al. also discovered issues when using virtual keyboards for search term input and propose the integration of physical keyboards instead [8]. We acknowledge these issues and thus suggest a digital pen & paper interface that provides a well-known interaction style for text input where users build on pre-existing knowledge of the everyday, non-digital world [4]. We further believe that collaborative Web search systems enable verbal and non-verbal face-to-face communication and more natural gesturing to intensify discussion and to yield superior outcomes. Besides these effects on communication, a simplified user input also allows users to focus on the primary search task instead of being busy with secondary tasks such as text input.

DG4: Traceability

Gathering results and additional information automatically *during search* allows users to trace the directions of search and the keywords used to find the results. Morris [6] writes that *"this information helps collaborators understand what techniques have already been tried and how to interpret the authoritativeness or appropriateness of the results"*. Thus, we consider traceability as an important aspect, especially if Web search is carried out in several sessions.

SYSTEM DESIGN

Based on the four design goals, we designed and implemented our prototype TwisterSearch. TwisterSearch is a distributed user interface running on a shared display and multiple private displays. The shared display is used to collaboratively collect search results in a visual workspace. This workspace is provided on a Microsoft Surface multi-touch tabletop that also recognizes physical objects (tokens). Private pad-sized displays (Apple iPads) are used around the table to individually search the Web and publish findings to the shared display. The following scenario provides an example for a typical usage situation.

Figure 2. Three TwisterSearch sets, each consisting of an Apple iPad, an Anoto pen, a token, and several paper snippets.

In the beginning of a history course, three students are requested to do research about the history of *Switzerland*. They are asked to collect facts about culture, topology, and politics and, further, they need to write an essay about their findings until the end of the term. They are allowed to do this as a group. The group meets at the library where a workroom is equipped with TwisterSearch. The three students sit around the tabletop and each user takes a TwisterSearch set consisting of an Apple iPad, a digital pen (Anoto), a small pile of paper snippets, and a *tablet token* (see Figure 2). This token is a tiny acrylic glass block with a colored frame. Each set and thus each user has a unique color (red, green, blue) that is also visible as the color of the iPad's cover, the ink of the pen and the frame of the tablet token. Before the group members start individual search activities, they first frame the topic (DG1). For this purpose, all users write relevant keywords they can think of on their paper snippets with the digital pen (see Figure 3) (DG3).

Figure 3. TwisterSearch supports natural hand writing for text input to collect keywords.

All ink strokes that are written on a paper snippet are automatically converted to a text string that is internally attached to the snippet and can be used as keyword by the system from then on. Collecting keywords is either done in parallel or in joint work recommending keywords or consulting other group members for relevant terms (DG2, DG3). This process leads to a framing of the search's context and results in a collaborative construction of a skeleton of keywords, which is filled with search results in the next step. Since all pens have different ink colors and each color is assigned to a single user, a great degree of traceability is given (DG4). The keywords are collected on the tabletop surface or the surface rim. It is possible that a user starts clustering keywords according to their semantic coherence while the others are collecting further keywords. However, clustering can also be done in joint work supported by discussion (DG3).

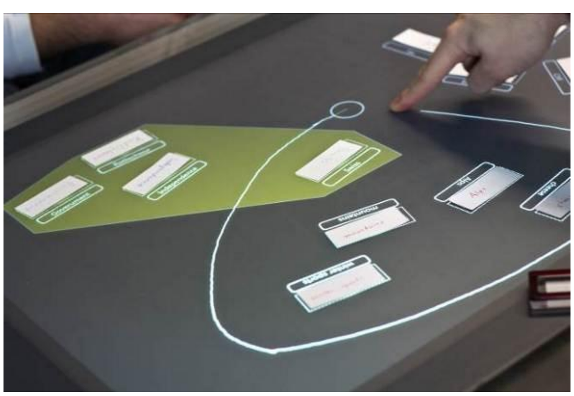

Figure 4. Touch input is used to cluster keywords.

Clusters are created and become visible by encircling one or more keywords with a finger. Furthermore, clusters can overlap to convey the search topic (e.g. Switzerland) (see Figure 4). Since requirement refinement often occurs in social search, users can change clusters and cluster content at any time. For instance, add new keywords, rearrange keywords to different clusters, or split clusters. Moreover, keywords can be removed and put aside tentatively on the rim of the interactive surface for later usage. After students agreed on clustering, the group members are assigned to different clusters by putting users' corresponding tablet tokens on different clusters (DG1). The token indicates the search responsibility so collaborators know who is searching information for a specific cluster. This highly increases the overall awareness. Moreover, cluster keywords are transferred to the linked Apple iPad if a token is put on a cluster.

Figure 5. The search interface on the Apple iPad featuring relevant keywords (left) and a Web browser (right).

Now, individual search is performed on private displays. This can be done either loosely coupled in parallel (no 'backseat driving' [6]) or tightly-coupled in collaboration (DG2). Moreover, novice searchers can learn vocabulary and syntax from experts when searching in close collaboration [6] and apply their knowledge instantly. On the private display, received keywords are displayed in the left column and a Web browser is displayed in the right column (see Figure 5). A user selects one or more keywords by tapping on it. Then, pressing the 'Google' or 'Wikipedia' button opens the corresponding webpage with results matching the selected keywords. Users can navigate to included links or adjust search manually. The browser is operated as known from the Apple iPad Safari app. A complete website or parts of it can be selected by touching and holding the information until the selection rectangle shows up. By pressing the *Publish* button the selected information including search paths taken and user id is transferred to the shared display. The result is displayed immediately in the result view of the cluster on the shared display (see Figure 6). Each cluster has its own scrollable result view. Users can hand over private displays to show and exchange interesting information before publishing. All results can be reviewed on the shared display and private displays at any time. Tapping a result on the shared display opens the corresponding result on all private displays linked through tablet tokens, which is useful for discussion and especially important to argument the final outcome (DG3).

Figure 6. Tapping a result in the result view (shared display) triggers the result view on the private display.

We implemented most of the design goals, however, it is not yet possible to distribute or organize results from a collaborative Web search session (DG4). This will be future work and can be implemented easily since required data is already persisted in a database.

IMPLEMENTATION

The application on the shared display (server) is implemented in C#/WPF with the .NET 4.0 framework and the application on the private display (client) is implemented in iOS 5. The cluster visualization on the Microsoft Surface displays a convex hull to indicate encircled objects. A Windows Communication Foundation (WCF) web service and OSC is used for client/server communication. The clients communicate with the server via WCF web service, which will be opened on the Microsoft Surface on application startup. Multicast OSC messages distribute keywords and object IDs of existing results to the clients. The implementation of TwisterSearch supports theoretically unlimited clients, however, the table size constrains the number of collaborators to a maximum of four. All paper snippets have an Anoto pattern on the front and a visible marker on the back. Strokes are analyzed and transformed to machine readable text with help of MS Windows 7 SDK. The recognized text is, then, assigned to the corresponding paper snippet. BaseX[2] persists session data, all results including search paths and the user id, all connection data, and the interaction log. Latter will be used in future to evaluate the system in a controlled experiment.

CONCLUSION AND FUTURE WORK

Based on the canonical model of social search by Evans and Chi [2] and implications for design of Morris [6], we identified four design goals for the emerging topic of DUIs for collaborative search: 1. *Strategic Planning and Coordination*, 2. *Amplify Collaboration*, 3. *Intensify Discussion and Simplify User Input*, and 4. *Traceability*. On this basis, we presented the design and implementation of our interactive prototype TwisterSearch, which uses post-WIMP interaction with a tabletop and tablets to distribute collaborative Web search across device boundaries. In a next step, it will be important to evaluate to what extent our design meets the design goals and enables efficient collaborative Web search for typical users. Therefore, we plan to first conduct a qualitative and less formal user study similar to WeSearch [8]. After this, we will make TwisterSearch accessible to a broader user population in the library of the University of Konstanz to recruit participants for a controlled experiment with real library users and students in our lab.

ACKNOWLEDGMENTS

This work was partially supported by DFG Research Training Group GK-1042 "Explorative Analysis and Visualization of Large Information Spaces", University of Konstanz and by the Ministry for Science, Research and Art Baden-Wurttemberg under the project Blended Library[3].

REFERENCES

1. Amershi, S., and Morris, M.R. (2008). CoSearch: A System for Co-located Collaborative Web Search. In *Proc. CHI 2008*, ACM (2008), 1647-1656.
2. Evans, B.M., and Chi, E.H. An elaborated model of social search. *Inf. Process. Manage.* 46, 6 (November 2010), 656-678.
3. Geyer, F., Pfeil, U., Höchtl, A., Budzinski, J., and Reiterer, H. Designing reality-based interfaces for creative group work. In *Proc. C&C'11*, ACM (2011), 165-174.
4. Jacob, R.J.K., Girouard, A., Hirshfield, L.M., Horn, M.S., Shaer, O., Solovey, E.T., and Zigelbaum, J. Reality-based interaction: a framework for post-WIMP interfaces. In *Proc. CHI 2008*, ACM (2008), 201-210.
5. Jetter, H-C., Gerken, J., Zöllner, M., Reiterer, H., and Milic-Frayling, N. Materializing the query with facet-streams: a hybrid surface for collaborative search on tabletops. In *Proc. CHI 2011*. ACM (2011), 3013-3022.
6. Morris, M.R. A survey of collaborative web search practices. In *Proc. CHI 2008*, ACM (2008), 1657-1660.
7. Morris, M. R., and Horvitz, E. SearchTogether: An Interface for Collaborative Web Search. In *Proc. UIST 2007*, ACM (2007), 3-12.
8. Morris, M.R., Lombardo, J., and Wigdor, D. WeSearch: Supporting Collaborative Search and Sensemaking on a Tabletop Display. In *Proc. CSCW 2010*, ACM Press (2010), 401-410.

---

[2] BaseX is a light-weight XML database – http://basex.org

[3] http://hci.uni-konstanz.de/blendedlibrary/