Using Physical Signaling to Support Collaborative Mobile Search

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Abstract
Often when people search the web from their phones, they do so collaboratively. We present a mobile application that supports in-person collaborative search by allowing users to physically signal a willingness to share. While the core application provides standard mobile search functionality, users rotate their devices to landscape orientation to indicate (to the device and others) they are entering a collaborative mode. We study two uses of collaborative mode, one where users rate results to create a group list, and another where screens and actions are shared across devices.

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Mobile search; local search; collaborative search.

ACM Classification Keywords
H.5.m. Information interfaces and presentation: Misc.

Introduction and Related Work
A growing body of research reveals that people work together on search tasks [7]. While it is often assumed that collaborators search from their desktop computers, separated by distance or time, collaborative search is increasingly common from mobile devices, where users are usually co-located and searching synchronously [2][7][9]. For example, Morris [7] found 93% of smartphone owners engage in co-located collaborative

Figure 1. We present a mobile application that supports co-located collaborative search. The two users on the left have rotated their phones to a landscape orientation to invoke collaborative search features, while the third user searches independently with her phone in portrait orientation.

searches with multiple phones, and Church et al. [2] found 65% of mobile searches take place with others.

We present a mobile search application called *O-SNAP* (Orchestrating Search Negotiations Among People) that uses physical proximity to augment the search process. People performing collaborative mobile searches typically begin by searching on their own, and then switch to a collaborative mode where they move closer to each other to discuss results and share screens. Because this interaction can be impractical for large group sizes and socially awkward [3], O-SNAP enables users to instead signal their willingness to share by how they hold their phone (Figure 1). In the default portrait orientation O-SNAP supports traditional individual mobile search, but when users rotate their phones into landscape orientation they "snap" into a collaborative mode.

Researchers have begun to explore how to support co-located mobile searchers. Amini et al. [1] discuss several approaches, like shared ratings, notifications, and queries. Kotani et al. [5] developed a prototype that shares Web browsing information and search results across phones. WaggleBee [8] allows co-located smartphone users to mark webpages as shared, and displays thumbnails of all shared pages along the bottom region of participants' phones. We extend these efforts by explicitly augmenting the physical cues co-located searchers use when sharing information. The use of device orientation to control interaction is an active area of research. For example, Codex [4], a prototype dual-screen tablet computer, activated collaboration features upon detecting the device was in an "outward facing" posture. O-SNAP evolves the concept of sensor-based interactions to multi-person, multi-device collaboration scenarios, in which a device's orientation serves as a signifier of a desire to collaborate both to the controlling software and the co-located group members. Luff and Heath [6] note that small adjustments to the position and orientation of paper or mobile devices supports delicate shifts in collaboration, and we use this in our work to allow searchers to signal their readiness to share via device orientation. Our experience creating O-SNAP provides insight into how the co-located collaborative search experience can be improved via physical signaling.

Physically Signaling Mobile Collaboration

O-SNAP is a smartphone application for the Windows Phone. The core application provides generic mobile local search functionality common to most applications. There are three views that display information about local businesses: a List View, a Map View, and a Details View. Figure 2 shows screenshots of the List and Map Views. A user begins searching for a business by entering query terms. Local businesses are identified using a major search engine's API and displayed as a list in the List View and by location in the Map View. Swiping the screen switches the view. The Details View presents detailed information about a specific result, such as the business' address, description, and website.

Additionally, O-SNAP provides collaborative features. Users enter their name and a session ID into a login screen, and select a color to represent themselves. Once phones are connected, they share information using Microsoft's SMASH (Social Mobile Sharing) toolkit. To enable people to move smoothly between individual and group search, we designed an interaction that takes advantage of people's natural physical cues to indicate the transition. O-SNAP provides an individual search experience in the default portrait orientation,

Figure 2. List View (left) and Map View (right). Both show results for a search for "café."

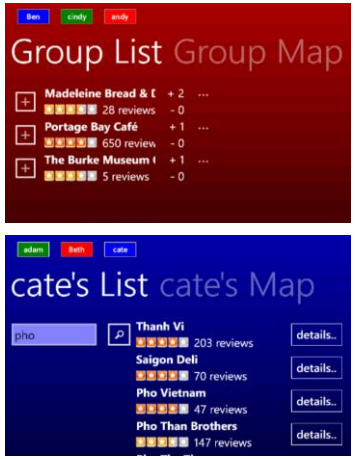

Figure 3. Two different uses of collaborative mode. With shared ratings (top), results are shown that were voted positively by group members. With a shared experience (bottom), users see one group member's screen.

and snaps into a collaborative mode when rotated into landscape orientation. Orientation serves as a physical indicator (to the phone, the user, and those observing) as to whether they intend to search on their own or share search-related information. We built two variants to explore different interactions while in collaborative mode: Shared Ratings and Shared Experience.

Shared Ratings

In Shared Ratings, users vote on results and their votes are aggregated and shared. The goal is to facilitate the discussion of results that commonly takes place via voice communication among co-located searchers. Results in the List View and Map View are augmented with a 3-way checkbox (Figure 2). Clicking it once indicates a positive ("+") rating and twice indicates a negative ("-") rating. Three clicks restores the value to the neutral state. Regardless of orientation, results are augmented with tallied group ratings. However, in the individual mode a user will not see the results others have rated unless they appear in their result list. To view all rated results a user must snap into the collaborative mode by turning the phone into landscape orientation. A user then sees the Group List or Map View with all items that have been rated positively by at least one group member (Figure 3, top).

Shared Experience

Because people searching together often hold their phones out to let others to see their screen, in the Shared Experience variant users share the entire search experience when in landscape. When users enter the collaborative mode their interaction with the application is reflected on the screen of everyone else in collaborative mode (Figure 3, bottom). The first person to enter collaborative mode has their application state (e.g., search terms, result list, current view) propagated across devices when others enter the mode. Everyone in the group can also interact with (e.g., point to) and change the state of the group perspective, with their interactions propagated.

Use of Collaborative Mode in Practice

We ran a user study to understand whether rotating the phone to signal a desire to collaborate was an interaction that made sense to co-located users, and to build a picture of the relative value of the two collaborative modes. Twenty-two students participated in eight groups (six with 3 people, two with 2 people). Group members knew each other. Gender was evenly split, and ages ranged from 20 to 32. All participants owned smartphones. We supplied Windows Phones for the study. The study had a within-subjects design, with each group conducting two tasks, one with all group members using the Shared Ratings version, and the other using the Shared Experience version. For each version we provided a brief tutorial and then asked participants to find a restaurant in a specific location. Afterward, participants completed questionnaires. Each session took about an hour.

The action of rotating the phone to enter into a collaborative mode appeared intuitive, and participants said that they liked that they "could switch between publicly and privately searching easily." Another participant noted that, "[We] could easily show what we were thinking without passing around a single phone." Fourteen participants (64%) preferred Shared Ratings to Shared Experience. Questionnaire responses indicated they preferred Shared Ratings because it allowed them to track what group members liked and review them all when making a decision. Participants felt that searching

Task description: "Suppose your group is at <neighborhood in a metropolitan area>. Your task is to find a restaurant for your group to eat lunch at in that area. Please be realistic and find a restaurant that all group members are willing to eat at."

with Shared Ratings was faster than with the Shared Experience, even though there was no significant effect of application on the actual time participants took to complete a task (3.9 vs. 3.0 on a 5-point Likert scale; z = -2.99, p = .003). One participant, for example, reported that providing ratings sped the task up and "made it more accurate. We could be sure we were talking about the same restaurant, not two different ones with the same name." Participants also felt that they contributed to the task more when using Shared Ratings (4.4 vs. 3.7; z = -2.30, p =.02).

Participants sometimes found the Shared Experience frustrating because it required coordination (e.g., searching "got a little confusing when we were all trying to control the screen at once"). Questionnaire responses reflected this with a significant effect of application on frustration (1.9 for Shared Ratings vs. 2.8 for Shared Experience; z = -2.98, p = .003). However, participants also felt the Shared Experience was more social because it required them to coordinate control of the screen and jointly focus their attention on the same things (e.g., it "felt more like we were working together"; it "is much more social"). Given these findings, there could be benefit to providing both types of collaborative functionality in a single application, combining the simplicity and perceived efficiency of Shared Ratings with the social benefits of the Shared Experience.

Conclusion

When people use their mobile devices to engage in co-located collaborative search, they often move between individual searching and shared exploration of results. To support this behavior, we developed a local mobile search application that uses phone orientation to physically represent what mode of search a person is in. A portrait orientation shows the individual is searching on their own, and a landscape orientation indicates a desire to share. Based on our findings, we recommend incorporating Shared Ratings during the entire search experience, while using orientation to indicate entrance into a Shared Experience screen-sharing mode, as the explicit attention and physical signaling of this action seems particularly suited to the higher amount of shared attention and coordination participants needed to utilize screen sharing effectively.

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