Proximity Sensor - Privacy-Aware Location Sharing

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Abstract
In this paper we report on a participatory design study with young girls. Our goal was to create a mobile phone app to display the spatial proximity of friends in an abstract and privacy-aware manner. A group of 16 girls worked along the user-centred design process to create initial paper-based designs of an app that respects one's friends privacy while displaying their proximity to allow for spontaneous meetings or re-grouping after separation. Our participants created very promising results which we intend to implement and evaluate further against a broader audience.

Author Keywords
Navigation; Smartphone; Privacy; Participatory Design

ACM Classification Keywords
H.5.2 [User Interfaces]: User-centered design.

Introduction
When going out together in a group to go shopping or have fun at the local fair, sooner or later the group will start falling apart due to various reasons. Once group-members realise the split a time-consuming negotiation process of making phone calls, sending text messages etc. starts in order to regroup. A more traditional way would be to set up a meeting point where

everyone shows up at a pre-determined time. But the place may be forgotten, the time might be missed and the group might thus not reunite causing frustration among group members.

When available, users might use their smartphone with one of the available apps such as Google Latitude or Glympse - to name only two of the many available - to share their whereabouts with friends. However, these apps are not designed for an abstract, privacy-aware display of your friends' positions. Therefore, any stranger checking over your shoulder while you are using the app could see who and where your friends are.

We suggest the use of a smartphone app designed to display the whereabouts of group members and friends once a group is split apart in a more privacy aware manner. In order to gain further insights into the problem space, we invited a group of 16 girls to our lab and conducted a participatory design study. The girls were very familiar with the scenario described above and were enthusiastic and creative in exploring the problem space and creating initial design ideas for a possible smartphone app.

Related Work

As mentioned in the introduction, there are many smartphone apps available designed to inform you and your friends of each others whereabouts[1][2]. These apps do not address privacy issues that users might have when using the system in public and not wanting to give away information on their friends.

A way to address this problem might be by using another modality such as a vibro-tactile interface which operate in a very private manner. Pielot et al. suggested a tactile compass application that would inform users about the location of group members by using a set of vibro-tactile stimulations through a smartphone [5]. Williamson et al. report on a system that helps pedestrians find the nearest meeting point by using a mobile phone and vibro-tactile feedback [11]. These systems provide a private and non-visual representation of either the group members' locations or a virtual meeting point. We therefore added the vibro-tactile modality to our questionnaire.

There is a vast number of publications on privacy concerns in location-sharing [2, 3, 6, 7, 9]. However to make the information shown on the screen of a smartphone more abstract and private against blunt "shoulder surfing" intrusions is not part of the research when addressing privacy issues in location sharing.

Work on providing protection against shoulder surfing usually adresses the process of entering pin codes or passwords [10, 8, 1]. This is rather a momentarily act than an on-going activity like tracking your friends whereabouts.

What is missing is an approach to display the location of separated group members in a manner that preserves the group members privacy and hides their location from strangers, without "security getting in the way" [4].

Study

Our participants were 16 girls aged between 11 and 14 ($M = 12.6, SD = 0.8$) that visited our lab for one day for a work-experience. The study lasted for 3.5 hours and was interrupted by a number of breaks. To motivate the human-centred design process and give the girls an insight into our daily work we introduced them to the scenario of

[1] Google Latitude, http://google.com/latitude
[2] Glympse, http://www.glympse.com

going out in a group and then trying to regroup, once the group members were separated. All participants were familiar with such a scenario. After introducing the participants to the problem, we asked them to fill out a questionnaire containing yes-no and open questions as well as statements to be rated on a 5-point Likert scale.

Upon completion of the questionnaire by all participants, we explained the sense behind our questionnaire and collected the results on a computer (yes-no and Likert scale answers) as well as in a group discussion on a whiteboard (open questions). From the collected data we tried to derive requirements for the design of a future smartphone app. Once again we included our participants in the discussion and decision making process. We then split the 16 participants into four groups of four (some of which knew each other beforehand) and asked them to come up with an initial paper and pen sketch of their ideas for a future app, considering the requirements derived before. All groups presented their ideas which were then discussed by all participants.

Results of the Questionnaire
In our questionnaire we collected quantitative as well as qualitative data. 11 of the 16 participants posessed a smartphone, all 16 were in favour of using a smartphone app to help them regroup when going out and losing a member of the group in the crowd. Asked for their preference of the modality in which the information should be conveyed (5-point Likert scale, 1=totally disagree, 5=totally agree), participants preferred a visual representation on the display of the smartphone ($Mdn = 4.5$) over vibro-tactile feedback ($Mdn = 3.0$) and sound ($Mdn = 2.5$). Vibro-tactile and sound feedback were not regarded as very reliable by a number of participants. Asked about privacy concerns we received a very uniform answer that neither participants wanted to give away the position and name of their friends in plaintext to a stranger ($Mdn = 1.0$) nor did they think that their friends would want their information accidentally released to strangers ($Mdn = 1.0$).

As open questions, we asked about situations where a group member got lost. We received answers like "going to the fun fair", "going shopping in the city", "in school" amongst others. Asked about strategies for regrouping, 15 participants said that they had used their phones to call or text each other, or use a chat to communicate. Doing so they had encountered various problems such as noise making calls impossible, not noticing the phone going off, empty battery or phone left at home. Another strategy that was wide-spread amongst our participants was the use of a pre-set meeting point and time. This lead to problems such as forgetting where the meeting point was. Forgetting about the time. Not making it in time due to congestions along the way.

Requirements
After collecting and discussing the results obtained from the questionnaires we asked our participants to derive requirements for the design of the future app. We agreed to develop a system that would give visual feedback on the smartphone to the user. We identified the need to encode/anonymise the information in such a way that it could not be easily deciphered by strangers. On the other hand we derived the need to have a configuration screen in which group members could be managed and in which suitable representations for each group member could be selected. With this set of requirements, we split our participants into four groups and asked them to create an initial pen and paper design idea for the app.

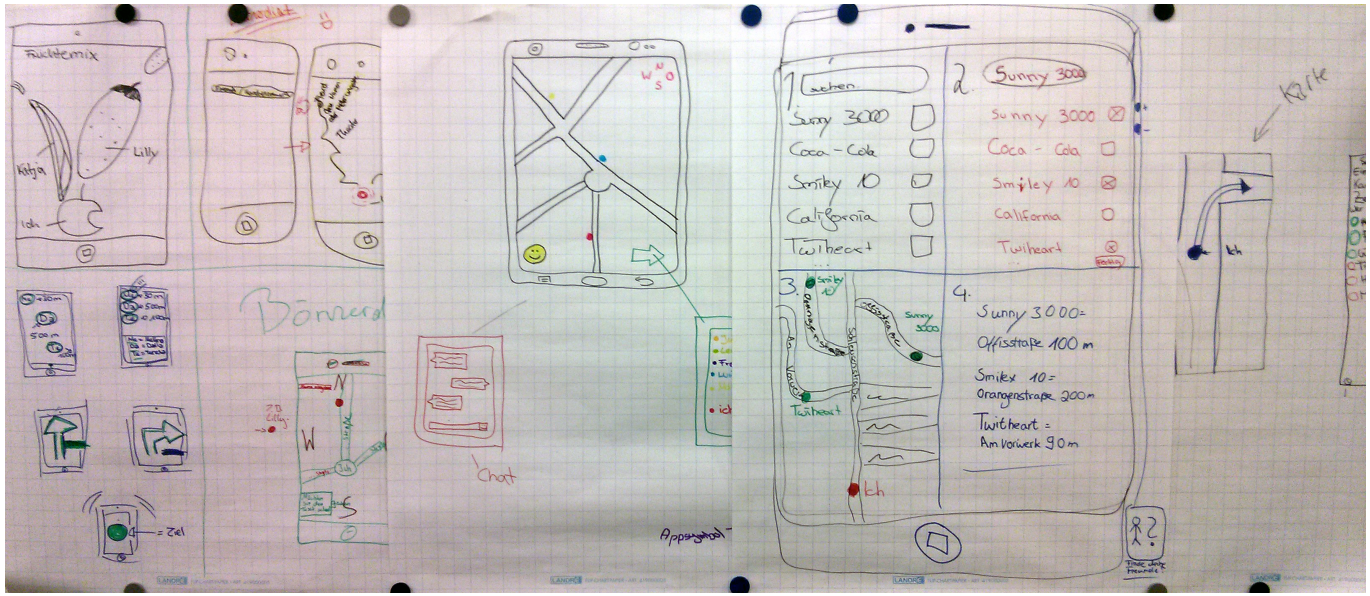

Figure 1: Design ideas of our participants

Initial Designs

We asked each of the four groups to present their ideas to the plenum and encouraged everyone to discuss the ideas. An overview of the design ideas can be found in Figure 1. We received a variety of ideas ranging from a rather classic map view using codenames instead of real names of users up to an abstract solution consisting of an adaptive fruit basket in which each fruit represented one group member and would tilt towards the direction this group member was seperated from the group as well as distort its form to represent the distance. In order to keep track of the friends and fruits the group envisioned to use the first letter of the group members first name and match to a fruit starting with the same letter. This seemed intuitive to the rest of our participants.

When using map representations, groups either suggested code-names or coloured dots to represent their friends or chose to display navigational arrows but without showing distances and/or destinations thus adding an implicit meaning to the explicit representation. One group left out street names in their map design so that it might not be obvious to a stranger on where the dots were actually located.

Each group came up with an idea of managing group members either by entering names or consulting existing contact and chat lists. In the discussion, it was decided

that sharing one's location should be an opt-in process. One group suggested adding a function with which group members could acknowledge that they knew that one of the members was missing. Another group suggested adding an in-app chat function to coordinate the re-grouping process.

Conclusion and Outlook

We conducted a participatory design study with a group of 16 girls aged 11-14. During this study, we received a large quantity of suggestions and ideas. We found that young girls can be very enthusiastic in taking part in a design experiment that also involves data analysis and requirement capturing. The age group of 11-14 year-olds is definitely an interesting audience as they already have a vast experience with smart-phones but seem to have a different view on things than (young) adults. Members of this young age group are well concerned with keeping information private.

In the future we would like to select and implement two of the design ideas into prototypes and evaluate them in a user study with participants from this target group. One would be the abstract idea of the fruit basket, the other would be a map based suggestion. We are further exploring the same topic with students from our university classes to derive more age-related differences in the approaches. Another interesting path to take would be to investigate the same topic with a group of boys the same age.

We encourage fellow researchers to work with younger participants, as they require a different look at things and can provide great ideas and feedback. There are some very relevant topics for this age group and their enthusiam in trying to solve these topics can be quite high.

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