Showing-Displays-Together: A Co-located Web Search Support Exploiting the Terminal Orientation

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Abstract. Today, people perform web search tasks with smartphones on a daily basis, forming a group of several users to achieve a common goal, such as finding a good restaurant and deciding a product to buy. During such a task, they naturally show the smartphone screen to share the displayed information, Showing-Displays-Together, after personally performing a web search. If the functions of a tool to support the collaborative web search could be automatically switched, users would be able perform their task more smoothly. In this paper, we propose a function to compare shared web pages among users, which is automatically invoked by exploiting the terminal orientation. We have developed a collaborative web search support tool which has three functions switched each other according to the terminal orientation, searching personally in portrait mode, browsing a shared favorites list in landscape mode, and comparing web pages in horizontal mode. The result of evaluation shows that user satisfaction, communication, and easiness in making a decision had a good impact on the tasks, but usability needed to be improved to avoid unintentional switching of the functions to users.

Keywords: Collaborative web search · Co-located collaboration · Information sharing

1 Introduction

Today, smartphones are the most popular terminal on which to use the web. People perform search tasks not only personally, but also collaboratively, forming a group to achieve a common goal while searching and sharing websites. This collaborative form of web search is called "Collaborative Web Search" [4,5], and a collaborative web search task is performed both in a co-located setting and in a remote environment.

In a co-located setting, users gathering in proximity often show their display to others to share the content of web pages of their interest. If three or more users are working together, each of them holds their terminal horizontally to

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the ground to *show the display together* and compare web pages, after personally performing the web search to find pages to share by vertically holding the terminal. If the user interface could reflect a characteristic that users naturally change the orientation of the terminal depending on what they are doing, users would be able to perform their collaborative web search task more smoothly.

In this paper, we propose to automatically invoke a function to compare shared web pages according to how the terminal is held by a user, specifically to the situation where users show the display of their terminal together. We also report a user study to evaluate the effectiveness of this function, in terms of user satisfaction, communication, usability and easiness in making a decision.

2 Related Works and Our Approach

Many of research works on collaborative web search focus on the remote environment [2,6]. These systems typically support sharing queries and web pages synchronously or asynchronously, also allowing users to send messages each other.

Research works to support co-located collaborative web search have been also conducted. CoSearch [1] uses a shared large display which is incorporated with mobile devices for each user. A content comparison function [3] provides users with an interface on mobile devices to effectively share web pages collected by group members and add reviews to compare such pages, considering that a collaborative web search task is performed in three phases, personal search phase, opinion exchange phase and comparison phase. O-SNAP [7] uses device orientation (portrait and landscape) to change the functions between personal mode and collaborative mode in web search. The specific feature of O-SNAP is that users can physically signal collaboration intent to others around them by using their phone's orientation. In the portrait mode users can perform traditional search, but when users rotate the device into landscape orientation, the device snaps into a collaboration mode in which users can share their search results.

Our approach is to add the third mode to O-SNAP, the horizontal mode. When people search in a group, they naturally show the display of their device to other members in order to exchange opinions and compare web pages. O-SNAP assumes that users see only their own display even though they are facing each other, so web contents which can be seen by individual users are limited. Showing multiple web pages on a screen of each of users' devices would make it easy to compare the content of pages collected by group members.

3 Proposed System

3.1 Functions

Figure 1 shows the transition among functional states when users are conducting collaborative web search using our system. Functions given by the system are automatically switched to each other depending on the following three states of how the user holds the terminal.

Portrait mode: Google's search site is displayed at the beginning, and users can perform a usual web search. If the user finds a page to share with others, the page can be added by tapping a button on the screen to the favorites list which is shared by all users.

Landscape mode: The shared favorites list with titles of web pages is shown at the left side of the screen, and users can see the content of the web page by tapping one of the titles on the list.

Horizontal mode: Web pages in the favorites list are displayed at the terminals, each of which shows one of the web pages in the list. Users can navigate through the web pages stored in the list and compare them at a glance.

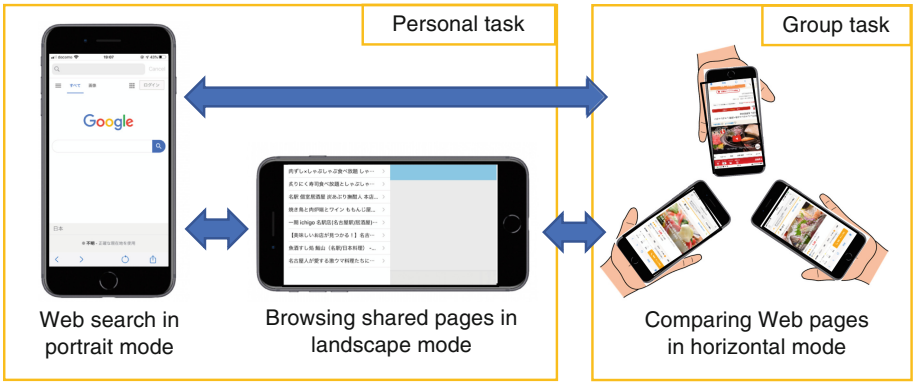


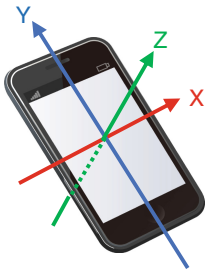
Fig. 1. Transition among functional states in co-located collaborative web search

As described in the previous section, users search the web personally at beginning of a collaborative web search task. While searching personally, they keep several web pages to share with others for later reference. This activity is performed in the portrait mode in our system. During their personal activity, they also want to know what pages are found by other users to get some hints for their further search. This activity is performed in the landscape mode. After the users finish collecting web pages of interest, they compare the collected pages for discussion. This activity is performed in the horizontal mode.

The favorites list stores the references to web pages with a timestamp representing when the page is added by the user. An item which has the latest timestamp in the list is displayed in the terminal of the user, who changes the terminal orientation to the horizontal mode first. If another user changes the terminal orientation to the horizontal mode next, an item which has the second latest timestamp in the list is displayed in the terminal of this user. In the tab bar of the horizontal mode screen, there is a button labeled "Discard" which enables users to remove the corresponding web page from the list. There is also a button labeled "Defer" with which users can move the corresponding web page at the end of the favorites list.

3.2 Implementation

Detection of the Terminal Orientation. We use Apple's iPhone as an implementation platform. The terminal orientation is detected by using the internal accelerometer equipped with iPhone. Detection of the orientation is performed every 0.2 s, based on the conditions shown in Fig. 2.




```
if the slant is within 15 degrees from the initial status
    mode = horizontal
else if X-acceleration > Y-acceleration
    mode = landscape
else
    mode = portrait
```

Fig. 2. Detection of the terminal orientation

Management of Shared Web Pages. This system uses the service offered by Firebase Realtime Database to share the content of the favorites list among terminals. All terminals access a common database built on this service. The database contains the following fields for each of the shared web pages.

Title: Title of the web page
URL: URL of the web page
Timestamp: A timestamp when shared
Switch: A Boolean value to indicate whether the web page is already shown on the terminal in the horizontal mode (true: shown, false: not shown).

In this prototypical implementation, how to make a group with multiple terminals is not considered, and all terminals running at the same time are grouped together.

When the terminal is changed to the horizontal mode, it looks up the favorites list and finds an item which has the latest timestamp in those with the false value in the "Switch" field. If such an item is found, the terminal changes the value of the "Switch" field to true and shows a web page according to the URL stored.

When the "Discard" button is tapped, the terminal deletes an item corresponding to the currently shown web page from the favorites list. When the "Defer" button is tapped, the "Switch" field is changed to false and the timestamp field is assigned to a negated value of the current time to make it the oldest time.

4 Evaluation

In this section, we evaluate the system in terms of what effect is obtained for communication between users. We also verify the usability of the system.

4.1 Experiment Settings

The purpose of this experiment is to investigate whether the proposed system has an advantage compared to an existing system in terms of promoting communication among users and the system usability in a co-located collaborative web search environment.

For this experiment, 18 student participants were recruited, forming six groups of three participants. They sat in a circle where they could show their iPhone's display each other.

This experiment was conducted in a way that our system which has the "showing-displays-together" function was compared with the pre-installed web browser, Safari, used with Apple's AirDrop which enables users to exchange a web page with other users. When using Safari, the participants were not forced to use AirDrop.

The task for participants to perform in collaborative web search was to choose a party place near a specified train station. They achieved two tasks of this nature by using each of the two systems, the proposed system and Safari with AirDrop. They were given 10 min for each of the two tasks. Considering the order effect, three groups used Safari with AirDrop first while the other three groups used the proposed system first.

After completing the tasks, participants answered the questionnaire in Table 1. They answered in the 5-point scale and were requested to leave comments for each of the questions.

Table 1. Questionnaire

Q1	In which task do you feel that you could get a satisfactory result also for the group members?
Q2	In which task could you make communication with the group members?
Q3	Which system could you use without feeling stress?
Q4	With which system could you easily make a final decision?

Q1 is to evaluate the satisfaction level of users. Higher points would mean that participants felt a sense of fulfillment in performing their task, led by more collaborative activity. Q2 is to evaluate the communication among users, in terms of how showing the displays together affects their communication. Q3 is to evaluate the usability of the system. The proposed system might interfere their task if automatically switching the function did not work well. Q4 is to evaluate

the easiness of making a decision. Higher points would mean that showing the displays together had a positive effect in their decision.

4.2 Results and Discussion

Figure 3 shows the questionnaire result for Q1 to Q4. Each number in the result represents how many participants rated their preference ranging in five points from the existing system (Safari with AirDrop) to the proposed system (Showing-Displays-Together) for each question. As an overall tendency, we can see that the proposed system is rated high in terms of satisfaction, communication and easiness in decision, while it is weak in usability.

We validate this result by referring to participants' comments on each of the questions.

- Satisfaction
  One of the participants commented that each person had an equal opportunity to say something by having at least one piece of information to share. Being given a chance to naturally recommend their own candidate would increase the collaboration level, leading to higher satisfaction on the result of a task. Others commented that they could make a decision from multiple choices, and they could easily show their own candidates on the display and compare them with each other. Enabling users to compare several candidates on multiple smartphones at a glance in the horizontal mode would also increase the collaboration level.
- Communication
  Participants commented that they could examine each of the candidates one by one through all of their intentions, they could explain in the horizontal mode why they chose their candidate, they could make a discussion while looking at all of the terminals, and they naturally felt the necessity of discussion on each of the candidates collected by the participants. Showing the displays together would offer an opportunity to explain their candidates on the displays and make a discussion by comparing them, leading to a rich communication among users.

	Existing system		Neutral		Proposed system
Q1 (Satisfaction)	0	1	5	6	6
Q2 (Communication)	0	3	5	4	6
Q3 (Usability)	7	4	0	3	4
Q4 (Easiness in decision)	0	0	5	10	3

Fig. 3. Questionnaire result

– Usability
  The proposed system was rated low by the participants. They commented that the function was switched unintentionally depending on the terminal orientation, and the detection of the horizontal mode was not accurate. Five groups out of six pointed out the incorrectness of switching the function. Another possibility to switch the function is to let users press a button on the screen, but this might lose the advantage of using the terminal orientation which enables users to physically signal collaboration intent to others, as emphasized for O-SNAP. In order to improve the accuracy of automatically switching the function, the conditions to detect the terminal orientation illustrated in Fig. 2 have to be elaborated by changing the threshold value of the slant degree.
– Easiness in decision
  Participants commented that comparing the candidates on multiple displays was comprehensive, and showing different websites on multiple displays led to reducing time. Showing the displays together would allow users to easily compare the candidates while discarding or deferring them, leading to easiness in making a decision.

5 Conclusion

In this paper, we have proposed a function called "Showing-Displays-Together" which automatically switches the functions of a tool for supporting the collaborative web search by exploiting the terminal orientation. Using this function, users can easily move across the phases which are taken during a search task. We also have described the result of evaluation on the effectiveness of the tool, showing that user satisfaction, communication, and easiness in decision had a good impact on the tasks, but usability had a problem of switching the functions unintentionally to users.

As a future work, we will elaborate the mechanism to detect the terminal orientation to improve the usability. Comparative evaluation with other collaborative web search systems would also be necessary to reveal the user awareness and engagement in tasks as well as the effectiveness of using the terminal orientation.

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