Public Photos, Private Concerns: Uncovering Privacy Concerns of User Generated Content Created Through Networked Public Displays

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ABSTRACT
Networked public displays offer new ways of connecting communities through user-generated content. For example, they allow taking situated snapshots, i.e., photos taken through a display-attached camera, and viewing them on displays in the network or potentially somewhere on the web. Little research has looked into users' privacy concerns for this novel type of content. This paper reflects on two longitudinal studies of the Moment Machine application that was running in the UK and Switzerland for 12+ weeks, and summarizes some of the privacy concerns this type of user-generated content can raise, namely: communicating where the publicly taken situated snapshots are stored, where they appear, that no surveillance is taking place, content control for situated snapshots, where (in what place) and how interactions happening on the web will appear on a display network. Based on the two studies I make recommendations and inform the design of similar future networked public display systems.

Author Keywords
Situated snapshots; urban screens; privacy.

ACM Classification Keywords
H.4.3 [Communications Applications]: Bulletin boards; H.5.1 [Multimedia Information Systems]; H.5.3 [Group and Organization Interfaces]

INTRODUCTION
Although there is a plethora of new communication media available, new ones are coming out every day. One of them – networked public displays – is envisioned as "the communications medium for the 21st century" [8]. Due their embedded nature in public spaces, they can stimulate community interaction between members of the same or distinct communities residing within and across public spaces [19]. This vision is coming to reality as public displays are "painting" the urban scenery [13] and more "live test beds" are emerging where researchers can investigate the use and effects of this medium, e.g., [5, 12, 21, 22]. One way of stimulating community interaction is through situated snapshots, i.e., pictures taken through a display-attached camera. These photos can be viewed on the local network or somewhere on the Internet. For example Plustouch [23] released a situated snapshots application on their displays in shopping malls in the Netherlands and report on 300 photos taken through their displays on a daily basis. Similarly, Snips – a popular sneaker shop in Zurich – installed cap and sneaker cam that allow posting situated snapshots to their Facebook page, and similar installations have also been noted in the World Duty Free store at the Gatwick airport (cf. Figure 1). The Moment Machine [16] and Moment Machine 2.0 [15] are two examples of such applications that will be discussed in this paper.

Figure 1 –Example of situated snapshots from the real world. Snipes store: cap cam (left) and shoe cam (second left) capture situated snapshots, which can be found on Snipe's Facebook page [25]. World Duty Free store at Gatwick airport (right) that allows taking situated snapshots and posting to one's Facebook page.

Previous work has reported that interacting with networked public displays can raise privacy concerns [1]. When it comes to privacy and networked public displays previous work has described general privacy challenges for networked public displays [17], technical architectures that support application broadcast in privacy safe manner [7], or have investigated how viewing personal content on public displays can be made privacy oriented [4, 24]. In other

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Figure 2 – The Moment Machine's user interface. The first version of the application allowed posting and viewing photos only on a public display network.

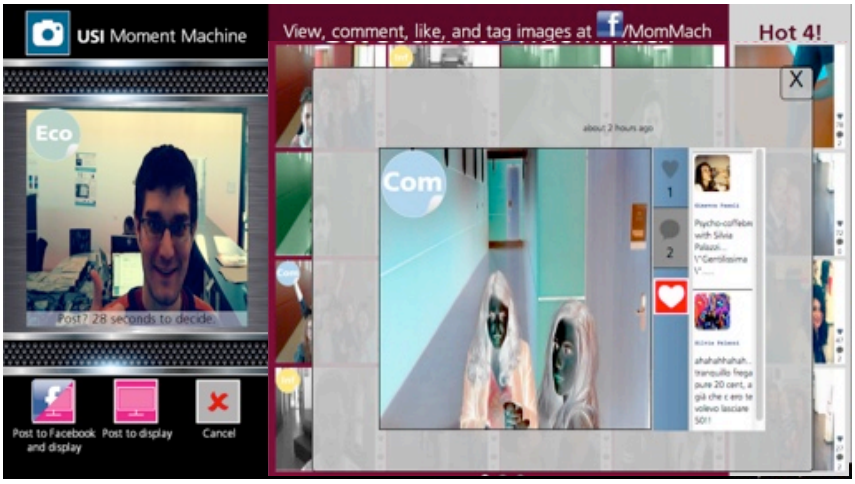

Figure 2 - The Moment Machine 2.0 user interface. The application allows posting situated snapshots through a display-attached camera to a public display network and a dedicated Facebook page. Comments and likes from Facebook are also shown on the display.

words, little research has looked into privacy considerations of creating user-generated content through networked public displays and viewing it on them, as well as understanding implications of posting user-generated content to other places on the web, e.g., Facebook. The contribution of this paper is twofold:

- I show privacy considerations raised through two longitudinal 12+ weeks deployments, i.e., communicating where the publicly taken situated snapshots are stored, where they appear, that no surveillance is taking place, content control for situated snapshots, where (in what place) and how interactions happening on the web will appear on a display network.
- I discuss how identified issues could be addressed and offer guidance for designers and developers of similar future networked public experiences.

After describing related work I will present two versions of the Moment Machine application as well as the settings where the applications have been deployed. Next I will describe privacy concerns that were raised by the users. After that I will present implications for similar future applications and experiences. Finally I present concluding remarks.

RELATED WORK

Situated snapshots are an emerging topic in pervasive displays. So far, they have been scarcely explored. The research team in Oulu was the first one who started exploring the possibility of using public displays for taking situated snapshots via display attached camera. It was first used in UBI-Postcards [22] – an application that allows taking photos and posting them to an email address (photos do not appear on a display network). Later on it was used in Ubinion [11] to allow young adults to create photo scenarios and stories about their views and problems in the city of Oulu. The Moment Machine and Moment Machine 2.0 applications complement the two applications by allowing unconstrained use and exploration of situated snapshots.

While situated snapshots are emerging topic, privacy for networked public displays has been researched for quite some time now. Previous work has shown that privacy on public displays is one of people's main concerns [1] and has described the tension between personalization and privacy for networked public displays [17]. These tensions come mainly from finding appropriate ways to identify users in front of a public display and to what extent (user identification); where a user profile is located (profile location); and what information is stored in it (profile content); how noticeable content tailoring should be for a particular user (content tailoring); how to learn about users (model refinement); and creation of personalized applications for this public medium in general.

The Tacita system [7] describes experimental privacy aware personalization architecture for networked public displays. In this system displays signal to potential users what applications they support. The Tacita mobile phone client detects available display applications, and based on the user's preferences decides if an application will be displayed or not. In order to preserve user's choices all communication between a user and a display is handled by an application that requires to be shown on a particular public display. Similarly, PriCal architecture [24] supports display of a user's calendar events on public displays depending on the user's privacy preferences that are stored on his/her mobile device. Brudy et al. [4] discuss several

proxemics-based techniques for signaling shoulder surfing to public display users (i.e., flashing the display borders, showing a person's silhouette, and showing a red dot on a display that represents a person's eye gaze) and techniques for adapting the content so that its privacy (as well as user's privacy) is protected (moving the content, blacking out the content, and blurring the screen except for the part that is directly in front of a user). Lastly, the UbiOpticon [10] application explored how networked public displays can be used for susveillance – participatory citizen surveillance – by complementing video feed broadcasted from cameras located on top of 12 networked displays in the city of Oulu, with two additional feeds that were coming from two roaming mobile phone cameras. Their study revealed that older adults had privacy concerns with video feeds coming from mobile cameras – who would control and moderate the video feeds and misuse, e.g., drunken teenagers filming each other, and who would be a responsible person for that.

The work presented here complements previous work in several ways. Previous work has described potential privacy challenges [17] and has presented technical solutions for showing applications in a privacy aware manner [7] and viewing more personal content on public displays [4, 24]. This work complements all of the above-mentioned research by going beyond just showing content on situated displays and describing challenges that arise when networked displays are used for content creation.

THE MOMENT MACHINE DEPLOYMENTS

The user interfaces for the Moment Machine and Moment Machine 2.0 are shown in Figure 2 and Figure 3 respectively. The two applications are based on the WE-BAT framework [9], a JAVA Play client server web framework. The first version of the application allows posting photos only to a display network, i.e., it supports only tethered interaction [14]. The application was deployed on the Screens In The Wild network[1] comprising from four displays. Two of the displays are located in London – in Walthamstow's "The Mill" community center and at Leytonstone public library – and two of the displays are located in Nottingham – in New Arts Exchange gallery/café and Broadway cinema and café. The Moment Machine application was deployed in February 2013 and was running until the beginning of October 2014. Findings reported in this paper come from reflections on some of the interviews – 13 interviews with individuals and groups, interviewing 19 people in total – and three weeks of observations that were conducted for the purpose of evaluating its effects on community interaction during the first 12 weeks of deployment [16]. Overall, 3390 photos were taken across the four locations, 1189 at the Mill. Participants' age ranged from 11 – 15 (8), 31 – 35 (4), 36 – 40 (2), 41 – 45 (2), and 56 – 60 (3), with 10 participants being male. Information on social media use was collected for seven participants due time constraints of the interviews and prioritizing questions. Six out of seven participants reports using social media, mainly Facebook for uploading personal photos (5 interviewees), while some also use Flickr for the same purpose (2 interviewees). One participant does not use social media at all.

The Moment Machine 2.0 [15] is the second version of the application and it allows posting photos to a display network as well as to a dedicated Facebook page[2] (cf. Figure 3). Also, the second version of the application shows interactions from the Facebook page on a display network, i.e., once a person clicks on a photo on a side s/he can choose to view comments or likes by clicking on the appropriate button (cf. Figure 3). For likes a person's profile picture and his/her Facebook name are show; and for likes also the comment s/he made. The second version of the application was deployed in a different setting – University of Lugano main campus – on four displays in January 2014; the application is also still up and running. The University of Lugano has three faculties on main campus – informatics, communication science, and economics – and displays were located representative buildings: one display is located in front of the university canteen in the main building where most of the students socialize, one display is located in a building where students of economics and communication science attend classes, and two displays are located in a building where students of informatics have classes. Overall, 1382 photos were taken on the four displays.

Findings used for this paper come from 20 interviews conducted with 27 students for the purpose of evaluating the applications impact on community interaction and sense of community at the University of Lugano. Most of the participants (16) were 21 – 25 years old, followed by the group of people 26 – 30; the rest (3) were 16 – 20 years old and 31 – 35 (1). More females were interviewed (15) than males (12). Most of the participants report using Facebok regularly (24) or sometimes (3); in contrast to that almost all participants reported that they do not use Twitter at all (24); while their reported use of Instagram is somewhere in between with 11 interviewees using Insagram regularly and 7 sometimes.

PRIVACY CONSIDERATIONS FOR SITUATED SNAPSHOTS

While people were in general excited about the use of the two applications, there have been some concerns with respect to privacy of the situated snapshots. These concerns can be grouped around five themes presented below: communicating where the photos are stored, communicating where the photos will appear, on-display content moderation for situated snapshots, communicating there is no surveillance, communicating where and how

[1] http://screensinthewild.org/

[2] https://www.facebook.com/MomMach

interactions on the web appear in a physical setting, and issues related to content ownership.

Communicating Where the Photos Are Stored

One of the challenges that relates to privacy is communicating where the photos are stored. While this was not the problem for the Moment Machine 2.0 as it allowed posting the photos to Facebook, which might have hinted to the users that photos are stored on Facebook or somewhere else, it turned out to be challenging for the first version of the application. For the Moment Machine application at the end of an interview the participant and I would browse the photos in order to find potential future participants. One participant expressed that it was really strange to see the photos on my laptop as he thought that photos were stored only on the display itself, while in fact they are stored on a secure server (far away from the display's location). This caused some unexpected privacy concerns, i.e., who can see the photos and who can access them, as it was not clear from the application's design that photos are not stored "there" on a display. Interesting to note that a person who is graphical designer that uses Flickr and Facebook on a regular basis raised the issue. This points out how much "situated" is the mental model of the users when it comes to public displays, and also shows the importance of having a clear user interface design that communicates where the data is stored.

Communicating Where the Photos Will Appear

Similarly, not only is it important to communicate where the photos are stored, but also where they will appear. Some of the interviewed participants that interacted with the Moment Machine application did not realize that their photos not only appear on the display where the photo was taken, but also on other displays in the network. Although this misunderstanding might seem trivial for a display network with only four displays, it can become more challenging in the future with potentially hundreds of thousand (or even millions!) of displays: your photo could end up really easily in an undesired location if a user does not understand where it will appear.

On-display Content Moderation for Situated Snapshots

Connected to the above two challenges is the challenge of supporting on-display content moderation for situated snapshots. This relates not only to deciding where to store the photos (as potentially they could be stored on a user desired location), where to post the photos (on what displays and places on the web), but also how to support controls that allow deletion of photos. In one case for the Moment Machine deployment, a person complained that she could not delete a photo that she was in. She appeared in the photo by accident, i.e., someone else took the photo while she was passing by a display. The participant commented that she is a "perfectionist" and that she does not want to have photos of her where she is not looking good, especially not in a place that she attends/passes-by on a regular basis. Similar cases also happened for the Moment Machine 2.0 deployment where the application

Figure 3 –An example of students flipping the camera up so it would not show them on the live video feed

admin was contacted through Facebook with requests to take down the photos, because a person did not want to appear in them (one thing to note is that all the photos that were requested to be taken down did not contain any rude gestures or behavior).

Communicating There Is No Surveillance

In order to communicate to the passers-by that a display is interactive a live video feed was shown, as suggested by prior research [20]. However, this raised some concerns that the live video feed is being used for surveillance. This was especially evident in the informatics building where frequently the camera on the ground floor would be flipped up pointing to the ceiling, as shown in Figure 3.

Communicating Where and How Interactions on the Web Appear in a Physical Setting

While most of the aforementioned problems relate to situated interactions with a display, there were also concerns coming form interactions on the web. For the Moment Machine 2.0 application an open challenge remains in what way to indicate to the online users where and how interactions happening on the web appear on a display network. While liking and commenting on Facebook (or potentially from somewhere else on the Internet) has to be discovered and is potentially seen by a known (and potentially limited) audience familiar to the

user, comments and likes on a public display might be seen by anyone who passes by a display. Passers-by could see comments that might be thought as funny within a close group of friends as very rude. As in the current version of the application a commenter's profile picture and Facebook name are shown s/he could be easily identified and his/her views could be misinterpreted, potentially leading to undesired confrontations and public judgment within the locality where they appear.

Content Ownership

The same Moment Machine participant who was concerned where the photos are stored was also concerned with who owns the photos. Just to mention again, all the users took the photos with the Moment Machine on their own free will and without any incentives to do so. While for similar photo taking experiences content ownership might be clearer, e.g., taking a photo with your own digital camera makes you the owner or taking a photo with a mobile phone using a dedicated service like Instagram makes service provider the owner, for networked public displays things are a bit different. As reported by previous research [2, 18] there are different stakeholders involved, e.g., people owning the display or the entire display network (display owners), people who have provided the service (content providers), and people who actually took the photo (content viewers).

DISCUSSION

I discuss here privacy concerns raised by the Moment Machine users and offer guidance for addressing the above-mentioned issues, thus allowing future designers and developers to create more privacy friendly applications that support creation of user-generated content through networked public displays.

When it comes to the question *where the content is stored* there are a couple of options to be considered. One option would be to offer the users to choose where they want to have the content stored, e.g., sending the image information over the Internet or mail and storing it on a personal server or other locations (e.g., Facebook or mobile phone). Another option to consider is to offer temporal storage where the content gets deleted after a user-predefined amount of time. In any case, the least thing that could be done is to show a message notifying the user where the image will be stored before the user posts the content, allowing him/her to make a more informed decision (although making comprehensible notices comes with a set of challenges on its own [6]).

Providing a sneak preview of where exactly and how the photos will appear could communicate where the photos will be displayed/shown. This could be done by showing a live video of a display and its surrounding for the chosen locations where the snapshot is to be published. Similarly a preview could be provided for the web. In the same way *showing a preview of where the comments and likes would appear* could be done, allowing the person also to make these interactions only visible on the web or only on a display. While providing preview for a handful of locations cold be feasible, for tens or hundreds of displays this would become more difficult. In such cases other ways of conveying the information where the photos will appear could be done, e.g., by grouping the displays according to their physical location or other criteria [1].

When it comes to *offering controls for content moderation for people who are in the photos* there have been previous works that have addressed this issue to a certain extent. For example, this has been done by flagging inappropriate content, which would then trigger the application administrator to take a look [1]. The same approach has been also used by other platforms that support sharing of user-generated content, e.g., YouTube. This approach could be further developed for public displays: as they are located in physical settings user IDs (e.g., Bluetooth names) could be recorded at the time when a photo was taken, thus assuring that only true passers-by get to flag (or even delete) the content that they feel uncomfortable being in; or even face recognition could be used to authenticate people in the photos in order to give them editorial control.

Communicating that *no surveillance is taking place* could be addressed very simply by adding a sign that states no surveillance is taking place. However in the two studies I have observed that, although a display is big, user's attention is typically focused on only one spot where the interaction happens. A more proactive way of addressing this issue would be by obscuring the live video feed by using a silhouette or a faded/blurred video until a user is close enough to a display and then showing the clear video stream, as previous research has shown that blurred image conveys enough awareness information while preserving users privacy [3].

Lastly, *content ownership* needs to be addressed. While with current photo taking technologies and sharing platforms, e.g., mobile phone and digital cameras and platforms such Facbeook and Instagram, users understand who owns the photo, for networked public displays this is not clearly defined as there are different stakeholders involved, i.e., display owners, application developers, and content producers [2, 18]. This problem can be linked with previous issue of where the photos are stored: for example, if there would be the possibility to allow a user to choose where s/he wants the photo to be stored (e.g., some personal server), then the user would be owning the content. In case of networked public displays where potentially multiple stakeholders can own the content there is not right or wrong answer, as content ownership depends on other factors such as business models or research questions. The message here is that content ownership needs be made clear. For example, this can be done by providing a short explanation of the terms of service before a user posts a photo (e.g., when choosing where to post the photos as depicted with two buttons in Figure 2).

CONCLUSIONS

As a novel communication medium, networked public displays offer new ways of creating user-generated content and interactions within and across public spaces, e.g., through situated snapshots taken through a display-attached camera. Applications supporting them are not only gaining popularity in academia, but also in the real world (cf. Figure 1). Reflecting on two longitudinal deployments of the Moment Machine application this paper summarizes some of the privacy concerns that are associated with situated snapshots, thus contributing to the knowledge of privacy and networked public displays. To note, this is a first paper that reports on the issues relating to user-generated content created through networked public displays and related privacy concerns. Future research in the area can build on the issues described in this paper as well as recommendations on how to address them.

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