Enhancing Interactive Public Displays
with Social Networking Services

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ABSTRACT

In this paper, we suggest utilizing modern social networking services for building versatile applications for interactive public displays. We demonstrate the functionality and potential of this approach by presenting a set of services deployed on top of a network of public displays, utilized in a longitudinal study in an authentic city setting. We further propose utilizing users' personal online profiles for building personalized and appealing public social services, and suggest that this may enhance the attractiveness of interactive public displays. Results of this study indicate that using interactive public displays is inherently a social event, and that services supporting group use and sociality succeed in urban smart spaces.

Categories and Subject Descriptors

H.5.1. [**Information Interfaces and Presentation**]: Multimedia Information Systems **-** *evaluation/methodology*

General Terms

Design, Experimentation, Human Factors

Keywords

Social networking, Social computing, Public spaces, Urban Computing.

1. INTRODUCTION

Online social networking and media services (later SNSs) have recently gained great interest from research institutes and businesses alike. Research efforts in this area have focused mostly on user characteristics and motives, including the correlation and, at times, discrepancies between online profiles and real personal traits [1,2]. Other research tracks include the types of interactions occurring in these services [3,4] and privacy issues [5]. SNSs have gained a large role as medium for interaction, and can already be seen as the central hubs of communication.

During the last years, many SNSs have opened their APIs for external developers, and the amount of web mashups utilizing 3rd

party SNSs APIs has been steadily rising. Programmableweb [6] currently lists over 2000 open APIs, out of which the most popular ones include several social services, such as Flickr, YouTube, Twitter and Facebook.

SNSs have rapidly extended their reach and have become integral parts of the daily lives of young and adult alike. Facebook, the current leading SNS, offers 3rd party websites various means of integrating its features, such as shortcuts for liking and sharing content or different widgets displaying visitor's Facebook connections' activity. Today, a Facebook feed represents a dynamic, real-time performance and a frequently refreshed advertisement for oneself. Users are creating literal personality profiles which accurately reflect the personalities of the users online with a series or self-conscious acts [2,7]. Utilizing open APIs, it is possible to leverage this available social capital in various web applications.

However, SNSs together with the profiles users have built in them are still a young phenomenon and have not been leveraged in all ways imaginable. Potential exists in utilizing them with rapidly proliferating large public displays and social services tailored for them in so called hybrid spaces, where physical, social, and digital domains meet to form a playground for the future pervasive applications [8]. We see SNSs as enablers for enhancing many features of public displays, which often also suffer from the inherent lack of interest from the general public [9] – a phenomenon known as display blindness. SNSs APIs can be used, besides the dedicated client software and contemporary web applications, with public interactive displays in urban areas to gain several practical conveniences including efficient community coordinated content moderation, near-perfect uptime of backend systems, and off the shelf social enhancements, such as publishing, sharing, commenting, tagging, and rating of content (Fig. 1).

A common enabler for building applications for interactive public displays is to utilize direct manipulation using touch screens. Furthermore, solutions have been introduced for building distributed user interfaces that include personal mobile devices [10]. Thus, the challenges in building social interactive applications on public displays are increasingly dependent on supporting the sociality of interactions and provision of immediate perceived value to the user.
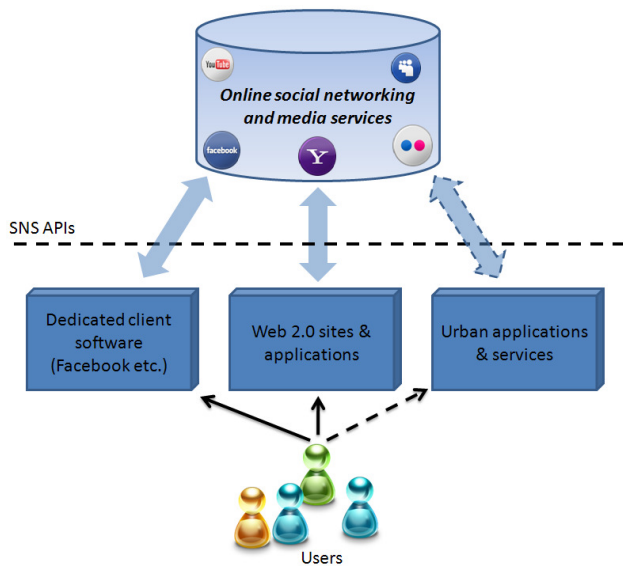
Figure 1. Utilization of social networking services (SNSs) APIs.

Using large public displays is often highly social by nature. Many different kinds of interactions and uses take place around public displays located in urban areas [10,11]. As suggested in [11], interactions on large public displays are based on asymmetric participation patterns and rapid adoption of differing user roles. However, users of social applications have a tendency of traversing from one service to another in a fluid manner. Thus, it is important that an application offers instant perceived utility value to its users. We argue that using SNSs open APIs together with user generated social content is a viable solution for building persuasive and appealing applications for public displays in urban areas.

This paper presents ways to utilize popular online SNSs as a basis for building services tailored for an interconnected grid of large public interactive displays in an urban setting. We have built social services that leverage multiple open APIs and unique features of today's SNSs on public displays in urban areas. The services have been evaluated in an authentic urban setting. The focus of this study is on services that take advantage of SNSs, touch screens, and co-located, embedded computing resources, such as web cameras and Bluetooth access points.

The contribution of this work is as follows:

1. Suggest and empirically evaluate a set of services that utilize 3rd party SNSs for interactive public displays in an urban setting.

2. Based on the evaluation, present a set of observations and suggestions, and identify topical challenges for SNSs based services on large displays in public spaces.

3. Propose and present seamless integration of users' personal SNSs accounts for enhancing features and capabilities of interactive public displays and services running on them.

The rest of the paper is structured as follows: section 2 introduces related work on social networking in public spaces and public displays. Section 3 introduces study objectives and methods.

Section 4 continues with system and services overview, and section 5 presents the results of our user studies. Section 6 discusses the results and section 7 concludes the paper.

2. RELATED WORK

Research on utilizing social media with public displays is a steadily rising research topic. Prototypes that leverage SNSs for enhanced interaction and awareness in public spaces [12,13] show early promise of socially useful applications that bring additional value to the expression of the public space itself. One of the aspects this work benefits from is the authenticity of online digital social networking profiles. Research shows that most of the profiles accurately portray the persons behind them [2], hence allowing researchers to build applications that connect users to their surroundings both spatially and emotionally.

The CityWall is a successful example of an application supporting communal behavior in public [11]. It is deployed at downtown Helsinki, and tested in large public events such as the Eurovision Song Contest and the Helsinki Samba Carnival. The CityWall is essentially a large, touch-enabled public surface displaying user-generated photographs. The CityWall utilizes Flickr as a 3rd party photo gallery. In the CityWall users can take photos that are propagated to a large touch screen surface via Flickr. Users are able to browse, share and play with the photos, creating a compelling social experience.

The CoCollage [14] offers a way to explore other user profiles via public displays and personal devices. The CoCollage uses both its own social networking backend infrastructure and 3rd party content sources, and is also designed to increase community awareness and interaction in public via offering details and extra information of other users present in the same space. It has also been partly commercialized, thus hinting about the real life business value that social content might add to a public space.

The Instant Places builds on the innovative use of user generated and controlled content [15]. It allows users to dynamically leave messages or pull online images to a display by renaming their personal devices' Bluetooth device names, using tags or usernames at Flickr. Results of this study involving a prototype deployment in a campus bar for several weeks suggest that the simple Bluetooth interaction techniques used were effective to sustain situated interaction around a public display. Furthermore, Instant Places appropriated new forms of social practices in the public space it was deployed in. Continual of this work illustrates how to increase the situatedness of a public display by constructing a "place profile" for a display with the help of visitors suggesting new tags for autonomous content selection [16].

The role and importance of online content should not be neglected when designing and building social services for public. Van House's study provided insight to the changing usage of online image content in social interaction and in multimodal communication [17]. Subjects indicated their content in Flickr as a transitory stream, a "throwaway", rather than a photo archive. The users' primary interest was focused on recent photos, and tagging of photos was done mostly for the benefit of other Flickr users, as study subjects rarely searched for their own photos. This encourages further explorations in the use of online social content, not only photos, but for example social networking

profiles, friend connections, status updates, etc., to provide socially meaningful applications.

Hermes Photo Displays [18] are displays situated in an office environment, and allow uploading and downloading of photos using e-mail, MMS, and Bluetooth. The user studies concluded several interesting issues. Firstly, there is a need for rich types of content to be shared and interacted with on a public display instead of only images, which tends to be the first and easiest solution for many prototypes. Secondly, the possibility for interacting with a public display from a distance, even just few meters, is a clear benefit for an application. For example, Bluetooth technology is a viable option for uploading, downloading, or interacting with a public display and its content. Finally, an important issue of one being able to remove / flag own uploads or otherwise offending content from public displays was highlighted. These results can be regarded as design considerations for applications utilizing user generated content on public displays.

3. STUDY OBJECTIVES AND METHOD

This study presents a set of services that integrate with well-known SNSs, and are deployed on top of a network of interactive public displays in an urban setting. The services were deployed for a period of 10 months "in the wild", and were subsequently used by thousands of people. The primary objective of this study is to identify and empirically validate the types of social services people perceive as useful and/or fun for interactive public displays in an urban setting. Further, a set of observations and design considerations are presented for such services. Lastly, it is proposed that the users' personal social networking accounts can be utilized to enhance the attractiveness of interactive public displays. For this purpose we present an implementation which allows the users to pair their Facebook accounts with the displays.

Throughout the longitudinal study, data on actual usage was gathered automatically by logging. The log files are analyzed for identifying emergent trends and behavior related to the use of social media services in public spaces. Additional data was collected through ethnographic methods, such as participant observation [19]. Researchers organized open events to the general public to come and familiarize themselves with the public displays and their services. Participants were asked to fill in a questionnaire during these events. Additional data was gathered by informal interviews and observation. Further, ten hours of passive observation of the usage of the public displays was conducted, as well.

We also organized a questionnaire study to collect feedback on the usage and impressions of the most popular social media service (as determined by usage statistics) from a group of users who reported using the service regularly. This further analysis is helpful in providing a deeper insight into why this particular service succeeded in this type of environment.

4. SYSTEM OVERVIEW

4.1 UBI-hotspots

In our long-term vision the urban space is populated with hotspots, which provide rich interaction between the physical, virtual and social spaces. For this purpose we have deployed a network of 12 so-called "UBI-hotspots" (Fig. 2, later hotspot) at

downtown Oulu, Finland [20]. The hotspots are a key component of our open urban computing test bed for conducting ubiquitous computing research in real-world setting [21]. A key component of the hotspot is the 57" landscape full HD LCD panel with a capacitive touch screen foil. Other computational resources available in a hotspot include a loudspeaker, an NFC reader, two embedded cameras, and Bluetooth and WLAN access points.

We do not offer our hotspots as a solution to particular (research) problems at downtown Oulu, which undoubtedly would survive just fine without the hotspots. Instead, we promote our hotspots as 'heavyweight' urban probes [22] and research enablers. The hotspots enable continuous in-situ urban computing research with real users and with sufficient scale and time span. The hotspots are versatile computing platforms, which facilitate provisioning of a diverse range of services to the general public in authentic urban setting.

Figure 2. Outdoor UBI-hotspot at downtown Oulu.

4.2 Services

In the interactive mode of the hotspot the right half of the screen is allocated to so-called UBI-portal. It is effectively a collection of web services browsed with the touch screen, including maps, a service directory and daily news. In this study we focus on the following services that build on different SNSs:

"Photos" offers a large image gallery from the city and its surrounding areas, categorized by tags and browsed with an orb-like interface. All images are pulled from Flickr using "Oulu" as the initial tag. The browsing interface is a slightly customized version of Tag Galaxy [23], selected for its visual aesthetics and good usability with a touch screen.

"UBI-photos" is similar to *Photos*, but the gallery contains only user-contributed photos uploaded from mobile devices over Bluetooth. Once a user uploads a photo, it becomes visible in every hotspot's *UBI-photos* service. *UBI-photos* utilizes a dedicated Flickr account as the online photo archive.

Both of these photo gallery services have additional features, as well. Users are able to vote for their favorite images and report any offending photos. Further, the images can be downloaded directly to a personal mobile phone over Bluetooth (Fig. 3).

"Videos" is a video gallery provided by the research group and collaborators such as the City of Oulu. It uses a customized

YouTube player for browsing and playing the videos that are stored on the local disk.
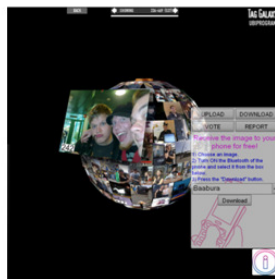

Figure 3. User interfaces of *Photos* and *UBI-photos*.

"**UBI-videos**" is similar to *Videos*, but it contains only videos uploaded by the users of the hotspots. *Videos* and *UBI-videos* both have identical user interface (Fig. 4).
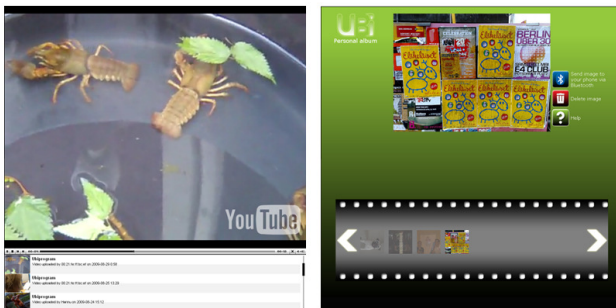

Figure 4. *Videos* (on the left) and *Personal gallery* services.

"**UBI-postcard**" is a virtual postcard, which takes advantage of embedded cameras. It allows the user to take a snapshot with bits of Oulu in the background. The photo, accompanied with an optional textual greeting and a customizable frame, can then be sent to several e-mail recipients (Fig. 5).

Account creation / logging in. Although most services in the hotspots do not require registration, many services, especially social ones, benefit from it. The user registers into the UBI realm, not to any individual service, hence registration needs to be carried out only once. Registration provides the user with a UBI-account which is coupled with the user's mobile phone serving as the personal identity key [10] and a user-created personal identification number (PIN). An account can be created at any hotspot. Having an account, the user can log in to the hotspot by choosing his/her Bluetooth enabled device from a list of available devices scanned to be nearby the hotspot and entering his/her PIN. After this, the services will get the user's data and properties from the UBI realm.
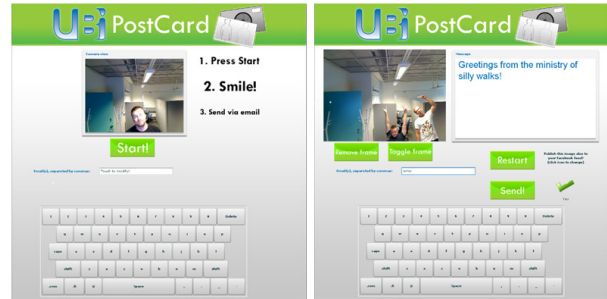

Figure 5. UBI-postcard: start and send screens.

"**Personal gallery**" is a service that allows logged in users to manage their own uploads to the hotspots. With this service, users can delete or download their own uploaded photos. *Personal gallery* comes in handy when a user wants to remove a photo that he/she has uploaded to the hotspots, and is thus visible to everyone in UBI-photos service (Fig. 4).

Personalization. Users are able to customize the hotspots' appearance in a similar fashion to many popular online social media services, such as MySpace or Twitter. The hotspots can be customized to use different color schemes. The user can also configure the service portfolio that appears in the starting menu. The UBI realm remembers the users' customization, and whenever the user logs in to any of the 12 hotspots, the color scheme and the customized menu is applied.

4.3 Facebook integration

The hotspots allow the user to pair his/her UBI-account with his/her Facebook account. This is a powerful enabler for many social features in public displays, making it possible to enrich many existing services, build completely new ones with more advanced social features, and otherwise enhance the capabilities of a hotspot.

After creating a UBI-account at a hotspot, the user downloads a link (.html file with an URL in it) from the hotspot to his/her mobile phone using BlueInfo, a simple free Bluetooth based information service for the hotspots [24]. The link leads to a page that instructs the user to grant the UBI-account access to the user's Facebook account. The actual pairing between the UBI-account and the Facebook account employs the users' mobile phone's Bluetooth device address as the identity token embedded as a parameter in the original link sent by hotspot. The process of registering a UBI-account and connecting with Facebook is illustrated in Fig. 6.

Facebook integration enables users to publish various activities from the hotspots to their Facebook feeds, for example high scores of particular games and *UBI-postcards*. The hotspot also leverages Facebook APIs by further customizing its visual appearance towards a more personalized one. When the user logs in, his/her Facebook profile picture is placed in the upper left corner of the hotspot, and a welcome text with the first name from Facebook is shown, contributing to the personalized experience of the hotspot.
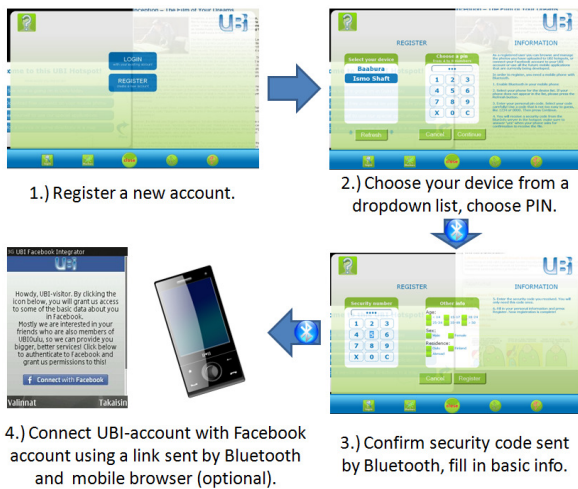
1.) Register a new account.

2.) Choose your device from a dropdown list, choose PIN.

4.) Connect UBI-account with Facebook account using a link sent by Bluetooth and mobile browser (optional).

3.) Confirm security code sent by Bluetooth, fill in basic info.

Figure 6. Registering a UBI-account at a hotspot and coupling it with a Facebook account.

5. EVALUATION

We empirically assess the usage of the five SNSs, UBI-postcard, Photos, UBI-photos, Videos, and UBI-videos, with different types of quantitative and qualitative data collected between June 2009 and May 2010. We also briefly address the personal gallery, the UBI-account, and Facebook integration that were introduced in June 2010.

5.1 Quantitative service usage

We logged the usage of the five services during the ten-month period from Aug 2009 - May 2010. Table 1 and Fig. 7 present the number of monthly and total launches (sessions) for each service. This statistic regards as a launch each time a service was launched on the hotspots. Hence, the number also includes "curiosity launches", where a user just launched a service without really using it, due to leaving the hotspot or immediately launching another service.

UBI-postcard was the most popular of the five services, attracting 38.9% of the total 61779 launches. UBI-photos ranked second with a significantly lower share of 23.4% and UBI-videos was the least popular service with 7.6% share.

Table 1 also reports *meaningful* service usage which corresponds to a service being used continuously for at least 30 seconds. Meaningful service usage omits the curiosity launches, and thus provides a more reliable estimate on the real usage. Using the 30 second criterion, 21% of the launches appears meaningful overall.

UBI-postcard becomes even more prominent with 47% share of all meaningful launches, which correspond to 32% of all launches of the service. The other four services, Photos, UBI-photos, Videos, and UBI-videos, respectively, contributed 23.9% (27%), 16.0% (24%), 8.7% (18%), and 4.5% (16%) of the meaningful usage with the respective proportions of meaningful launches of all launches in parentheses.'

Table 2 reports the average and median durations of meaningful sessions for each service. In the current interaction model the hotspot times out after 90 seconds of inactivity, i.e. there are no clicks on the touch screen and no faces are detected by the

embedded cameras, closing the current service and returning to its initial state.

Table 1. Monthly service sessions with meaningful sessions in parentheses.

|	UBI-postcard	Photos	UBI-photos	Videos	UBI-videos	Total
Aug	3197 (1033)	2285 (650)	1880 (511)	1261 (255)	741 (142)	9364 (2591)
Sep	2770 (872)	2053 (548)	1434 (309)	1086 (174)	653 (109)	7996 (2012)
Oct	2509 (790)	1699 (440)	1256 (298)	968 (172)	579 (49)	7011 (1749)
Nov	2713 (908)	1562 (422)	1208 (315)	947 (226)	583 (102)	7013 (1973)
Dec	2047 (640)	1233 (316)	827 (184)	690 (106)	405 (78)	5202 (1324)
Jan	1870 (537)	1005 (271)	720 (166)	647 (129)	293 (47)	4535 (1150)
Feb	2813 (896)	1288 (386)	782 (200)	747 (131)	459 (72)	6089 (1685)
Mar	2345 (784)	1167 (315)	907 (250)	600 (73)	394 (61)	5413 (1483)
Apr	2076 (674)	1136 (263)	986 (240)	539 (91)	335 (49)	5072 (1317)
May	1665 (519)	1033 (277)	718 (132)	405 (57)	263 (28)	4084 (1013)
Total	24005 (7653)	14461 (3888)	10718 (2605)	7890 (1414)	4705 (737)	61779 (16297)
Percentage	38.9% (47.0%)	23.4% (23.9%)	17.3% (16.0%)	12.8% (8.7%)	7.6% (4.5%)	
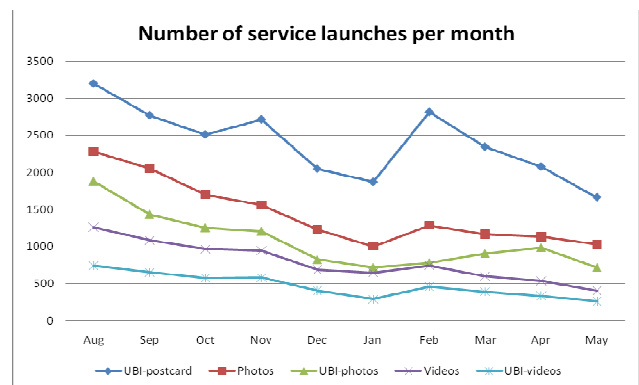
Figure 7. Visualization of launch trends per month.

Table 2. Average and median durations of sessions with total and proportional usage time for each service, using only meaningful sessions.

Application	Session lengths in seconds average (median)	Total usage times hh:mm:ss (percentage)
UBI-postcard	240 (104)	510:03:51 (61%)
Photos	118 (61)	127:38:02 (15%)
UBI-photos	169 (61)	121:59:10 (14%)
Videos	147 (60)	57:53:05 (7%)
UBI-videos	112 (53)	23:00:50 (3%)

UBI-postcard had the longest average session duration of 240 seconds with a median of 104 seconds while UBI-videos recorded the shortest average session length of 112 seconds. The total meaningful usage time of the services included in this evaluation exceeded 840 hours. The total and proportional usage times per service are also presented in Table 2. UBI-postcard contributed 61% of all usage time with more than 510 hours of meaningful usage. The second most used service in this regard was Photos with 15% share. Similarly to earlier results, UBI-videos with 3% share was the least used service. However, despite the seemingly low number, it is worth noting that in total it was used over 23 hours, which is a fairly long time for evaluating any single service.

5.2 User feedback

To gain general feedback on services, a familiar concept from online social services such as Facebook or YouTube, thumb

voting, was implemented. When the hotspot is in the interactive mode, i.e. any of the services is visible on the right side of the screen, thumb voting buttons become visible in the menu bar below. The user can give either a "thumb up" or "thumb down" to the current service. Table 3 shows the thumbs up/down numbers for each services.

Table 3. Thumb votes breakdown for each service.

	UBI-postcard	Photos	UBI-photos	Videos	UBI-videos	Total
Thumbs up	217	101	29	73	27	447
Thumbs down	203	96	39	81	29	448

During the fieldwork we organized open events where researchers helped and guided the general public in using the hotspots. In these events, a short questionnaire containing statements on the general suitability of the hotspots for providing services in public was distributed. The respondents (n=124) were asked to assess the statements on a 5-point Likert scale. The largest age group participating in these events was 51-65 (~30%). Table 4 presents relevant findings from these questionnaires.

Table 4. Questionnaire results from field studies.

Statement	Avg	Std. dev
UBI-hotspots fit in downtown Oulu	4.46	0.86
Using hotspots feels natural in a public setting	4.15	0.93
The UI is easy to understand	3.89	1.04
Hotspots give enough instructions during use	4.13	0.96
I prefer using hotspots together with someone	3.78	1.21
I am interested in creating a personal user account to the hotspots	2.35	1.37

The user acceptance of the hotspots and related services was measured with the following questions: "Hotspots fit in downtown City", and "Using the hotspots feels natural in a public setting". These were given high scores of 4.46 and 4.15 on a 5-point Likert scale. Statement "The UI is easy to understand" scored 3.89 and "Hotspots give enough information during use" averaged 4.13.

The statement 'I prefer using the hotspots together with someone" received an average score of 3.8. Teenagers (<15 years) gave this statement the highest average score of 4.4, while elderly people (>65 years) gave an average score of 3.05. Women gave the statement a slightly higher score than men (3.8 vs. 3.4).

The statement about being interested in creating a personal account received a rather low score of 2.35. To this, teenagers (<15 years) responded more positively (average 3.2) than older people (35-50 years average 1.7; >65 years average 1.85). Further, men responded more positively (average 2.4) than women (average 1.89).

5.3 Case study: UBI-postcard

The preceding analysis showed that UBI-postcard is a successful social service for public displays. In this section we explore its usage in more detailed fashion.

Cards sent. During November 2009 – May 2010, a total of 3552 UBI-postcards were sent. Unfortunately, the log files from Aug – Oct 2009 are missing due to a technical glitch in our logging mechanism. The ratio between the number of postcards sent (3552) and the number of meaningful sessions (4958) was over 71%. This indicates that a high percentage of all meaningful usage sessions led to a card being actually sent. During the data collection period the number of cards sent has not dropped significantly, even though the number of service launches has decreased heavily (Fig. 8 a.). From this, we conclude that UBI-postcard has indeed succeeded in creating a group of active and loyal users - this conclusion is further supported by interviews.
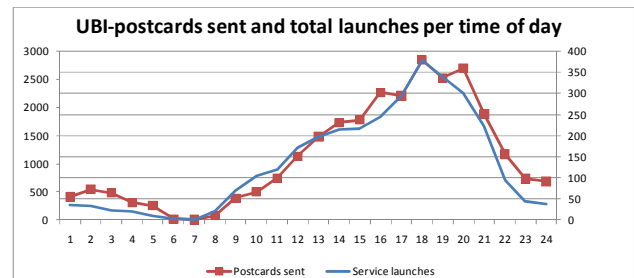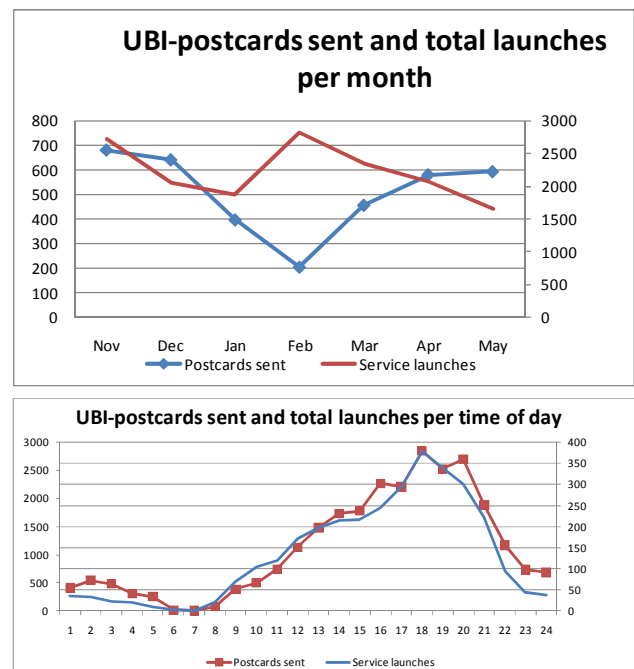

Figure 8. a.) Number of UBI-postcards sent (primary y-axis) and all UBI-postcard sessions per month. b.) All UBI-postcard sessions (primary y-axis) and number of UBI-postcards sent per time of day.

Time of day of use. Fig. 8 b. shows how the launches of the UBI-postcard and the number of sent postcards were distributed over the time of day. The quietest hour was from 06:00 to 07:00 (12 sessions and one sent postcard) and the busiest from 17:00 to 18:00 (2839 sessions and 379 sent postcards). This clearly follows the daily routines of people at downtown. UBI-postcard is a convenient service to send e.g. greetings to friends or family after the standard office hours.

Questionnaire study. 23 self-proclaimed UBI-postcard users answered an online questionnaire addressing their personal experience with the service. The questionnaires were completely anonymous and users answered them independently without any reward incentives. The questionnaire was advertised by spreading an invitation in Facebook. The respondents (19 male, 4 female, ages ranging from 21 to 34) were accustomed users of UBI-postcard with an average usage count of over 15 times. One respondent reported to have used UBI-postcard 70 times.

First, users were asked how they prefer to use the service, together with other people, or alone. 21 (91%) wanted to use the service

with someone, and only two alone. UBI-postcard is clearly a service that encourages group participation and is socially stimulating.

Secondly, users were asked about to whom they mostly send cards to. Respondents were able to choose multiple answers. 22 sent cards to friends in Oulu, five to friends elsewhere in Finland, and 2 to friends abroad. Five users reported to send cards to relatives and family, while three users sent cards to their spouse.

As UBI-postcard users are currently offered a possibility to publish a postcard to one's Facebook feed, we asked whether this is a good idea. 15 of the responses were in favor and five against. Common comments stated that they would not use it often, but the possibility would be good to have in case an exceptionally funny picture gets taken - it is handy to publish content fresh on the spot. Another common issue brought up dealt with password / username privacy. This should not be a problem, however, since the Facebook authorization mechanism we use is not more unsecure than any Facebook application out there. Perhaps the usage of this functionality in such a highly public setting is still too new for users to really understand [3].

Users were also asked to make suggestions for improvement. Seven of the respondents would have liked to have image editing and effects. Funny items such as moustaches, animations or other "mad effects", as one respondent described, were requested to make the card livelier. Better resolution than the current 640x480 pixels for the virtual postcard image was also requested five times. UBI-postcard is clearly seen as an entertaining service, with which people would be willing to spend more time if they could further enhance the expression of the card being sent.

Finally, users were asked to give a general score to UBI-postcard service on a scale from one to five. The average score given was 3.8, which goes to show that while active users are relatively happy with the service, additional features are still needed.

6. DISCUSSION

The findings of this study indicate that interactive large public displays can be a good fit for the urban cityscape. Their usage seems to feel natural for modern people, and easy-to-use user interfaces for these kinds of displays can be provided. Thus, a network of such displays provides a powerful test bed for evaluating social applications in public.

The success or failure of an application deployed on a public display can be assessed based on the amount of usage it has attracted in terms of application launches, session durations, and sustained usage. Out of the service repertoire studied in this work, UBI-postcard was the most prominent. During field work we observed that UBI-postcard was often used by large groups of people. This suggests that playful interaction with social co-experience provides strong incentive for interacting with a public display.

The added value perceived by the users of social applications on public displays can be increased by offering something to do or to instantly interact with. UBI-postcard encourages immediate creation of social media that is to be shared with other people. We believe this explains its success in persuading users to use it for longer periods of time. A public social application offering instant value to its users can expect to see active and sustained use.

In contrast to our initial assumption, our user contributed video service did not attract substantial usage, as the many current popular video SNSs do. Possible reasons include the low number and quality of the video uploads in our service. It is clear that many of these uploads were done just to test the technology, and not really to provide valuable, easy to share viral content. Perhaps these kinds of services requiring more time to produce and consume content are better suited for personal desktops, where people can interact with the video content in a more private and familiar setting.

Conversely, the usage of the user-contributed photo gallery was significantly more extensive than that of the general photo gallery. While a large gallery of general photos can be useful for a tourist or someone without any spatial or emotional link to the content, a smaller number of photos uploaded by the community close to the user may persuade to interact with the photo gallery for longer periods of time, just to see friends or other familiar faces.

The implemented thumb voting system did not yield expected data on subjective user experience. Although hundreds of votes were given, the even vote counts appear merely as random noise. Exploring different feedback systems for such settings is a fertile ground for further research needed to uncover best practices.

6.1 Implications and challenges

Results from this work may be used as design guidelines for social services on public interactive displays in urban spaces. Firstly, the use of the displays appears to be a highly social event. This is confirmed both by the questionnaire studies and field observations. Many times groups of tourists or teenagers were seen playing games together or taking a UBI-postcard multiple times before finally settling for a particular shot and sending it. The social nature of using these kinds of displays should be reflected in the design of the services. Social services inherently supporting multiple simultaneous users, such as the UBI-postcard, are attractive because the whole user group can participate. SNSs provide a powerful way to extend the reach of these kinds of social applications as they allow the users easily to share the content beyond the boundaries of the public display itself.

Services driven by user-contributed content emerge as an attractive application domain for public displays. Similarly to online social networking sites, people seem to prefer viewing content provided by their friends instead of strangers. However, these applications should provide a quick and effortless interaction as public displays are often located in crowded spots, which call for rapid and short-term usage sessions. In our case, we experienced severe problems with video content, as the time and effort required to upload and view content were obviously too inconvenient.

Persuading elderly users to contribute to SNSs remains a challenge, not just with public displays, but with SNSs in general. It is important, yet rather difficult, to entice participation from new users of SNSs. Many times, they may be unwilling or unable to make a contribution, either due to not understanding the community itself, not being able to use the required technology, or in the worst case both [3]. However, during our guided public events and "walkthroughs", we noticed that older people are very willing to become active users with a little encouragement and careful guidance. This was also supported by the fact that he

biggest age group participating in these events was surprisingly 51–65 years.

Conversely, we also often asked teenagers to participate in the events, but they usually declined, claiming to be already familiar with the hotspots and their services. This suggests that the younger population adopts more eagerly new technology as part of their daily lives, and thus are the first to either accept or reject a particular service. This is even clearer for more complex services that require external devices in conjunction with the public displays. For example, creating a user account requires the use of a mobile phone, which can be seen as gadgetry appealing better to the youth.

When designing services for longer deployments instead of short term case studies, obtaining returning users presents as an important problem. The novelty value wears out quickly, as we observed with the linearly decreasing number of total service launches. If a service does not offer enough incentives for the user to return, it faces a loss of interest from the general public. UBI-postcard, for example, allows users to create a personal postcard with new expressions and greetings every time. Consequently, over 70% of the meaningful UBI-postcard sessions led to an actual card being sent.

6.2 Social networking for hybrid spaces

Besides using SNSs as backend systems for applications, we propose a more seamless SNS integration for public display systems as a means for easily obtaining socially and emotionally meaningful content. It can be utilized in both personalizing the displays and in building attractive social services with sustained user value. Further, if the content acquisition from SNSs could be automated, they could provide a powerful way to combat display blindness.

One of the very cornerstones to a successful social application is a continuous stream of updated content [12]. SNSs integration provides access to fresh updates and content from the users' online peers in different services. In addition to the benefit of obtaining important content for personalization and building social services, many novel use cases for this integration can be envisioned. As the users already indicated with UBI-postcard, there is a need for the possibility of instantly updating personal online feeds on the spot when something worth an update occurs. This is possible with the APIs of most modern SNS. Also, one perk is the real-time acquisition of users' social connections from SNSs where people maintain accurate information about their friends, peer groups, family, etc. They can be leveraged by various map based social services on public displays with more powerful visual and interaction capabilities than the users' personal mobile devices, in advanced location based notification systems, recommendation services, and much more.

We further proposed utilizing the personal mobile devices as the access tokens, the keys, to the public displays and especially its augmented social networking features. We argue that personal mobile devices will increasingly dominate access to resources embedded to our casual and everyday environments as they are truly ubiquitous, highly personal, regarded safe and familiar by their respective owners, and constantly increasing their role as the central communication devices for people in urban areas [10,25].

A display can also increase its perceived value by adapting to the social setting around it. Physical sensing around a display is relatively easy, but obtaining socially meaningful, up-to-date data is difficult [15,16]. Seamless integration with the users' online content would enable this effortlessly, as the available online content tends to be accurate and timely [2,17]. The users having opted to integrate their SNS accounts with the public display realm can easily contribute their fresh and socially meaningful content to the physical space around the display, contributing to the situatedness of the display. Naturally, new privacy control mechanisms are needed for this kind of situated revelation of one's online identity.

We reported such an integration mechanism with Facebook as the first linking of users' SNSs with our hotspot infrastructure. It allows users to couple their Facebook accounts with our hotspot realm using their personal mobile phones, and by doing so, to gain several enhancements and new services in the hotspots. This coupling allows the users to further personalize the hotspots and their services, and to access the related social media content online. We are in the process of gathering data and user impressions on this integration.

7. CONCLUSIONS

We presented a set of services utilizing SNSs for interactive public displays, which have been subjected to long-term evaluation in an authentic urban setting with a large population of real users. We identified several factors and challenges influencing the adoption and success of SNSs on public interactive displays. These include the inherent social nature of using a public display, the importance of user-contributed content, and the need to offer instant rewards to the users to make them return. This is done by UBI-postcard, which was by far the most successful service in our study. It allows a user or a group of users to create rapidly, in a playful and social co-experience, a virtual postcard to be shared with friends. Finally, we proposed a mechanism for seamlessly integrating the users' Facebook accounts with the public displays, which opens up new opportunities for enhancing the social features of the services provided by the hotspots.

8. ACKNOWLEDGMENTS

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