Image Space: An Empirical Study of Geotagged Mobile Media Content Capture and Sharing

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ABSTRACT
In the past few years, there has been a rapid increase in the everyday usage of cameraphones and image sharing services. The existing services offer means to store, tag and share photos, but they offer only limited means to geotag and offer meaningful representations of the captured media content. We conducted a two-month field study of *Image Space,* an Internet-based service that allows people to automatically share and geotag photos (and sounds) onto 2D and 3D representations of photo collections online. In the study, we explored people's perception with regards to capturing and sharing geotagged mobile media content and whether geotagging increases the personal and social value of the photos. The study also looked into *Scenes,* which allow people to organize photos according to spatial and/or chronological associations. We report our findings based on three types of geotagged media content: photos, *Scenes,* and sounds. Our findings suggest that participants took photos of *objects* for self-documentation of their daily lives, of *places* to show to others what life is like where they live, and of *people,* which they used to reflect on overall aspects of privacy. Regarding the creation of *Scenes,* participants used them for storytelling, to save a journey, and to explore places by means of guided tours. Sounds were mainly used to support storytelling. Additionally, we report on novel practices with respect to the creation of *Scenes,* and photo capturing for *Scenes,* i.e., by taking photos and sounds from a moving vehicle.

Categories and Subject Descriptors
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Experimentation, Human Factors.

Keywords
Digital Photography, Geotagging, Cameraphones.

1. INTRODUCTION
The last years have witnessed a rapid increase in the number of both high-quality cameraphones and services that support picture taking, browsing and sharing. As a result, new photo taking and sharing behaviors can be observed among mobile users. Services such as Flickr[1] and Photobucket[2] allow users to share and comment their photographs online. Location-based image services such as Google Panoramio[3] and Zonetag[4] for Flickr, allow geotagging photographs, i.e., placing the pictures spatially as a pin on a map. Other services such as Microsoft's Photosynth[5] [20] provide new ways to interactively browse and explore large collections of photos in 3D-reconstructed environments. More recently, specific iPhone and Android apps such as EveryTrail[6] or Path[7] allow people to share their personal photos, link them to their location and, in the case of the former, document them as trips. From the users' point of view, most of these services require extended photowork [13] (i.e., reviewing, downloading, organizing, sorting, filing photos), before they are able to see the captured content online.

With regards to people's geotagged mobile media content capture practices, our interest was to look at: how do people perceive technologies that automatically do some of the photowork for them? What sort of content do they want to capture using such technologies? What do they consider worth photographing and sharing? How do these technologies affect their earlier photo practices? And how do they explore geotagged mobile media content when it is presented online on a 2D map and in 3D space? Our main concern was to look at whether adding location information to mobile media content increases their personal and social value.

This paper presents the results of a two-month empirical study of geotagged mobile media content use. We equipped 20 people with the *Image Space* [15] service, an Internet-based service that allows people to automatically share geotagged mobile media content captured with their cameraphones onto 2D and 3D representations of photo collections online. The service also introduces *Scenes*, which allow people to organize photos according to spatial and/or chronological associations. We report our findings based on three types of geotagged media content: photos, *Scenes*, and sounds. Our findings suggest that participants took photos of *objects* for self-documentation of their daily lives, of *places* to show to others what life is like where they live, and of *people*, which they used to reflect on overall aspects of privacy.

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[1] www.flickr.com
[2] www.photobucket.com
[3] www.panoramio.com
[4] zonetag.research.yahoo.com
[5] www.photosynth.net
[6] www.everytrail.com
[7] www.path.com

Regarding the creation of *Scenes*, participants used them for storytelling, to save a journey, and to explore places by means of guided tours. Sounds were mainly used to support storytelling. Additionally, we report on novel practices with respect to the creation of *Scenes*, which allow people to organize photos according to spatial and/or chronological associations, and photo capturing for *Scenes*, i.e., by taking photos and sounds from a moving vehicle. Our key contribution is that we expand the knowledge on people's mobile media content capture and sharing practices with the help of geotagging.

2. RELATED WORK

2.1 Personal Photography

There is a rich literature on both conventional and digital personal photography and their associated practices. In the field of anthropology, Chalfen [5] studied conventional family photography and the role of photos in the home. The term Kodak Culture refers to the old practice of sharing printed photos or video footage of friends and family in a 'home mode' type of communication. Chalfen describes in detail the behavior of *storytelling* or using one's photos to tell stories *about* the pictures.

When consumers adopted digital cameras, the HCI community began a rich tradition of studying people's practices surrounding digital (and conventional) photos. Van House *et al.* [24] identified three social uses of personal photography: constructing personal and group *memory*, creating and maintaining *social relationships*, and *self-representation and self-expression*. Miller and Edwards [18] looked at people from the Kodak Culture who had fully converted to digital photography to see how their practices have changed. They also studied people's digital photo sharing practices on Flickr. They found two types of practices: the Kodak Culture and 'Snapr' people. Compared to the former, 'Snaprs' are less concerned with privacy, share photos outside their existing social networks, and concentrate on *taking* pictures instead of *sharing* them.

2.2 Mobile Photo Taking and Sharing

More recently, the use of cameraphones opened a new line of research for personal photography. With their prototype, Mäkelä *et al*. [17] first studied networked digital photography enabling photo sharing that was nearly synchronous with capture. They identified that people shifted from telling stories *about* the pictures, to telling stories *with* the pictures. Koskinen *et al.* [14] and later Kindberg *et al.* [12] looked at another type of image sharing with cameraphones via MMS. Ames *et al.* [4] conducted a 5-month study of cameraphone photography and derived a list of requirements for mobile photoware. A new line of research looks at collocated photo sharing with cameraphones. Based on four inter-related studies on collocated photo sharing, Van House [27] identified 11 forms of face-to-face sharing, each bearing unique advantages and limitations. Stelmaszweska *et al.* [22] studied collocated photo sharing where both capturing and sharing are done through cameraphones. They focused their work on understanding the role of the place where sharing occurs, how and when people share photos, what determines who the photos are shared with, and what influences their sharing experience. Mobiphos [6] supports capturing and real-time sharing of photos among members of a collocated group using cameraphones. *Pass-them-around* [16] supports *ad hoc* photo sharing for small groups of collocated people by taking into account the spatial arrangement of people around a table.

2.3 Geotagged Photo Content

There are several applications and services that support 3D or 3D-like navigation of digital images. Davis *et al.* [7] 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. Location-based image services such as Google Panoramio and Zonetag for Flickr provide such a map as an option to present pictures. People 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 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. Other services such as Microsoft's Photosynth [20] provide new ways to interactively browse and explore large unstructured collections of photographs in 3D reconstructed environments. Torniai *et al.* [23] 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. PhotoField [9] is a personal photo album software that enables users to create spatial slideshow effects to support storytelling. Slideshows are created manually by adding arrows and geotagged metadata to create 3D animations, requiring extensive editing work.

Inspired by Ames *et al.* [4], we conducted a two-month field study of geotagged mobile media content capture, share, and use, by introducing participants to the *Image Space* service.

3. IMAGE SPACE

Image Space [15] is an Internet-based service that allows people to share photos (and sounds) from their cameraphones. When contents are captured, the service automatically: 1) collects location and orientation data (i.e., GPS and compass metadata), 2) uploads both content and its associated metadata, and 3) produces 2D and 3D representations (i.e., map and 3D view) of the photo collection online. In addition, we introduce the notion of *Scenes*, which allow people to organize their photos according to spatial and/or chronological associations. We will now describe how people experience the *Image Space* service based on how content is captured, shared and explored.

3.1 Photos and Sounds

People take photos (and sounds) as they normally would with their cameraphones. As mentioned earlier, location and orientation data are automatically uploaded together with the photo to the service online, where 2D and 3D representations of the photo collection are created. On the 3D View (Figure 1a), the photos are shown in a similar spatial relation as the locations they depict in the real world. On the 2D Map View (Figure 1b), photos are represented on a map by means of icons that indicate both photo location and direction. People can browse the photos by either clicking a photo on the 3D View or an icon from the 2D Map View. The Sidebar (Figure 1c) contains a list of users and their contents (i.e., photos, sounds and *Scenes*). We decided for all content to be visible to all users in order to quickly populate the service with everyone's content. As we were planning to evaluate the service with existing social groups, we adopted a blanket strategy for privacy that simulates a situation where people have already managed their social network.

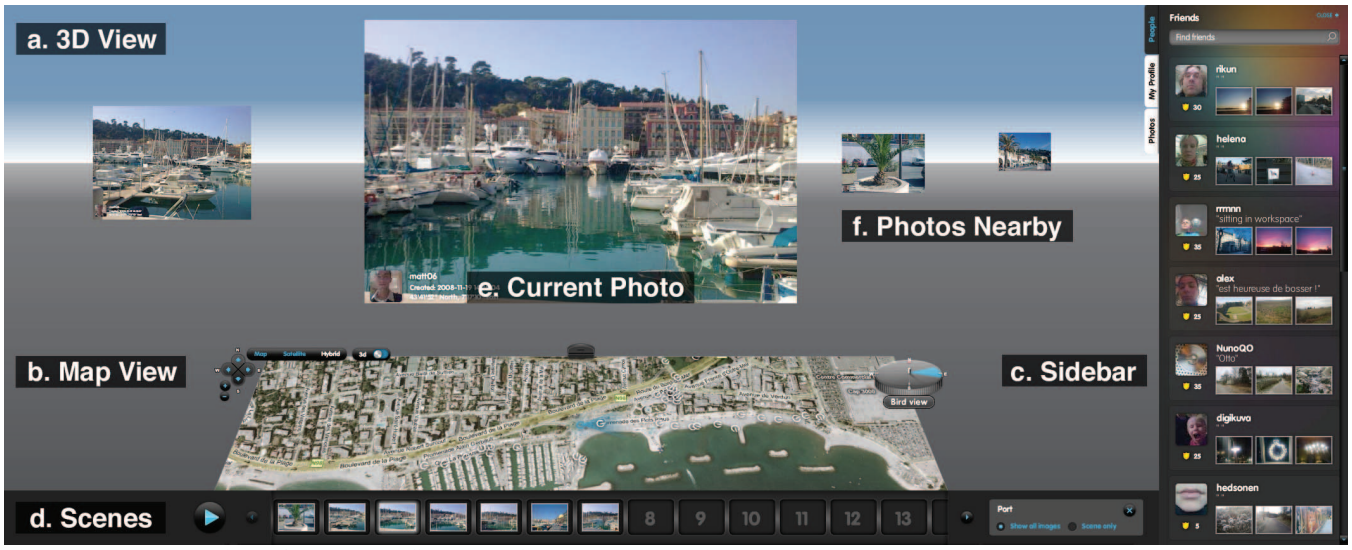


Figure 1. Extended view of the Image Space service. The three main UI parts: a) the 3D View, b) the 2D Map View, and c) the Sidebar. Scenes (d) allow spatially navigating between the current photo (e) and the locations of photos taken nearby (f).

3.2 Scenes

From their cameraphones, people can also create *Scenes,* which are photo sequences with a spatial and/or chronological relation. When users press 'Start Scene' from their cameraphones, all captured content is assigned to that *Scene* until 'Stop Scene' is pressed. People can add a title to the *Scene*, which acts as a folder. *Scene* contents can be visualized online from the timeline (Figure 1d). The slideshow mode generates animations that connect the locations where contents were captured, which result in 'flying' or navigating between the current photo (Figure 1e) and the photos nearby (Figure 1f). This creates an immersive navigation on the 3D View.

In a prior publication [15], we have presented a detailed description of the design principles and interaction techniques of *Image Space,* together with a YouTube video of the interaction[8]. In this paper, we concentrate on the evaluation of the service by exploring people's perception with regards to capturing and sharing geotagged mobile media content and whether geotagging increases the personal and social value of the photos.

4. EVALUATION

We conducted a two-month field study of *Image Space.* The main purpose of this study was to investigate how people experience and appropriate the service. We were also interested in finding out if the online 2D and 3D representations increase the personal and social value of the photos. Finally, we were interested in how people create and perceive *Scenes.*

4.1 Participants

The study was originally to be conducted in mid-November. However, at that time of the year in Finland the amount of daylight is limited to 6 hours and so we were worried the quality of the pictures captured using the cameraphones would suffer from the poor lighting conditions. Therefore, we added a second group of participants located in southern France where the amount of daylight would be less of an issue. In addition, having a second group of participants with slightly different characteristics would help increase the generalizability of our findings. As we are not doing any cross-cultural or other comparisons between the two participant sets, we will now present them together as one group.

We recruited 10 people at each location for a total of 20 study participants. Participants belonged to existing social groups since we were interested in studying how they would influence one another while using the system. Participants varied in their age (22-60) and gender (17 male, 3 female). Before the study, most of them took pictures with their cameraphones on a daily or weekly basis (16/20), while the remaining four said they only used it rarely or not at all. About half of the participants owned a digital SLR camera (11/20). The majority used Web-based commercial services such as Flickr or Facebook[9] to share photos (15/20). One participant dropped out shortly after the start of the study.

4.2 Method

The evaluation consisted of five parts. First, participants were asked to fill-in an online questionnaire where we collected data on their photo sharing practices. Second, we met the participants *in situ* in November 2008 where we introduced the study. Each participant was provided with a Nokia 6210 Navigator phone (SIM included), equipped with a 3.2 megapixel camera, a GPS chip and compass. Participants were asked to use this phone as their primary phone for the duration of the study. Participants created a username and password to gain access to the service. We then explained participants how to interact with *Image Space*, allowing them to freely explore the available functionality and giving them enough time to get acquainted with the service. At each location, we informed participants about the existence of another participant group (in France or Finland) and that all content would be available to everyone for exploration. Third, we had individual telephone interviews with each participant one week into the two-month study period to inquire how things were going in general and if they had encountered any major problems. Fourth, we then let participants freely use the system for the remaining seven weeks of the study. We did send them one 'reminder' SMS per week to make sure that as many participants as possible tried the service (e.g., freely explore the service,

[8] http://youtu.be/pDppvYNwBAU

[9] www.facebook.com

capture a place that is dear to you, visit other people's content, create a *Scene*). Finally, we conducted semi-structured interviews *in situ* in January 2009 at the end of the study, which were recorded on video. In this final interview we asked participants a series of open-ended questions to gather their general impressions on the *Image Space* service. Whenever possible, we used photo-elicitation [26] by reviewing and discussing their photos to relate their responses to the actual captured content. Besides covering their data transfer costs, participants were given a €20 voucher to compensate them for their time.

We used affinity diagramming [11] to analyze the data from the semi-structured interviews and the captured content. At each location, two researchers made notes independently as they watched videos from each interview. The same researchers collaboratively analyzed the qualitative data during several rounds of interpretation. In addition, we also analyzed the media content created by each participant during the study.

5. FINDINGS

In the following sections, we present the main findings from the *Image* Space evaluation. First, we describe how participants experienced *Image Space*. Second, we briefly discuss the different types of content collected during the evaluation. Finally, we present the main capturing, sharing and exploring practices of geotagged mobile media contents that our findings suggest.

5.1 The Image Space Experience

Overall, participants were positive about the experience offered by *Image Space.* They often referred to two main aspects of the service: geotagging and automation. Participants mentioned the geotagging of media contents as a unique feature of *Image Space* when compared to other photo sharing services (e.g., Flickr and Facebook). In particular, users especially referred to how photos (and sounds) are represented on the 2D Map View and the 3D View as adding a personal and social value to the contents:

"This service has given a geographical dimension to photos. Now that I've been using this, I've become interested in the places where the pictures are taken and where other people have been moving." (P13)

"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." (P20)

"It allows you to share other places, see what people take pictures of, where they like to go." (P3)

"If someone has been in Rome in some good restaurant you could ask 'Hey, was it a nice place?' I'm going to Rome, could you give me any recommendations?'" (P20)

Participants also praised the combination of automatically 1) collecting the necessary location and orientation metadata, and 2) uploading both media contents and their related metadata online:

"The idea of sharing one's pictures online is old but automatically adding location information separates this from other services." (P14)

Table 1. Total mobile media items created during the study.

Photos	Scenes	Sounds
1909	75	48

"When I've told my friends about the idea that the pictures are going straight to the service, they were impressed by it." (P13)

"It's fascinating, it's so simultaneous." (P14)

5.2 Created Contents

The different mobile media contents created by the study participants can be found on Table 1. A total of 1909 photos (mean=95.5, SD=91.2), 48 sounds (mean=2.5, SD=4.2), and 75 *Scenes* (mean 3.9, SD=2.8) were created. We had two extremes where one participant very actively contributed photos during the evaluation (n=353) while one other participant barely took photos (n=8), which explains the high standard deviation. The small amount of sounds can be explained by the fact that participants encountered a usability problem (i.e., long delays before recording sounds would start), which frustrated the participants and reduced their interest in further recording sounds. Compared to photos and sounds, *Scenes* were more evenly distributed across participants.

Regarding the photographer's situation at the time of capture (Table 2), participants took most of their pictures while walking outdoors (70%). Some of the participants were aware of the need to obtain a GPS fix in order for their contents to be correctly located and presented online. In addition, having to manually define on the online service the exact location where the photo was made takes away some of the automation aspects mentioned earlier. Thus, we believe these factors may have had an influence in the overall amount of outdoor photos created. Having said this, all participants explored taking pictures while being indoors (11%), and some took pictures from moving vehicles (15%). As for the rest of the pictures where the context remained unclear they were categorized as "other" (4%).

Regarding the content of the pictures, we were expecting participants to mostly take pictures of views and natural landscapes due to the issue with the GPS fix. However, in the end participants took almost an equal amount of pictures of objects (47%) and places (44%). Pictures of people represented only a small percentage of the photo content created in the service (9%).

In the following seven sections, we will describe how and the reasons why participants created, shared and explored the three main media contents that were available to them through the *Image Space* service: photos (3), *Scenes* (3) and sounds (1).

5.3 Photos to Document Their Own Lives (Objects)

Participants used the service as a tool to document their everyday lives, as a kind of diary. They often described mobile photography as a spontaneous activity that consisted of taking pictures whenever something interesting came up. Participants took photos of objects (Table 2) that mattered to them:

"Mostly I've been documenting my life, how my day was. I tried to photograph the span of my day." (P15)

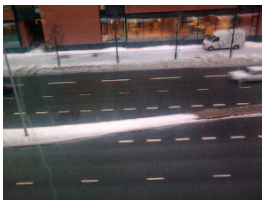
"I didn't try to find objects to photograph. I just took pictures whenever something interesting came my way." (P11)

"I took pictures of sceneries, my desk, my dog. That's it." (P8)

As most participants were carrying the cameraphones with them at all times, it became a useful tool to make notes and memorize things while on the go:

"Mostly my cameraphone use is about taking snapshots of good food and wines, just to remember their names." (P20)

Table 2. Photographer situation and photo subject of the total pictures made (n=1909), with numbers and percentages.

	Photographer Situation. Place or means of transportation when taking the photo.			
Photo Subject Main photo content	**Outdoor** 1328 (70%)	**From a Vehicle** 281 (15%)	**Indoor** 218 (11%)	**Other** 82 (4%)
Objects 895 (47%) Photos to document their own lives.	 683	 31	 110	 71
Places 838 (44%) Photos to show what life is like where they live to others.	 530	 243	 56	 9
People 176 (9%) Photos of others are private.	 115	 7	 52	 2

5.4 Photos to Show What Life Is Like Where They Live to Others (Places)

Participants also used the service to share personal places or views that were dear to them (Table 2). Some participants were openly sharing places with everyone (i.e., with no particular group or person in mind):

"I took a few places that meant something to me, (that were) close to my heart." (P1)

Other participants shared photos of places in a slightly more targeted way. As mentioned earlier, both groups (i.e., French and Finnish) were aware of each other's participation in the study and thus of the fact that the other group could see their content. Therefore, some participants were motivated to share with the other group what life was like in their city, the main attractions the city has to offer, the most interesting places, etc.

"(I especially took these pictures) to show Nice and the Côte d'Azur to the Finns, to show them how it was, (…) the people who didn't know the place." (P4)

"I've been photographing nice views and especially the snow to show them to the French." (P11)

"I looked at some pictures of the Finns participating in the study, to see a bit of the pictures in Finland." (P7)

5.5 Photos of Others are Private (People)

As mentioned earlier, we designed the service in such a way that all contents were visible to everyone in order to quickly populate the service with everyone's content. Our original plan was to evaluate the service with existing social groups. The French and Finnish participants were familiar with each other within groups, but not between groups. As a result, almost half of the participants were concerned about sharing photos of others, which may result in exposing their identity [1]. These participants did not perceive the service as intended for this type of content, and they did not want to share pictures of their peers with strangers:

"I wouldn't add my personal pictures or pictures of my friends. It doesn't feel right, because I don't know the other users." (P19)

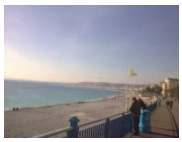
"People want to photograph other people, objects and occasions, but these do not fit into this concept. This is rather for landscapes and geotagged pictures." (P12)

A few participants opted for self-censorship to avoid disclosing their friends' identity or location [1]:

"I did not necessarily want to take pictures of my friends, (…) to respect their privacy." (P2)

By looking at the captured content, we found different attitudes on identity privacy. In Table 2 (bottom row labeled 'People'), we see in succession: 1) a girl who manages her own privacy by pulling her winter hat over her face, 2) a study participant behind the wheel who asks a friend to take a photo of her, 3) two persons who seem quite happy about having their picture taken, and 4) a participant partially hiding the identity of the person portrayed by taking their photo from the back. The automatic sharing of geotagged content with a group of strangers in another country had an influence in how people felt about sharing people photos.

Table 3. Three reasons to create Scenes according to the participants: for storytelling ('Christmas Saarijärvi'), to save a journey ('Cemetery Park'), and to discover new places by taking a guided tour ('Promenade des Anglais').

Story-telling Scene 'Christmas Saarijärvi'						
Journey Scene 'Cemetery Park'						
Tour Scene 'Promenade des Anglais'						

5.6 Scenes for Storytelling ('Christmas Saarijärvi')

The creation of *Scenes* was used as a means for storytelling. Through the use of *Scenes,* participants grouped photos together according to a topic (e.g., see "Christmas Saarijärvi" on Table 3) and created a narrative around them:

"At Christmas when we were bringing the Christmas tree from the forest, one of us couldn't join and we took pictures of the snowy forest to be able to show what it looked like in winter." (P14)

Scenes were used as a tool to take individual photos of (apparently) unrelated events or locations, and tie them together through a story. For example, some *Scenes* would mainly consist of participants documenting unusual events occurring in the context of their daily routines:

"You combine photos and it becomes a narrative." (P13)

"If you are taking pictures during the day, they would constitute a story of the day and how it went." (P17)

PhotoArcs [2][3] allow the creation of photo-narratives organized around chronological 'arcs' of photos or timelines. In PhotoArcs, the geotagging aspect is not as prominent as in our service. Nonetheless, both prototypes support the organization of photos according to time, space, or other creative storytelling structures [3].

5.7 Scenes to Save a Journey ('Cemetery Park')

Scenes were also created as visual representations of a given path or trail (e.g., see "Cemetery Park" on Table 3). In other words, participants frequently created *Scenes* to document and share how they went from point 'A' to 'B'. One participant created a *Scene* while using public transport to document a trip in Helsinki:

"You can show with pictures how you got from Arabia to Töölö (city areas of Helsinki), for instance." (P13)

"I took a journey in the city, next to the tram. I went through the touristy (scenic) aspect of Nice." (P2)

Participants created several *Scenes* that included photos taken from a moving vehicle (e.g., car, bus, tram, train) (Figure 2). There were two aspects that influenced creating *Scenes* while participants were commuting from one place to another. First, participants had the time to use the system as a secondary activity to getting to where they needed to be. And second, there was a convenience factor as it was easier for participants to skip walking and comfortably collect content from the window of a moving vehicle:

"I made a Scene when going to the gym with P7, while driving in town. (…) I only took pictures from the car; it is where I could take most pictures." (P3)

5.8 Scenes as Guided Tours ('Promenade des Anglais')

Finally, participants praised *Scenes* for the opportunities they offer to discover new places. Once *Scenes* were created online, the other participants began exploring their contents. Participants mentioned a feeling of 'being there' together with the author of the photos (e.g., see "Promenade des Anglais" on Table 3):

"The Scene in which someone had walked all along the beach or road and taken pictures frequently was really good." (P18)

"What mostly interests me, (are) rather some landscapes that make you feel like going there."(P8)

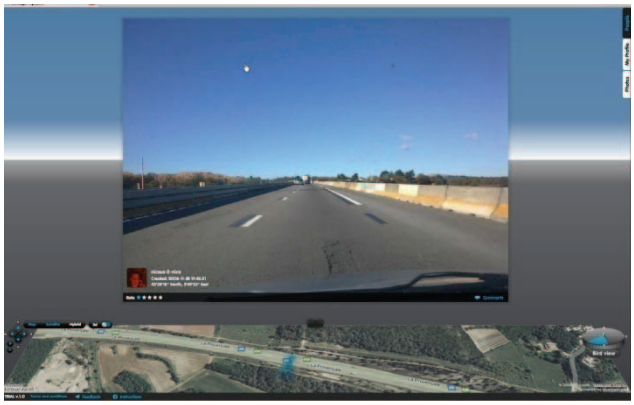


Figure 2. A photo taken by a participant while driving his car along a highway.

"One can see the Scene as (a person) is moving, one can see many pictures at once, and you do not have to click on each of the pictures." (P2)

Some users emphasized the immersive experience provided by playing someone else's *Scene*:

"I have enjoyed having little virtual holidays to sunny places with this." (P14)

"It's nice because you discover, you see new things, (…) new landscapes, and it's appealing." (P8)

In summary, *Scenes* provided a possibility to share someone else's experience and appreciate a place in a broader and more immersive manner.

5.9 Sounds to Support Storytelling

Participants captured altogether 48 media elements that contained sound (Table 1), either together with a photo or *Scene,* or a sound recording on its own. Participants mostly used sounds while making a *Scene* in order to emphasize storytelling aspects. Sound clips were added in order to explain the pictures for others, or to describe the soundscape of a photograph or a *Scene.* Some participants added sounds to accentuate the narrative behind the *Scene.* One of the participants (P8) created a *Scene* and for each picture recorded a comment of her own, half singing and half laughing, telling therefore a story in a novel and playful way. Sounds were also recorded as background music while browsing the pictures.

Some participants mentioned that the recorded sound was a song they had heard on the radio while driving. These sound recordings allowed them to share the kind of mood they were in when the photo was taken, therefore emphasizing the mental state of the photographer at the time of photo creation.

Some participants reported that they did not want to add sounds into pictures because they felt that the visual experience of images was enough for them.

"I don't like sound clips. I want to have photos as they are, the photo doesn't have to be a multimodal experience." (P16)

6. DISCUSSION

6.1 Capturing Practices

As shown in previous research, mobile cameras are always at hand and therefore taking pictures becomes a more frequent and spontaneous activity [25]. Accordingly, participants captured *pictures* that emotionally meant something to them and with the purpose of sharing them to others, thus following the spontaneous behavior previously observed in other studies [4]. Also, *sounds* allowed people to personalize the created content a little more and make the pictures more vivid, following practices observed by Frohlich [8].

Cameraphones are known to have changed the definition of what is photo worthy, from what is special and enduring to what is transitory and ordinary [25]. Some of our Finnish participants used Flickr to share their photos with others who had a similar keen eye for aesthetic detail. These Finnish participants reported changing their existing photo capturing practices with SLRs once they started using the provided cameraphones. Since with *Image Space* all captured contents were automatically shared, these participants reported that they had to think more carefully about the type of pictures they wanted to share, before taking them. These Finnish participants often referred to the photos taken with the cameraphone as snapshots or quick photos without artistic intent. 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.

Regarding capturing practices for *Scenes,* the provided service was better suited for taking photos outdoors due to the need obtain a GPS fix. Moreover, in order to create the illusion of flying between the locations where the photos were taken, participants had to cover long distances so that contents would be physically distant from each other. As a result, we found that several people took pictures from different types of moving vehicles (e.g., car, bus, tram, train). As people began experimenting with the distance between photos (so that contents would not be too close or too far apart from each other), we believe there was a strong convenience factor in their decision to capture photos from moving vehicles. While commuting, participants both had the time and it was more efficient to capture content compared to stopping.

6.2 On the Specificity of the Geotagged Content

In contrast to other services, the captured media content did not need to be browsed exclusively from the 3D world of photos (as in e.g., Photosynth, Google Street View[10], or Snavely *et al.* [21]), nor just in relation to the 2D map (as in e.g., Google Panoramio or Zonetag for Flickr). In *Image Space*, people could follow their journey from both the 3D world of photos and the 2D map. To some extent, participants perceived the added value of the service in comparison to earlier experiences with related services. Novel aspects seemed to emerge from the possible geotagging of the captured photos which appeared as enabling them to capture aspects of the location, direction, route, and the surroundings where each picture is taken. Furthermore, the appreciation of content geotagging was emphasized as it was automatically done by the service and therefore did not require extra photowork from people, which is often the case in other services [4][9][13]. The geotagged content offered by the service was perceived as unique and different from other services.

Previous research has shown that people tend to prefer organizing their pictures according to time [10][19]. The timeline can refer to a specific event in time. Often the possibility of organizing pictures according to a location is not possible and/or appealing. Through the creation of *Scenes*, the time dimension can be associated to the dimension of space, which seemed to bring a new way of experiencing photo-taking and later photo browsing.

Scenes provided extra possibilities to tell stories, bringing the possibility not only to recall cues from a picture taken here and there but also recall an entire 'Scene of everyday life'. *Scenes* were also used similarly to tags, to categorize and connect photos. People wanted to browse a photo collection rather than individual photos. Therefore *Scenes* seemed to bring them a more organized and playful way to browse a larger amount of media content at once in a more immersive way.

7. CONCLUSIONS

In this paper, we have presented the results of a two-month field study of *Image Space,* an Internet-based service that allows people to automatically share and geotag photos (and sounds) onto 2D and 3D representations of photo collections online. In the evaluation, we explored people's perception with regards to

[10] maps.google.com/help/maps/streetview

capturing and sharing geotagged mobile media content and whether geotagging increases the personal and social value of the photos. The study also looked into *Scenes,* which allow people to organize photos according to spatial and/or chronological associations.

The results of the evaluations with 20 participants show that: first, people took photos of *objects* for self-documentation of their daily lives, of *places* to show to others what life is like where they live, and of *people,* which they used to reflect on overall aspects of privacy, thus confirming prior findings on photo sharing practices. Second, participants created *Scenes* for storytelling, to save a journey, and to explore places by means of guided tours. We presented novel practices regarding the creation and exploration of *Scenes* (e.g., by taking photos and sounds from a moving vehicle). Finally, although participants were unable to create sounds due to usability issues, those who did mainly used them to support storytelling.

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9. REFERENCES

[1] Ahern, S., Eckles, D., Good, N., King, S., Naaman, M. and Nair, R. 2007. Over-exposed?: privacy patterns and considerations in online and mobile photo sharing. *Proc. CHI '07*. ACM, 357-366.

[2] Ames, M. and Manguy, L. 2006. PhotoArcs: a tool for creating and sharing photo-narratives. *Proc. CHI EA '06.* ACM, 466-471.

[3] Ames, M. and Manguy, L. 2006. PhotoArcs: ludic tools for sharing photographs. In *Proc. MULTIMEDIA '06.* ACM, 615-618.

[4] Ames, M., Eckles, D., Naaman, M., Spasojevic, M. and Van House, N. 2010. Requirements for mobile photoware. *Pers. Ubiquit. Comput. 14*, 2, 95-109.

[5] Chalfen, R. 1987. *Snapshot Versions of Life*. Bowling Green State University Press, Bowling Green, Ohio.

[6] Clawson, J., Voida, A., Patel, N., and Lyons, K. 2008. Mobiphos: a collocated-synchronous mobile photo sharing application. *Proc. MobileHCI '08.* ACM, 187-195.

[7] Davis, M., King, S., Good, N. and Sarvas, R. 2004. From context to content: leveraging context to infer media metadata. *Proc. MULTIMEDIA '04.* ACM, 188-195.

[8] Frohlich, D.M. 2004. *Audiophotography, Bringing Photos to Life with Sounds.* Kluwer Academic Publishers.

[9] Fujita, H. and Arikawa, M. 2007. Creating animation with personal photo collections and map for storytelling. *Proc. EATIS '07.* ACM, 1-8.

[10] Graham, A., Garcia-Molina, H., Paepcke, A. and Winograd, T. 2002. Time as essence for photo browsing through personal digital libraries. *Proc. JCDL '02.* ACM, 326-335.

[11] Holtzblatt, K., Wendell, J.B. and S. Wood. 2005. *Rapid Contextual Design.* Morgan Kaufmann.

[12] Kindberg, T., Spasojevic, M., Fleck, R. and Sellen, A. 2005. I saw this and thought of you: some social uses of camera phones. *Proc. CHI '05.* ACM, 1545-1548.

[13] Kirk, D., Sellen, A., Rother, C. and Wood, K. Understanding photowork. *Proc. CHI '06.* ACM, 761-770.

[14] Koskinen, I., Kurvinen, E. and Lehtonen, T.-K. 2002. *Mobile Image*. IT Press.

[15] Lucero, A., Boberg, M. and Uusitalo, S. 2009. Image space: capturing, sharing and contextualizing personal pictures in a simple and playful way. *Proc. ACE '09.* ACM, 215-222.

[16] Lucero, A., Holopainen, J. and Jokela, T. 2011. Pass-them-around: collaborative use of mobile phones for photo sharing. *Proc. CHI '11*. ACM, 1787-1796.

[17] Mäkelä, A., Giller, V., Tscheligi, M. and Sefelin, R. 2000. Joking, storytelling, artsharing, expressing affection: a field trial of how children and their social network communicate with digital images in leisure time. *Proc. CHI '00*. ACM, 548-555.

[18] Miller, A. D. and Edwards, W. K. 2007. Give and take: a study of consumer photo-sharing culture and practice. *Proc. CHI '07*. ACM, 347-356.

[19] Rodden, K. and Wood, K. R. 2003. How do people manage their digital photographs? *Proc. CHI '03.* ACM, 409-416.

[20] Snavely, N., Seitz, S. M. and Szeliski, R. 2006. Photo tourism: exploring photo collections in 3D. *ACM Trans. Graph. 25*, 3, 835-846.

[21] Snavely, N., Garg, R., Seitz, S. M. and Szeliski, R. 2008. Finding paths through the world's photos. In *Proc. SIGGRAPH '08*. ACM, 1-11.

[22] Stelmaszewska, H., Fields, B. and Blandford, A. 2008. The Roles of Time, Place, Value and Relationships in Collocated Photo Sharing with Camera Phones. *The British Computer Society,* 141-150.

[23] Torniai, C., Battle, S. and Cayzer, S. 2007. The Big Picture: Exploring Cities through Georeferenced Images and RDF Shared Metadata. *CHI '07 WS: Imaging the City.*

[24] Van House, N., Davis, M., Takhteyev, Y., Ames, M. and Finn, M. 2004. The Social Uses of Personal Photography: Methods for Projecting Future Imaging Applications, 2004. http://people.ischool.berkeley.edu/~vanhouse/photo_project/pubs/vanhouse_et_al_2004b.pdf

[25] Van House, N., Davis, M., Ames, M., Finn, M. and Viswanathan, V. 2005. The uses of personal networked digital imaging: an empirical study of camera phone photos and sharing. In *Proc. CHI '05.* ACM, 1853-1856.

[26] Van House, N. 2006. Interview viz: visualization-assisted photo elicitation. *Ext. Abstracts CHI '06,* ACM, 1463-1468.

[27] Van House, N. 2009. Collocated photo sharing, story-telling, and the performance of self. *Int. J. Human-Computer Studies 67,* 1073-1086.