

Will I Tell You Where I Am? How Spatially Limited Social Networks Affect Location Sharing Behavior

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ABSTRACT

Location sharing systems often entail concerns about privacy when disclosing one’s position. Users worry that their location could be traced by people they do not know sufficiently well – a side effect of large friend lists in social networks. Earlier research observed large-scale networks such as Foursquare or Google Latitude. In this work, we investigate how a spatially limited location sharing system affects check-in habits. We evaluated our work in a two-week explorative field study with an on-campus location sharing system, *Ubiversity*, we implemented for that purpose. Our results indicate that from a privacy point of view, users tend to disclose more willingly their location if it is limited to a local area, even those who refrain from using large location sharing systems like Foursquare. We also found that reasons for disclosing one’s location in a local context are different from those in large social networks. The smaller spatial distances of check-ins simplify spontaneous meet-ups with friends and are a motivational factor for location sharing.

Author Keywords

Location sharing, social networks, indoor localization, privacy, university

INTRODUCTION AND MOTIVATION

With GPS-enabled smartphones and increasing 3G/4G coverage, mobile location sharing systems enjoy rising popularity. The trend goes from *purpose-driven*, one-to-one sharing like Glympse¹ towards *social-driven* location sharing [17] like Foursquare², where a large amount of users shares their whereabouts with each other. This allows discovering new places and people, earning discounts and benefits, gaming [4], or ad-hoc meetings with nearby friends [10]. Many systems follow the *check-in* principle: Users publish their location and associate it with a meaningful place name like an address, a shop, or a bar. Check-ins can then be retrieved by the user’s friend list, or by everyone using the service if the check-in was made public.

Location sharing not only takes place among intimate friends. Often, social networks’ friend lists contain a lot of weak relationships and acquaintances [5, 18]. Recent social network concepts even integrate vehicles and public transportation [3]. According to a survey, 58% of Foursquare users have friends in Foursquare they do not know personally [10]. In that case,

usage of location sharing systems resembles the concept of “following” people (like in Twitter or Google+) who visit interesting places, in order to discover new locations. However, this requires active publishers that share their location with people they potentially do not know very well.

The proliferation of location sharing coincides with increased privacy considerations and concerns [1–3, 9], all the more in one-to-many location sharing systems where the relationship to followers is not that close. People do not want to share in detail their daily routines with people they barely know. Foursquare users [10] even expressed concerns that strangers can track them, or that someone could break into their home when others can see that they are away.

Various motives for sharing one’s location in large-scale networks have been identified [10]: besides the social connectiveness, people use these systems for self-representation and gamification (“*I have been at event X*”, “*I am Foursquare mayor of place Y*”). Mixed-reality games that require the interaction with the real world (e.g., with NFC tags [8] or monuments³) to achieve progress in the game, increase the amount of location shares as well. The possibility to earn badges and rewards for check-ins are here an important factor to motivate (especially novice) users.

Existing location-sharing systems have an extensive user base which is distributed all over the world. This dimension naturally affects sharing behavior and privacy attitudes. Driven by prior findings for large-scale networks [1, 10, 15], our research interest is to identify how sharing motives and behavior would change if the scope of the system was *limited to a certain area* (and thereby implicitly to a certain group of users).

In particular, we are interested whether a locally limited scope could reduce privacy concerns of users. For this work, we chose the university campus as example scope. This is motivated by the fact that on campus user groups with similar interests are present (e.g., students who might want to find fellow students for learning together or for having lunch). Another use case is networking among docents in the context of professional experience exchange [14]. We implemented *Ubiversity*, a university-wide location sharing application as a working, live example for such a system, and gained user experiences during two weeks in an explorative field study.

¹Glympse. <http://www.glympse.com>, visited June 2014

²Foursquare. <https://foursquare.com>, visited June 2014

³Google Ingress. <https://www.ingress.com>, visited June 2014

The contributions of this paper are twofold.

1. We present survey and interview results on usage motives for spatially limited location sharing systems. We found that these motives differ from those that apply for large location sharing networks, as identified in earlier work.
2. We present indications that users are less concerned about privacy in local location sharing, compared to sharing in large networks like Latitude or Foursquare.

The paper is structured as follows: We first introduce our prototypic system in the subsequent section. After that, we describe the proceeding of the field study and survey, and present and discuss the results. We conclude with a summary of our findings and implications on future work.

UBIVERSITY – ON-CAMPUS LOCATION SHARING

Ubiversity is a location-based social network focusing on our university campus (Technische Universität München), operating on room-level granularity. The system allows to accurately view and monitor the location of friends around the university area. Usage scenarios of *Ubiversity* are e.g. locating a specific friend on campus for a meet-up, finding fellow students for collaborative work, or having lunch with friends hanging around nearby.

Functionality and Implementation

The system consists of a Django web application acting as server and a smartphone client app implemented in Android 2.3. Users can check in at the room they are currently in and share this location with their friend list or a subgroup thereof. Friends' location updates can be viewed as a news feed, i.e. in a list beginning with the most recent check-ins (see Fig. 1, left), or location-based on a map (see Fig. 1, right). We use maps from the university's room information service to be able to visualize detailed indoor floor plans.

We provide several ways to accomplish check-ins to simplify the procedure. The first one consists of selecting the position from a ranked list of location estimates, generated through WLAN positioning. A fingerprinting algorithm [6] runs on received signal strength (RSS) data and finds location estimates on room-level accuracy by querying a university-wide room database. As alternative check-in methods, we equipped the door signs of rooms in our department with QR codes (visual markers) and NFC tags (physical markers). Users can then check in to a room by photographing the QR code or touching the NFC tag. These methods correspond to different physical interaction techniques (*touching* using NFC, *scanning* using QR codes; for a comparison, see [11]). Finally, users can also manually select the building and room where they want to check in. Alternative indoor localization methods, such as vision-based localization [12, 13] could yield more accurate results, so that even a user's exact position inside a room or hallway could be determined. However, we decided to use the check-in concept to give the user more freedom when to share her location, so that room-level accuracy was sufficient for the purpose of this work. QR code, NFC and manual check-ins served as ground truth for training the suggestions of the WLAN indoor positioning system.

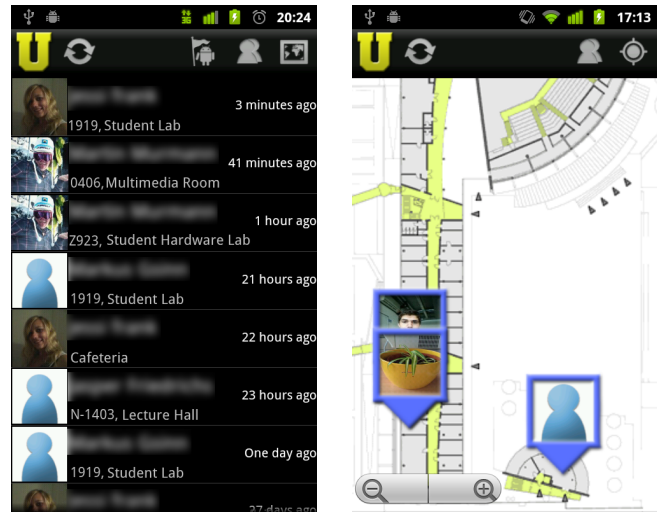


Figure 1. Left: The friend feed shows in which rooms people have recently checked in. For privacy reasons, real names have been blurred. Right: The map view visualizing nearby friends with and without photos on a floor plan of one of our campus buildings.

Design Decisions

Local Limitation

The service was intentionally only made available to students at our university and not connected to other services like Facebook or Twitter. Likewise, the geographical scope for check-ins was limited to the campus area. For manual check-ins, however, any custom label could be entered, e.g. “commuting” or the name of an off-campus location like a nearby café. No associated GPS location was saved in that case.

Subgroup Sharing

We offered the possibility to share a location with the entire contact list, subgroups of people, or individuals. Previous work has shown that people rather want to adapt their sharing habits according to the receiver, not to the location [9].

Manual Check-ins

Automatic and continuous location detection would be possible based on an existing indoor localization system [12]. However, unlike ubiquitous presence systems [7], we decided that check-ins have to be initiated by the user, being preferable from a privacy point of view [1]. We did not artificially limit the accuracy of the specified location (e.g. in a way that people can indicate the building they are in, but not the exact room), because once people decide to disclose their location, they tend to want to enter their location precisely [2].

EVALUATION

We evaluated *Ubiversity* in an explorative field study to find out how often and in what way such a location sharing system is used. In light of high privacy concerns that became evident in earlier studies [1, 2, 9], we investigated how a *local* location sharing system could affect users' willingness and motives to disclose their position.

Six subjects (5 males, 1 female) with an average age of 23 years ($SD = 1$) installed a *Ubiversity* prototype on their personal Android smartphones and added each other to their respective friend lists. We recruited students who knew each other before, in order to lower the inhibition threshold for check-ins and to make the study more realistic. Subjects were asked to regularly use the prototype for two weeks in their everyday routine on and around the university campus. All check-in activity was server-logged. Prior to the study, subjects answered a questionnaire on their previous experience with location sharing systems. At the end of the study, participants reported again their experiences in a questionnaire. The surveys were filled out online. Additionally, structured face-to-face interviews were conducted with three participants to get deeper insights about their experiences and motives.

Results

The feedback on our app was very encouraging. In the following, we present the results of questionnaires and interviews by category. For each item, the average agreement level, ranging from 1 (strongly disagree) to 5 (strongly agree) on a Likert scale, and the standard deviation (SD), are indicated in brackets. Table 1 gives an overview of all survey items.

Experience with Location Sharing Systems

We asked about the former experience with location sharing systems in general, and in more detail, with Foursquare, Facebook’s location sharing option (formerly Facebook Places) and Google Latitude. Two of six participants declared to use such systems regularly, four do not use them on a regular basis. The two “active” users mainly used Latitude (P1), and Latitude and Foursquare, respectively (P2). P1 and P2 stated to use these services “several times per day”. One of the remaining four participants “tested but abandoned” Latitude, the other three never tried location sharing services at all. They mentioned privacy reasons (concern of publishing too much information, commercial interest of platforms) as main barriers.

Check-in Behavior

All subjects regularly used the system, with in total 110 check-ins during the study. As expected, they checked in more frequently to locations on campus (3.5, $SD = 0.8$) than outside the campus (2.2, $SD = 1.3$). Examples for those were nearby coffee houses and streets. Subjects stated that they considered *Ubiversity* mainly as “university app”. Consequently, they used the manual check-in mainly for nearby locations and very rarely for places like “home”. One participant stated in the interview to use the off-campus check-in feature as indicator for his non-availability (e.g. because he was on his way home), while check-ins on campus were used to signal availability for a meet-up.

Participants liked seeing their friends’ location with an average of 4.3 ($SD = 0.7$). Interestingly, they averagely agreed with 4.8 ($SD = 0.4$) that they like their friends to know their position (4.8, $SD = 0.4$). Participants stated to check in with a certain purpose in mind (3.8, $SD = 0.9$), e.g. to signal that they are available for having lunch or hanging out together. Likewise, they checked in without purpose (3.7, $SD = 1.1$)

| Question | Avg | SD |
|--|-----|-----|
| Frequently checked in within campus | 3.5 | 0.8 |
| Frequently checked in outside campus | 2.2 | 1.3 |
| Frequently checked in with certain purpose | 3.8 | 0.9 |
| Frequently checked in without certain purpose | 3.7 | 1.1 |
| Like the friend feed | 4.2 | 0.4 |
| Like the map view | 3.8 | 0.9 |
| Like the idea of seeing my friends’ location | 4.3 | 1.0 |
| Like the idea that my friends can see my location | 4.8 | 0.4 |
| Shared location with entire friend list | 4.7 | 0.7 |
| Shared location with subgroup of friend list | 2.0 | 1.0 |
| Felt concerned sharing my location | 2.0 | 0.6 |
| Felt less concerned than sharing with other services | 4.3 | 0.7 |
| Should be connected to other services | 2.5 | 1.3 |
| The app was easy to use | 3.7 | 0.9 |

Table 1. Usage patterns and feedback on the *Ubiversity* prototype. The average agreement rates (Avg) on a Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), are given with the standard deviation (SD) for each statement.

just to indicate their position and to enable random meet-ups. One subject reported a feeling of ‘pleasant anticipation’ when checking in, because he was curious who would possibly pass by.

Check-ins were mostly shared with the entire friend list (4.6, $SD = 0.7$), and much less with subgroups of friends or individuals (2.0, $SD = 1.0$). However, in the interviews, the possibility of limiting location updates to circles was considered useful. It was due to the small number of users in the study that this feature was not used extensively.

Friend Feed and Map View

The friend feed was slightly more popular than the map view. Participants agreed to the item that they like the friend feed with averagely 4.2 ($SD = 0.4$), and that they like the map view with 3.8 ($SD = 0.9$). This indicates that it was considered more important *when* someone checked in to a location than *where* exactly the check-in was (in the map view, the location update’s recency was not visible). In the interview, one participant stated that the location would not matter that much for him, as the distances on campus are small anyway. By contrast, it was important for him to know that a friend *recently* checked in at a certain location, in order to be sure that this friend would still be there when he wants to meet her.

Privacy

The privacy concerns subjects had with our system were moderate. They agreed only with an average of 2.0 ($SD = 0.6$) that they were concerned of sharing their location. They agreed with an average of 4.3 ($SD = 0.7$) that they felt less concerned than when sharing their data with Latitude, Foursquare or Facebook Places. The higher inhibition on sharing with other systems was associated to the fact that the scope of these systems is global, and not limited as for *Ubiversity*. Further mentioned aspects were the commercial interests of these platforms and the concern that they might use location

information in other contexts and associate it with other personal data. In light of these findings, it is not surprising that subjects did not miss a connection to Facebook or other large-scale social networks. In average, they only agreed with 2.5 (SD = 1.3) to the item that such a feature would be useful.

Usability

Subjects agreed with averagely 3.7 (SD = 0.9) that the *Ubiversity* client was easy to use and that the user interface did not raise any questions. Two comments of individual subjects addressed a missing history view of own check-ins to assure that they were successful, and a possibility for directly entering the room number in the manual check-in view. Currently, building and floor have to be selected from a drop-down menu before the pre-filtered room list appears. For checking in, participants used mostly the indoor localization system, followed by manual room selection, QR codes and NFC tags. The question whether subjects used a certain technology for check-in often yielded the following levels of agreement: indoor localization (4.0, SD = 1.0), manual selection (3.8, SD = 1.3), QR-code (2.0, SD = 1.0) and NFC (1.3, SD = 0.7). The lower usage of QR codes and NFC could have two reasons: First, only our institute, and thus a small part of the campus, was equipped with this technology. Second, not all subjects owned a NFC-capable smartphone. This was confirmed in the interviews.

Discussion

The survey results indicate an high willingness to share one's own location, even slightly more than checking the location of friends. In the survey and in interviews, users declared that they were more motivated to share their location in *Ubiversity* than in Foursquare or Latitude. We identified several reasons. Firstly, check-in motives in Foursquare etc. are often driven by gamification [4], e.g., to earn badges or gratifications, or to demonstrate to have been at a "cool" event. The public image created by social network posts can also be a limiting factor: Lindqvist et al. [10] found that frequent check-ins to fast food restaurants convey a negative image. By contrast, in *Ubiversity* check-ins were rather intrinsically motivated, as they had concrete personal benefits for users: They could find fellow students for doing homework together, meet friends after lectures, jointly go for lunch, etc. The chance of being "found" was even a check-in motivation for subjects who did not see much use in Foursquare and similar platforms. They related this motivation to *Ubiversity*'s local scope and the small distances on campus. Users can quickly approach the specified location and meet the person there. In other location sharing systems, distances are typically larger, so that people might already have left when another person approaches the check-in location. Spontaneous meet-ups with friends become more likely in *Ubiversity*, so that the perceived benefit rises. This correlates with subjects' preference for the friend feed view over the map view: for a local scope, timeliness of location data was more important to them than the check-in location (as distances are short anyway).

Although we also observed the general acceptance of our system, the usage of different check-in methods etc., we were particularly interested in user's attitude towards privacy in

such a *local* location sharing system. Although prior work showed that users indeed care about privacy in a university context [16], results indicate that privacy concerns with *Ubiversity* played a subordinate role for most subjects, compared to services like Foursquare, Facebook or Google Latitude. Again, this is related to the local scope of the system, both in terms of users and of space. Most co-users will be fellow students, and check-ins are limited to the campus area. This minimizes the risk that "strangers" learn too much about one's daily routines, which was a frequent concern on large-scale social networks. The information of being in a certain room on campus, by contrast, was apparently not a privacy concern of our subjects. That is, in the worst case others can see that they are at a certain place on campus, which does not allow much of abuse.

Trust in the platform itself turned out to be an important factor for subjects – this aspect has, to our knowledge, not yet been addressed in previous research so far. Concerns in earlier work rather affected the tracking or stalking possibility by strangers [10]. In our survey, several participants raised concerns regarding what owners of social networking platforms could do with their data, e.g., interconnect it to other personal information. Users potentially put more trust in platforms run by universities than in profit-oriented commercial systems.

CONCLUSION

We have shown initial results of location sharing behavior based on a small-scale, two-week explorative study with a locally limited social network. The small number of subjects in this experiment can only reveal first indications. However, our findings suggest that users share information more willingly and show less privacy concerns when the network's spatial scope is limited. Users see more benefits in checking in at a place, since the chance of meet-ups initiated by these check-ins is higher than in a wide-scale social network. We bring up "trust in the platform" as an additional aspect of privacy that has barely been addressed yet, but has likewise to be considered. A university-scale system here entails a higher level of trust than large commercial networks.

Motivated by these results, we will further investigate how the spatial scope influences check-in behavior in location sharing systems. This will probably help us understand better what intrinsically motivates location sharing, and what factors prevent users from doing so. These research questions will have to be examined in further experiments and surveys with a larger base of users.

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