Image Space: Capturing, Sharing and Contextualizing Personal Pictures in a Simple and Playful Way

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ABSTRACT
The increasing use of digital cameras and camera phones has changed people's behavior regarding the amount of photos that they make. As a result, growing collections of photos are more and more difficult to understand, search and navigate. Helping users make sense of these collections and create an understanding of the world that they depict has become a challenging task. In this paper, we present the design, implementation and evaluation of the Image Space service, which enables users to capture, browse and contextualize their digital photographs with the aid of a community of other users in a simple and playful way. We report evaluations which indicate that the service was easy and to a lesser degree playful to use.

Categories and Subject Descriptors
H.5.m **[Information Interfaces & Presentation]**: Miscellaneous.

General Terms
Design, Human Factors.

Keywords
Digital photography, geo-tagging, camera phones.

1. INTRODUCTION
When consumers adopted digital cameras and camera phones in the late 1990s, people changed the way they made pictures and thus began to take increasingly more photos [12]. Later on, web-based photo collection services such as Flickr [5] or even Facebook [4] became popular and so consumers began sharing their photos online. As online collections of digital photos grew, so did the difficulty in making sense of the large volume of community-generated content such as photos that is available on these sites. Due to their magnitude, these collections are often difficult to understand, search and navigate [10]. Services such as PhotoSynth [18] provide alternative ways to interactively browse and explore large unstructured collections of photos in 3D reconstructed environments. Although both Flickr and PhotoSynth provide a map view to contextualize photos, from the users' point of view, these services require people to perform a series of tasks before they are able to see the end results online. For instance, "Photowork" [12] consists of all the activities that people must perform involved with their digital photos after capturing but prior to end use such as sharing. These activities include reviewing, downloading, organizing, editing, storing and filing photos. Furthermore, in PhotoSynth users must select, upload a large number of images, and wait for some time for the service to create the reconstructed 3D environment or 'synth'.

In this paper we present a service that allows people to capture, share and contextualize personal pictures in a simple and playful way. Our key contribution is a service that allows users to instantaneously upload photos taken with their mobile device to an online community service. The photos are displayed on a map and in a 3D view in their context (i.e. location and angle). Photos are grouped by Scenes to spatially navigate collections of images.

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2. RELATED WORK
In this section we will review two main areas of related work that have influenced the design of Image Space: photography cultures, and presenting photos spatially.

2.1 Photography Cultures
There is a considerable amount of work regarding what people do with photographs and how their behavior has evolved over time with new technologies (i.e. digital cameras and camera phones). Several authors have identified and described behaviors typical to three main photography cultures: the 'Kodak', the 'Snapr' and the 'Ubi' cultures.

People have different behaviors regarding consumer photography. The anthropologist Richard Chalfen [2] describes in detail the behavior of using one's photos to tell stories *about* the pictures. Chalfen uses the term 'Kodak Culture' to refer to consumers who typically share photographs or video footage of friends and family, in a 'home mode' type of communication. Although Chalfen's work is connected to analog photos and video, the 'Kodak Culture' type of behavior seems to be still alive at the time of digital photography [14, 22].

By the late 1990s when consumers adopted digital cameras and camera phones, people changed the way they made pictures. As there was no longer a need to pay for buying and developing film,

or to make paper prints, people began taking increasingly more and more photos [12]. Van House et al. [21] identify four social uses of personal photography: creating and maintaining relationships, constructing personal and group memory, self-representation, and self-expression. The 'Kodak Culture' emphasizes the first two of these. Mäkelä et al. [13] have identified that people shifted from telling stories *about* the pictures, to telling stories *with* the pictures. In this context, Miller and Edwards [14] report another culture, the 'Snapr Culture', which is built around the popular photo sharing and gallery service Flickr [5]. 'Snaprs', as the researchers call the members of this culture, take photos mainly to fill aesthetic aspirations. Moreover, 'Snaprs' consider comments received via Flickr as key motivators. Their attitude towards privacy was also one key differentiator between the 'Kodak' and 'Snapr' cultures with the latter being more open towards sharing photos with strangers.

A third evolving culture is resulting from the pervasive nature of camera phones and connectivity. Jacucci et al. [9] as well as Kindberg et al. [11] report behaviors that are different from the 'Kodak' or 'Snapr' cultures. From previous experience in other projects, we have decided to call this behavior the 'Ubi Culture' (short for ubiquity). In it people create instant experiences via technology, often with close acquaintances.

Users may adopt different behaviors related to photography depending on the context, the situation and their current motivation. A user who is keen on creating aesthetically pleasing photos and sharing them via Flickr for comments (and thus behaving often in the 'Snapr Culture' way) may adopt a behavior typical of 'Ubi Culture' when a suitable technology is available and the social context is supporting that behavior.

Our service aims at supporting these three types of photography cultures in a simple and playful way by removing the hassle associated with "Photowork" [12] or having to review, download, organize, and sort images before uploading or sharing them to the service. The service also introduces fun and entertaining aspects by supporting an exploratory search and serendipitous discovery of photos [17]. Finally, the service adds the extra aspect of creating a community of people around picture taking in general and presenting the photographic user-generated content.

2.2 Presenting Photos Spatially

There are several applications and services that support 3D or 3D-like navigation of digital images. Davis et al. [3] describe the use of contextual metadata for creating new experiences for users of digital cameras and camera phones. Currently, "geotagging" has become a common way to structure photos and present them on top of a map view on the user's personal computer (PC) or Web browser. Flickr [5] provides such a map as an option to present pictures. Users can position the photo either manually on the map or the location can be fetched from the metadata of the photo if the user has a camera equipped with Global Positioning System (GPS). Google Earth and StreetView [6] provide popular systems for users to add their photos and show them in their respective places on geographically contoured and 3D navigable views, together with some buildings shown as textured 3D models.

Microsoft's PhotoSynth (based on work published on PhotoTourism by Snavely et al. [18]) provides a way to interactively browse and explore unstructured collections of photographs in 3D reconstructed environments. A key aspect of the technology is the total automation of the reconstruction process. The system relies on computer vision techniques to analyze a collection of photos by triangulating distinctive image feature points, creating 3D point clouds. The resulting point clouds and camera poses are used to register and display 2D photos according to appropriate perspectives. Further research by Snavely et al. [19] describes methods for easing the navigation and improving some scene related rendering issues of the PhotoTourism work. There are key shortcomings regarding Photosynth's current implementation. First, there is a lack of instant experience with one's own images as it takes time for the service to create a 'synth'. Adding photos for synthing is not done automatically but requires a selection and uploading effort from the user. Placement of the created synths on a map is not done automatically, either. Second, the collection of photos has to have a significant number of pictures from a subject or scene to create a reasonably good awareness of a place. Third, navigation between places is not effortless in the current implementation. Nevertheless the implementation breaks new ground in providing a new 3D image navigation experience for larger masses.

Torniai et al. [20] present a system that uses a separate device to record heading information at the time of taking a photo. A browsing interface uses this metadata, providing users with arrows to move towards photos taken in selected directions from the current open viewpoint.

Our service organizes photos spatially on a map view based on geographic information (i.e. GPS location data) and sensor metadata. The GPS and sensor metadata provide the necessary position and camera angle information to put the photos into 3D space. We also introduce the idea of Scenes as a new way of navigating spatially between pictures.

3. CONCEPTUAL DESIGN

Based on the relevant work described in the previous section, we have decided to support picture capturing and sharing by designing and implementing the Image Space service that: 1) creates a community of people around picture-taking 2) simplifies the process of "Photowork" by automatically sharing the images to the service, 3) contextualizes the pictures by using metadata to position the image on a map and in a 3D-space (showing the location and angle in which the picture was taken), 4) introduces the idea of Scenes to allow users to spatially navigate within their collections of images.

3.1 Picture-Taking Online Community

Any online service with several users can become a platform for an online community, where people collaborate to drive a common cause. An online community cannot be designed, but the software on top of which a community is formed can be designed to guide certain social interactions [15]. Thus, all online services do not have communities. However, there are strong benefits for supporting the formation of communities.

Preece [15] defines sociability as a criterion for evaluating the success of an online community. Sociability includes the collective purpose of the community, the goals and roles of its members, and the policies that influence the interaction between the members. Furthermore, a service with good sociability encourages reciprocity, empathy and trust, and enables the development of online identities. In addition to just providing information or content, a service with good sociability mediates social interaction between people thus bringing added value.

Researchers working on the Image Space service had developed a model for understanding online communities [1]. The model defined a set of interrelated elements that make up an online community. Elements include e.g. Member Identity, Trust, Privacy, Policy, Roles, and Motivation. The model was used to identify different aspects that had to be addressed in order to facilitate sociability in the Image Space service. For example, a MicroBlog feature was designed for the purpose of increasing social presence (i.e. what a user was doing or feeling at the moment). Achievements were designed specifically to show progress, increase Motivation to create content, and stimulate social interaction through small competitions. Obvious features were the rating and commenting of photos, which provide feedback and leave visible traces that the service is "populated". Due to time constrains, several of the designed sociability features were not implemented for the first trial. The model also helped to identify relevant Roles for the users, and what to address in the Policy (e.g., how the service is moderated and governed).

3.2 Simple and Playful: Automatic Sharing

As we have previously mentioned, when digital cameras and camera phones became popular people started making more and more pictures. It also introduced the notion of "Photowork" or the activities that people perform with their digital photos after capturing but prior to end use such as sharing [12]. In "Photowork", users must review, download the photos from the device to a computer, organize photos in folders, edit photos (e.g. cropping, adjust color balance), sort photos, and file the photos.

With Image Space, our aim was to provide an overall simple and playful experience while capturing and sharing photos online. We have decided to automatize the capturing process from the moment the picture is taken until the image is displayed online on the service as much as possible. Hence, images are directly uploaded to the service via an Internet connection. The necessary metadata (i.e. from the GPS and the compass) to later position the image in the 3D world is uploaded together with the photo taken. Regarding the users' mental model, the photo is taken and sent directly online to the service for them to view it.

3.3 Contextualizing Contents

Making sense of the increasingly large volume of community-generated content such as photos that is available on popular sites such as Flickr [5] or even Facebook [4] is a complex challenge. Due to their magnitude, these collections are difficult to understand, search and navigate [10].

To increase the users' understanding of the environment (spatial awareness) and semantic structure of the places where photos are taken, Image Space aims at providing a spatial experience using contextual metadata. Once a picture is taken and automatically uploaded to the service, the metadata allows contextualizing the photo to position it on a map and in a 3D-space. From a user point of view, photos are symmetrically aligned both on a 3D world and on a map. On the map, photos are represented as a circular icon with a blue-colored cone pointing out from it to indicate the direction in which the photo was taken.

3.4 Scenes

Traditionally, photo sharing services and applications support a chronological order of photos to automatically arrange photos [7, 16, 14]. Besides providing this chronological arrangement of images, we also wanted to make use of the possibilities offered by the available metadata to arrange photos spatially according to the wishes of the users. These may or may not respond to chronological associations.

We introduce the idea of Scene to create sequences of pictures that may be related to each other by a spatial and/or chronological connection. A Scene can be visualized as a slide show mode on the Web browser creating the impression of an immersive navigation in the 3D world. From the users' perspective, Scenes can be created on location using the phone, in which case the arrangement of photos will be both spatial and chronological, or from the Web browser, in which case different types of arrangements can be created.

4. INTERACTION

4.1 Creating Content

The mobile client (Figure 1) is used for taking photos, recording short audio clips (also with an image), and creating Scenes. The use of the client is simple, the user has to open the application and wait for the GPS to get a fix of the location (when a blue light on the phone stops blinking) (Figure 1). This takes typically from 3 to 15 seconds. The user can then capture a photo, a photo with sound, or sound only. By default, the starting mode is "capturing mode", which shows the camera viewfinder for aiming and taking pictures. Using the key "0" (zero) allows users to switch between other capturing modes (i.e. Image, Image and Audio, or Audio). To take a picture (or capture other content), users must press the camera key. A shutter animation indicates that the photo has been taken. The photo is uploaded automatically to an online server for sharing with the other users. The user can immediately take a new photo while the previous one uploads.

Users can also create Scenes. Pressing the scroll key triggers "Start Scene" (Figure 1). Once a Scene has started, all contents made by the user are assigned to that Scene until the user presses the scroll key in once again, which triggers "Stop Scene". Once the Scene has been created, the mobile client requests users to assign a name to the Scene before it is uploaded to the service.

4.2 Browsing Content

To check the results of the uploaded content, users must use the Web client, which they can access with a Web browser. The Web client consists of three main elements: a 3D view, a Map view and a Sidebar.

Figure 1. The mobile client: Capturing images with sound and starting/stopping a Scene.

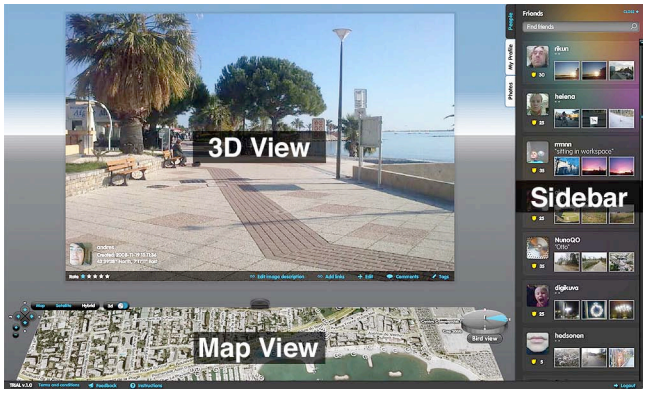

Figure 2. The three main parts of the Web UI: 1) the 3D View, 2) the Map View, and 3) the Sidebar.

4.2.1 The 3D View

The 3D View is the upper part of the User Interface (Figure 2). When users access the service, they are presented with the last content they have created. Here, the photos are shown in spatial relation to each other in a similar way as the locations they show in the real world. The photos form a virtual 3D world resembling the real world to the extent covered by the photos. The user moves in the world by clicking on the photos.

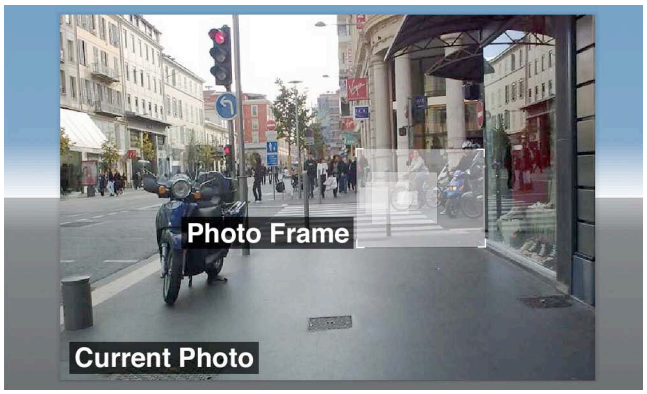

Figure 3. The 3D View: the current picture is shown in large. Images located further away are shown as photo frames.

Initially, the view to the 3D world is focused on a particular photo (Figure 3). If another photo is in the visual range of the current photo (but farther away in the 3D world), then a photo frame representing the photo is shown inside the current photo. The frame may also be presented beside the current photo depending on its position on the 3D world. The frames represent the exact situation in which the camera-phone was when taking the photo. When the user moves the mouse pointer on top of a frame, it turns into a thumbnail of the photo. To bring that photo to the front the user should click on the thumbnail. By clicking on any frame (or thumbnail) on the 3D view, users "fly" (navigate) to the position of the selected photo and can thus have a maximized view of the photo. When the mouse pointer is placed on top of the current photo, information about the photo (e.g. publisher, time of creation, location) is displayed on top of it.

The Bird View (Figure 4) provides an alternative, slightly top-down viewpoint of the 3D world. This view allows exploring the images that are not necessarily present in the visual range of the current picture. The current picture is shown at the front, while the other pictures are presented in their corresponding surrounding 3D space. Clicking on another image (i.e. other than the current photo) will result in "flying" (navigating) towards the newly selected photo.

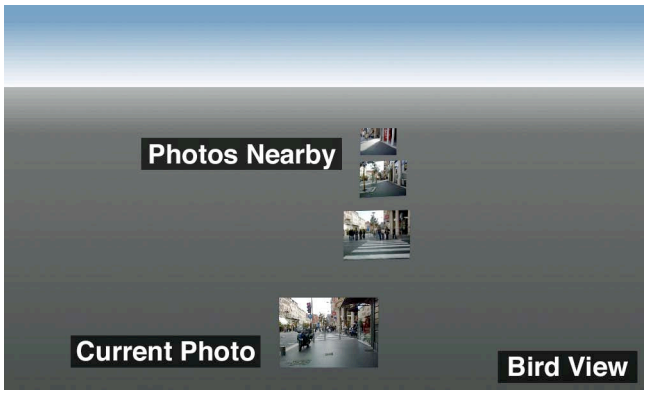

Figure 4. The Bird View: top-down viewpoint of the 3D world. The current photo is shown at the front while the other photos are shown in the surrounding 3D space.

From the 3D View, photos can be edited in several ways. The following functions are available to users from a horizontal bar overlaid on top of the current picture (Figure 5): 1) edit the position and angle of one's own pictures (due to GPS positioning errors in urban environments), 2) add or remove tags to one's own pictures, 3) rate other people's pictures, 4) add a hyperlink to one's own pictures, 5) write a comment and reply to a comment.

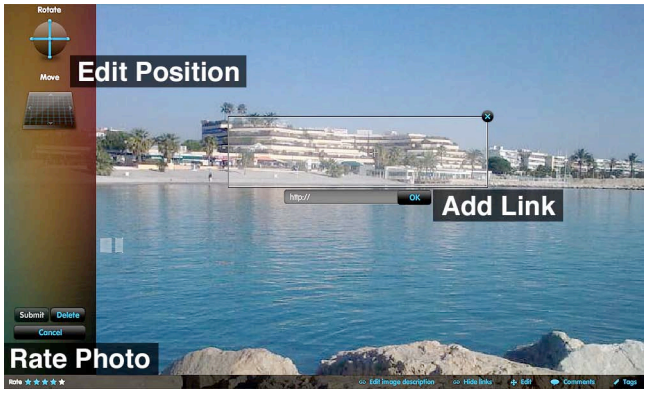

Figure 5. Editing photos: users can edit the position, add or remove tags, and add a link to their own pictures. They can also rate and write comments on other people's photos.

4.2.2 The Map View

The Map View (Figure 2) view offers three types of maps: "Map" is a traditional drawn map, "Satellite" consists of satellite images, and "Hybrid" is a combination of the Map and Satellite presentations.

Users can move the map by dragging it with the mouse, or by pressing the four small arrowed buttons labeled N, E, S, and W on the upper left side of the Map View. Users can also zoom the map in and out with the mouse wheel or by pressing the plus (+) and minus (–) buttons on the upper left side of the Map View. The size of the map can be changed (and thus also the size of the 3D View) by dragging up or down with the mouse the "Handle" in the middle-upper part of the map.

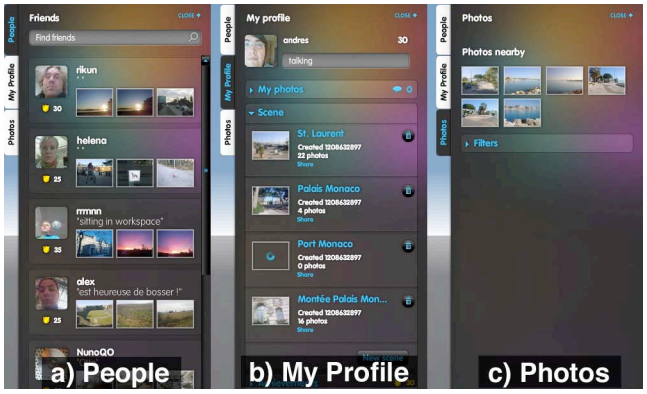

Figure 6. Tabs on the Sidebar: a) People with a list of users, b) My Profile with one's own photos, Scenes, and achievements, and c) Photos taken nearby.

A photo is represented on the map as a semicircle icon with a line indicating the direction of the photo. The user can bring a photo to the front of the 3D View by clicking on its icon on the map. An approximation of the visual range of the photo is shown as a blue-colored cone pointing out from the icon.

4.2.3 The Sidebar

The Sidebar (Figure 2) consists of three tabs on the upper right side of the screen: People (Figure 6a), My Profile (Figure 6b), and Photos (Figure 6c).

The People tab (Figure 6a) displays the user's contact list. Clicking the username or avatar image of a given user results in opening the corresponding user's profile in more detail. Therefore one can see someone else's Photos, Scenes, and Achievements (points awarded for participating in the service). The points collected so far are presented below the users' avatars. The My Profile tab offers users features for managing their own photos, Scenes, Achievements, and personal information. Users also have the possibility to create a MicroBlog entry. The subcategory My Photos contains thumbnails of the user's photos. Clicking on a given thumbnail results in presenting the photo on the 3D View. Under the subcategory Scenes the user's Scenes are listed. Finally, the Photos tab shows neighboring photos from the community of users to provide the user cognitive cues for understanding the semantic structure of a place.

4.2.4 Scenes

Scenes (Figure 7) allow users to spatially browse pictures through preset paths. Via navigating through a Scene, users develop awareness of the surroundings of an individual photo and a feeling of immersion. Users can divert from their own photos and find new places or views to places, thus supporting the kind of exploratory search and serendipitous discovery of photos that we were aiming for. The audio clips embedded to Image Space provide additional cognitive and memory cues. Also, the user can link other content to photos for annotation purposes, as well as comment and tag them. A satellite view provides additional cues about the location as one can compare features on the pictures to that view.

The Scene tool located at the bottom of the screen contains 1) a play/stop button, 2) a timeline on which images can be placed both from the 3D and Map views, and 3) a text area to assign a name to the Scene.

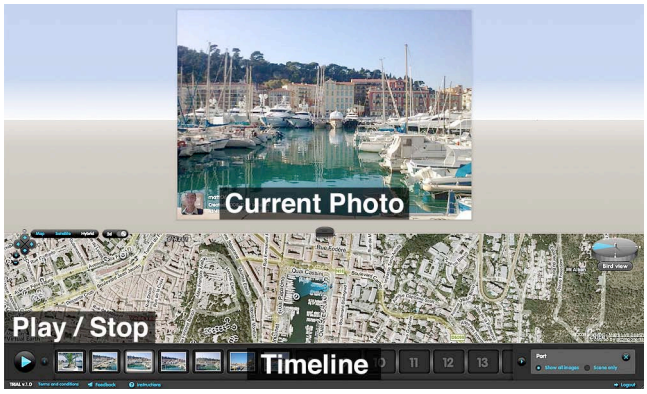

Figure 7. Scenes allow users to spatially navigate pictures through preset paths.

5. EVALUATION

We evaluated Image Space in an eight-week field trial in the fall of 2008. Our aim was to assess how people would experience and appropriate the service, and to identify usability problems that would allow us to improve the service. As the service was created mostly for outdoor use (i.e. due to lighting conditions and the GPS fix), we have decided to conduct a field trial to try out the full potential of the service with users. We were also interested in finding out how users understand the representation of their automatically uploaded pictures on the map (marking the location and the angle in which the picture was taken), as well as the users' mental model regarding the positioning of images in a 3D world symmetric to its representation on a map.

5.1 Participants

Due to the dark lighting conditions during the selected trial period in Finland (shorter days), we decided to have two groups of participants, one in Helsinki, Finland and the other in Nice, France. In total 20 people participated in the trial, for a period of 8 weeks. The first group consisted of 10 Finnish Flickr users (age 24-60; 8 male, 2 female), living in the Helsinki area, with a common interest in Flickr online photo sharing services, and who belong to a small Flickr user group of advanced photographers. The second group consisted of 10 French students (age 22-26; 9 male, 1 female) living in the region of Nice, with a friendship link and who were selected as representative of a small community. Regarding the photography cultures, the Flickr users were expected to be expressing the '*Snaprs'* behavior, while the young French participants were expected to show the behavior of the '*Kodak culture'*. Nevertheless, due to the nature of the service some participants from both groups were expected to evolve and represent the 'Ubi culture' in their behavior.

5.2 Procedure and Measures

Qualitative data was gathered during two interviews. The first interview took place after the first week of usage. The interview was directive, first focusing on the mobile device and web browser, and later on social related interaction questions. Participants were also asked about the content they had created and on their first impressions on using Image Space. There was a set of fixed questions and the answers were recorded in audio. The average time per participant was 25 minutes for the first interview. The second interview took place in situ at the end of the trial (i.e. week eight) and consisted of a similar procedure as

for the first interview, except that these interviews were recorded on video, and that the average time per participant was 45 minutes. Both interviews were held in the participants' mother tongue (i.e. Finnish or French) and the quotes reported here are our own translations.

Each participant was provided with a Nokia 6210 Navigator mobile phone (including a SIM) as well as a user name and password to be able to log in to the online service. A user guide was sent to them in their mother tongue in case they had questions on the possibilities provided by the service. Participants were first asked to freely explore the service on both devices (mobile and PC) and later to perform more specific tasks. These tasks were sent weekly by e-mail and/or SMS (e.g. "Please make a Scene with your mobile phone and look at other people's Scenes").

5.3 Implementation

The prototype consisting of a mobile client and a browser client (or PC client) was setup. The mobile client consisted of a Nokia 6210 Navigator phone, equipped with a 3.2 mega-pixel auto-focus camera, a GPS chip, acceleration sensors and a magnetometer (i.e. compass). These provide the picture and the associated metadata for contextualization. The browser client is accessible through any Adobe Flash 10 compatible browser. The application was written in Action Script CS3 as a mash-up component including open Application Programming Interfaces (APIs) so that they can be integrated into the users' web pages. The back-end is implemented on Apache and PHP with an SQL database distributed to several servers to balance the workload.

5.4 Findings

The data analysis consisted of creating affinity diagrams [8] based on the transcripts of the two interviews. In this chapter we will present the main findings from our affinity wall. We found that some categories were more linked to social aspects of the service while others were more related to the personal behaviors and personal feelings towards the system.

5.4.1 Simplicity and Playfulness

As a general observation, all the participants were able to use the system with little or no prior training. They especially liked the simplicity of the interaction and the service in general. The service in general was often referred to as simple and easy to use. Participants also mentioned some aspects of playfulness. Regarding the phone, they mentioned that uploading pictures to the service felt like taking normal pictures with a photo camera. Regarding the Web, participants felt that Image Space brings the pictures and the map together in a nice way:

• "Everything was simple to use, you should underline that. You don't need to know much about (the service), it happens on its own. […] (The phone) was really simple to use, very ludic and it was trouble-free, really no worries." [FR1]

• "(The phone part) couldn't be easier to use." [FI10]

• "Navigating from picture to picture was pleasant especially if you compare to Flickr." [FI7]

Regarding aspects of fun and playfulness, participants appreciated among other things how the service allowed them to make unexpected discoveries:

• "You can discover places you have never seen before. I think that's nice and funny." [FR7]

• "It's a fast and fun service to exchange pictures." [FR2]

5.4.2 Sharing

The other important aspect mentioned by the participants was related to (online) social interactions and mainly the aspect of (online) sharing. After the first week, Image Space was mostly understood as an online photo sharing service.

• "It is interesting to be able to share live with other people." [FR9]

• "Image Space allows you to share other places, see what people take pictures of, where they like to go." [FR3]

Image Space was well understood as a service to share different things online: photos, sounds, and sharing instantly but also sharing places (or the exact location where an event happened). However, many participants found that the lack of online social presence was disturbing them in the sense that they had no idea who was online, and had no sense of the amount of ongoing activity regarding their photos.

5.4.3 Time and Space

Their strongest feelings were expressed towards the automation of the system, which related also to the fact that the images were uploaded 'here and now'. While describing the service in their own words most of the French participants mentioned the aspects of taking pictures that are automatically later positioned accordingly to the original location and viewing angle. To them, it serves as a reminder of the place and the time where and when the pictures were made:

• "Seeing the map from where one took the pictures, be already able to point at the pictures with the dots and see all the pictures now, and also the locations of the pictures." [FR4]

• "Share on the Internet while knowing the exact spot, the exact site where the picture was taken and in which direction." [FR10]

Some Flickr users emphasized the informative aspects together with the importance of location information:

• "It's more informative than other services. It provides you with more information than just reading that I've been here and there. You get a better understanding of the place." [FI10]

In relation to the automatic uploading of pictures, some Flickr users were even fascinated by the speed and easiness of it:

• "It's fascinating, it's so simultaneous." [FI1]

• "When I've told my friends about the idea that pictures are going straight to the service, they were impressed about it." [FI3]

5.4.4 Scenes

The notion of time and space described earlier is tightly linked with the concept of Scene developed in Image Space. Some participants perceived the Scene functionality as a dynamic collection of images that allows them to move in space and time from one place to another. They also explored how to best create a Scene regarding the distance between images:

• "I took a journey in the city, next to the tram, I went through the city to see a bit of the touristy (scenic) aspect of Nice." [FR2]

• "I saw that with some pictures I could not follow because they were too far from one another." [FR2]

• "I made a test to see the spacing and how the images would then slide one after the other." [FR7]

This concept seemed to be fully understood after they got more time to try it out, thus during the second interview they could really tell about how they proceed to make their Scenes.

Flickr users were interested in using Scenes for telling stories and connecting pictures together:

• "You combine photos and it becomes a narrative." [FI3]

• "I liked this feature especially. This is the thing that makes Image Space important alongside with Flickr. The Scene in which someone had walked all along the beach or road and taken pictures frequently was really good." [FI8]

5.4.5 Photography Content and Quality

Both French and Finnish users mentioned picture content and quality. However Flickr (the Finns) users emphasized, that the content of pictures was important to them, and they felt that in Image Space there is not so much content, that pictures are mostly snapshots. Since they were advanced photographers, they also emphasized on good-quality pictures. They were critical about the current mobile phone camera because it limited the possibility to make aesthetically pleasing pictures. They also wanted to edit their photos and therefore felt that some photos taken during the trial were not good enough to be shared:

• "In IS the pictures are more like holiday pictures than thoughtful or artistic photos. Only friends' holiday photos are interesting to me." [FI10]

• "The camera isn't very good. If you make the effort to take pictures of good quality, all the work will be wasted." [FI8]

• "Usually I take almost a hundred pictures per day, and end up putting one of them to Flickr after I've polished it up with my computer." [FI3]

French participants mostly took pictures of sights and natural landscapes outdoors because they felt that was the best fitting with the service and they did not mind taking pictures of people and even tried indoor pictures. They also expressed an interest in aesthetic aspects of the pictures and were aware of the limitations of the camera's quality, but were surprised by the result in IS:

• "I took pictures of landscapes, at the beach, […] from the seaside there is a picture of a sunset." [FR7]

• "I took pictures of sceneries, my desk, my dog, that's it."[FR8]

• "With the service I can already see the quality of my pictures, […], on the computer the images are clearer, and bigger." [FR7]

5.4.6 Technical and User Interface Problems

Participants encountered some technical and usability problems due to the fact that they were using a prototype version of the service. Some participants perceived the issues they encountered to be more problematic than others. Some of these problems included difficulties in obtaining a GPS fix, as well as having some images and/or Scenes that would fail to upload to the service.

Regarding the user interface and more specifically the 3D view, participants mentioned that when browsing images belonging to a Scene, sometimes these images were too far apart from each other thus becoming unreachable by clicking on the map. Participants also reported that when too many pictures were taken in the same location the service presented them one on top of the other making it extremely difficult to access, which was considered frustrating. Some reported that they could not choose a picture they wanted from the pile of pictures:

• "If you take many photos from the same place they become a mess of overlapping photos. You cannot choose and watch individual photos." [FI8]

• "If two pictures are overlapping neither of them is suitable for viewing. It is totally impossible to view them." [FI2]

6. DISCUSSION

6.1 Creating an Online Community

As mentioned earlier, we took aspects of sociability into account while designing and implementing the service. This relates back to the community model developed earlier in our team.

We selected participants that were somehow tied together (i.e. friendship in the case of the French participants and a common interest in Flickr in the case of the Finns). Despite this and the presence of the implemented functionalities, many participants from both samples reported a lack of functionalities for social communication. Obvious shortcomings included the need for information about social presence, and lack of feedback such as cues regarding other people commenting one's images. Apparently, the users were not able to create meaningful online identities, as the information in the My Profile tab was too limited. The users were not able to create subgroups. The group of users was fixed for the trial, so the users could not share their photos and Scenes with others with the exception of showing them on PCs and to some extent on mobile phones. Thus, there was little room for social extension such as for inviting new users.

Concerning the online community aspect, we should further develop the functionalities that allow interactions between users such as allowing them to comment but also giving clear feedback.

6.2 Appropriation of the Service

The simplicity and to a lesser degree playfulness of the service reported by most of the participants seemed to be the major reason for a rapid and easy appropriation of the Image Space service. We were surprised to see that the automation of the photo uploading was reported as one of the most important aspects described by users. Although uploading contents to the Web automatically is not *per se* a novel aspect of the service, it is the combination with the contextualization of the pictures and the placement on the 3D and Map views that were novel to them. Participants were fascinated with the rapidity of uploading the picture and the metadata linked to it.

Participants became increasingly creative when they started to make Scenes, putting extra dedication when trying to present a new place to others in an appropriate way. In fact participants created many Scenes some of which were trying to tell a story about specific locations (e.g. showing the area where they lived). French participants tended to take pictures and make Scenes of the seaside view, or the ancient part of the city of Nice, while Finns tended to take pictures of the snow.

Due to poor lighting conditions and problems obtaining a GPS fix, participants were advised to use the service mostly outdoors. The service could have been perceived as limited to making pictures of landscapes and places (not people). However, some participants went beyond these limitations and took photos indoors, while driving a car, at night and also of their family members and pets.

Therefore they fully explored the service and to some extent managed to appropriate it accordingly to different social uses and photography cultures they were expected to express.

6.3 Flickr Users Versus non Flickr Users

Due to their photographical skills the Flickr users were more interested in creative, original and quality pictures. Thus, some participants emphasized their dissatisfaction due to the lack of quality of the camera itself, and the need to edit pictures individually. However, they also understood that the idea of the service differed from Flickr and that for its purpose, the quality was good enough. There was also a delay when opening the application that did not allow making spontaneous photos.

The comments from Flickr users were in line with the findings on 'Snapr' usage behavior described by Miller and Edwards [14]. Their motivations were strongly driven by aesthetic ambitions, and the quality and set of features provided by the camera phone did not serve such aspirations well. The Flickr users manifested a need to add semantics to the photos textually, both for expressive as well as for indexing needs. This is aligned with the motivations: a single photo may be relevant without contextual support as a piece of art, and a short descriptive name can add to the aesthetic experience.

The French group of friends was not interested in photography as a hobby as much as the Finnish users, and were expected by us to behave in a more 'Ubi culture' way. Their behavior did meet our expectations as we witnessed many photos of their friends. Furthermore, the French group made fewer negative comments about the quality of the camera.

7. CONCLUSIONS

In this paper we have presented the Image Space service, which allows people to capture, share and contextualize their personal photos in a simple and playful way. We have presented the concrete design and implementation of the Image Space service that provides an immersive, navigable representation of real life environments that are created from community photographs. We have conducted an eight-week field trial with ten French and ten Finnish users to see how people would experience and appropriate the service, as well as to identify usability problems with the service. In these evaluations, participants found the service easy to use and to a lesser degree playful. Participants found the combination of automatically sending geo-tagged photos and later browsing them in a contextualized form in the 3D and Map views novel, fast and motivating. Future work includes providing a similarly immersive experience for sharing and browsing video material, as well as including point cloud models to solve presentation issues in places where multiple images are taken.

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