

Mobile exploration of geotagged photographs

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Abstract Columbus is a mobile application that lets users explore their surroundings through geotagged photographs, presented to them at the location they were taken. By moving around the physical world, the user unlocks photographs and gets to see and experience them in unison with their location. During two consecutive field trials, we investigated how the application was used and experienced and how photographs and locations are explored together. We found that previous experience with the surroundings people was exploring affected how they experienced the localized content. We report on the system's design and implementation, the trials as well as resulting insights that can be used by other developers of locative media applications.

Keywords Location · Photographs · Geotagging · Locative media

1 Introduction

Location-based services and locative media have been gaining momentum in both industry and academia. Research ranges from studies on making digital content retrievable at a physical location [17, 22] to mobile tour guides using location and photographs [1, 3, 4]. Currently,

a lot of researches are available on how content can be created and placed or associated with a location. However, far less studies have focused on how existing digital content is experienced in the physical world, at the location this content is associated with. We here focus on the localized experience of photographs at the location they originated at.

The increasing amount of geotagged photographs has resulted in a multitude of web sites and applications offering users ways to browse these photographs according to their location. Web sites such as Panoramio (<http://www.panoramio.com>), Flickr Maps (<http://www.flickr.com/map>) and web applications such as Google Earth offer a way to explore geotagged photographs placed on globe or map interfaces. While these applications offer a convenient way of browsing through photographs from remote locations from the comfort of one's own home, we argue this experience decouples the viewer from the actual place where the photograph was taken. Browsing geotagged photographs on a computer screen arguably does not result in the same experience as looking at a photograph when at the location where it was taken. Though there are mobile applications that utilize geotagged photographs (e.g., for navigation [3]), how geotagged photographs can be experienced together with the place at which they originated and which effects this may have on the meaning assigned to these photographs have been underexplored.

In this paper, we present a user evaluation of Columbus—a mobile application for exploring geotagged photographs at the location they were taken [18]. Our aim with Columbus is to bring back a sense of discovering (or rediscovering) the world to the user, including the familiar places we pass by in our everyday life. The concept is inspired by notions of “adventurous journeys in the old times,” or computer games, where concepts like “here be

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dragons” used to indicate unexplored territories. The exploration of photographs in Columbus takes place in the physical world where the user must physically go to a place in order to “discover” and “unlock” the existing geotagged photographs associated with that location. We believe that this deliberate design decision to restrict browsing can actually enhance the user experience and promote exploration of the physical world. We are interested in the user’s experience and use of such an application and want to explore the meaning of the photographs when present at the specific, associated location. The differentiator of this application is the *in situ* “unlocking” aspect based on the real experience of the place.

Previous local knowledge and experiences may affect how localized content is appreciated. Along with the Columbus concept, this paper discusses the differences and similarities between the experience of localized content by contrasting two trials with the application: one with participants familiar with the local surroundings and a larger trial with participants who were not.

After an overview of related work, we will describe Columbus’ design process from concept to the final application, including lessons learned on the development of systems aiming to support local exploration or presentation of locative media. We then present the two consecutive field trials with the Columbus application, and our findings and insights gained on users’ experiences when exploring geotagged photographs in unison with their “actual location.”

2 Related work

Outside of academia, location-based services like Four-square, Gowalla, and Google Latitude are gaining traction and ever more geotagged content is created, ranging from pictures on Flickr, geotagged tweets on Twitter, to Youtube videos.

The HCI, CSCW, and UbiComp research communities have long debated the subject of location. People’s experience of “a location” hardly is dependent on its geographical coordinates alone. Space and place are socially constructed through our experiences with them [7, 11]. Human activity transforms a space into a meaningful, identifiable place [21]. Human-made artifacts are one type of tangible result of such activity. At the same time, drawing parallels to archeology, authors such as Golloway and Ward [10] refer to how the meaning of artifacts is reshaped when they are “re-found,” depending on who finds them and how they are found. In our work, we want to explore how both discovering photographs “in place” changes people’s experience of place and the possible effects of meaning assigned to the found photographs.

Even though there have been many systems in the past that let users place content in the world, few have looked at the meaning of experiencing placed content when at their locations. MobiPhos [5] is an example of a system for taking and sharing pictures in a colocated group. The photographs are shared when taken and thus explored and looked at when at the location. However, already geotagged photographs have not been explored in this way. While there are several systems that explore how geotagged photographs can be browsed, none are exploring the meaning and experience of exploring a photograph when at the location. Many of the systems are desktop based and thus not meant to be used when out and about [12], but also mobile applications are generally about using location as a filter as a starting point for finding photographs [13] or for navigation and games [4].

GeoNotes [17] allowed users to virtually place text notes in physical places. As the technical system deduced a coarse-grained location, they also let the users name the places where they put the notes, and studies showed that the names of places were given in creative ways beyond the authors’ expectations [8]. Place-Its [22] is a similar system that let users put reminders at physical locations to be presented to the user only when at the particular location. In these systems, (textual) content is bound to location such that it is to be consumed when the user is there. Despite these early systems, few studies have focused on how already geotagged photographs are consumed and experienced at their locations, something we try to do with our work on Columbus.

Yoon et al. [23] identified that the mobile phone is generally not a platform for “consuming” photographs and proposed a context-aware selection method for how a mobile photograph browser can select photographs captured on a mobile phone based on context such as time and place. Similarly, Push!Photo [19] demonstrated how the context of who is around during the taking of a photograph can be used to present photographs of interest based on the social context. Zurfer [13], for instance, is an application where you can look at photographs from Flickr on your mobile phone based on a channel metaphor. One of the channels is a spatial channel where you can see photographs taken near your current location, but there are also other channels to access other types of photographs. While these provide means for finding photographs around your current context, they do not allow you to explore the physical place you are in through the photographs that can be found there.

There are a number of systems that use photographs as a means for navigation. Pauty et al. [16] describe a system that let you virtually explore areas by browsing photographs. Their system provides a view inside closed areas and allows users to see what these areas look like in advance, using their current position as a starting point.

EyeSpy [4] is a game for gathering geotagged photographs that can later be used to aid navigation. In [3], photographs are instead shown in order to help users to navigate to a specific location, as opposed to just offer a means for exploration. As a contrast, with Columbus, we want to further explore how the user's experience of looking at photographs is altered by being where they were taken and how the experience of the place is altered by looking at local photographs. We do this by limiting the accessibility of photographs so that users need to physically move in space to find new photographs. Thus, instead of a means of navigation, it becomes a mean for exploration, comparable with practices such as geocaching [14].

3 Columbus

Columbus lets you see the world through different glasses. It is not a game and it is not a system used for navigation, but rather “something in between.” While it is not a game with a goal, it can be used both in a fairly “passive” way and in an active and playful way to explore your surroundings. At the same time, it can suggest where to go if you see an interesting photograph at a certain place, but it is not designed to tell you where to go. While there are systems that let you access and look at photographs taken in your vicinity, they are not concerned about the exploration, but rather about access of photographs. Where we deliberately want to restrict access, these systems try to broaden it.

Here, we will explain how the system is designed and built and how it works. We begin by elaborating the design process to explain the many choices we made. We include this to identify what design choices have to be made when designing systems similar to ours, for other designers to learn from. We then go on to describe the resulting application.

3.1 Design

The design process began with a set of brainstorm activities around a set of themes: sharing, browsing, and the meaning of place—in a mobile context. During several sessions of brainstorming around these topics, we discussed various ideas and application concepts and eventually focused on the concept of restricting access while browsing for photographs. The restriction would be to only allow access to photographs taken where you physically have been. We then continued with a bodystorming session to further investigate these design issues.

3.2 Bodystorming

To try out the initial idea, we had a wizard-of-oz style bodystorming session [15]. Two researchers would act as

users, and one would be acting as the system, using a tablet PC and an online map application that displayed geotagged photographs. The researcher acting as the system would then navigate the map as the users moved around in the city and show the photographs to the users. Initially, it was not determined whether we wanted to display a map to the user, so the map was not shown to the users but only the photographs when requested. The system researcher also made announcements when there would be new photographs in an area they entered, and the users would opt on whether they wanted to see the photographs.

The aim of the bodystorming was to get an sense of the experience of finding photographs originating from the location you are at and also to explore how far away a photograph can be to still be considered to be local (or “where you are at”). Would it be a radius of one meter or several blocks? Through the bodystorming session, we became aware of a number of issues.

First, we found that it was frustrating for the users not getting an overview of the photographs around them. When standing at one place, the users were told that there were photographs *here*, and they could choose to look at one, then the next, and so on. However, typically, there are a number of photographs of the same kind, many of which are not very interesting. With the ability of browsing through, e.g., thumbnails, it would let you quickly skip certain photographs and also give the ability to see what kind of photographs are around. We, therefore, concluded that we would need to show an overview of the photographs around, in order to go through these photographs more easily to see whether there is something interesting.

Second, not knowing the actual location of a photograph but only that a photograph was taken “here” became an issue. When the users saw an interesting photograph, they always tried to deduce where it was taken. Even though we tested out different radiuses, it was troubling not being able to know more precisely where a photograph was supposedly taken, especially not knowing whether it was supposedly in the line of sight or not. Some photographs were tagged on the other side of a building, or they could be taken from inside of a building. When taken inside a building, not knowing from which direction the photograph was taken made it difficult to even get an idea of in which building it was placed. Not knowing exactly where a photograph was taken, the users sometimes stopped trying to figure out where it was taken, even if it was taken quite close but in a strange angle. This is an interesting issue and has to be balanced by giving enough information to make the experience enjoyable rather than frustrating.

Third, related to not knowing the exact location of a photograph, we noticed that as the distance of a photograph grew, the sense of locality was lost. Photographs close to you were more interesting than photographs far away when

found in this way and photographs too far away almost lost all value. Thus, we found that the sense of locality must be preserved by keeping the radius of “here” small.

3.3 Final design

In summary, the brainstorming and bodystorming sessions resulted in a number of design requirements. After deciding on using a map interface to show where photographs were tagged, these were the following to be taken into account: 1) the location of photographs should be displayed on the map in order to tell the location and direction of where a photograph is supposedly taken; 2) it should be possible to quickly browse thumbnails of the photographs in order to find interesting ones to look at in detail; 3) the area to show on the map should be small enough to preserve locality. Furthermore, we decided that: 4) users should be able to distinguish between photographs that have been viewed and those that have not been; 5) it should be possible to go back and look at previously “unlocked” photographs without being at the location of the photograph.

This resulted in the final design of the application with a map-based interface showing photographs as dots on a map in two modes: an *explore* mode that shows the map fully zoomed in, only showing the location you are at (as gathered from the GPS), and a *browse* mode in which you can look at explored areas on a map fully zoomable and pannable. See Fig. 1 for the final interface.

The two modes—browse and explore—are UI wise roughly the same. Where the explore mode has a cursor that is movable across the map which is fixed at your GPS-location, the browse mode fixes the cursor at the center of the screen and let the user pan the map freely to move both the cursor and the map. The browse mode also only shows the photographs that have already been explored.

We would like to note that the Columbus concept also incorporates a social aspect for using the application together with others to allow for group exploration. We, however, do not focus on this feature in this paper.

3.3.1 Explore mode

The top left screenshot in Fig. 1 shows the explore mode while centered over Union Square in San Francisco. On top of the map, red dots show photographs and their location. When many photographs are tagged with (roughly) the same location the photographs are clustered together and rendered as a bigger dot. The dots have different colors depending on their state. A red dot indicates that there is a new photograph that the user has not looked at yet whereas an orange dot means that it has been looked at. The cross in the middle of the screen indicates the users location on the map. At the bottom of the screen, there is a bubble with

thumbnails of the photographs located at the red dot that the cursor is pointing at. The cursor is found at the end of the array drawn from the bubble to show where the thumbnails come from. The cursor is moved using the joystick on the phone. Pressing number keys 7 and 9, respectively, browses through thumbnails. The view is updated automatically as the user moves around the physical world.

3.3.2 Browse mode

The bottom two pictures in Fig. 1 show the interface when browsing already explored photographs. In the screenshots, the map is slightly zoomed out (the right image being more zoomed out than the left, but over the same area). The bright area is the area in which the user has been exploring, and the dimmed area is the area that is yet to be explored. Here, the cursor is fixed in the middle, and by moving the map such that the cursor points to a dot, the same bubble as in the explore mode is shown with the thumbnails of the photographs at this location.

3.3.3 Looking at a photograph

By selecting a thumbnail from the map, the photograph is loaded and shown in full screen as shown the upper right screenshot in Fig. 1. Below the photograph, the description of the photograph taken from Flickr is written. If the photograph is one of many photographs taken from a cluster, pressing left or right browses through the photographs, loaded as needed with a placeholder image as it is being downloaded.

3.4 Implementation

Columbus is implemented in Java ME targeting MIDP 2.0 CLDC 1.1, using standard APIs (JSR-179 and JSR-135). The map data are downloaded on demand from a map server, as well as the photographs. The server side code is implemented in PHP using MySQL as database engine. The database stores information about the explored photographs, and the explored regions of the world, and is automatically filled when the server is requested for content such as map tiles and photographs. For map data, we used Yahoo Maps. When requesting photographs while exploring, the server queries Flickr for photographs in the area around the users location.

To be able to render the map differently depending on whether the area is explored or unexplored, the system has to record where the user travels. This was solved by benefiting from the fact that the map data are fetched through our servers (that also cache the map tiles to increase speed) and not directly from Yahoo. When a user is running the explore mode, the map is fixed to the most zoomed in level.

Fig. 1 Screenshots of Columbus in different modes of operation. *Top left* shows the view when standing at the center of union square in San Francisco looking for photographs near by. *Top right* shows a photograph in full screen. Button two pictures show the view when browsing through already discovered photographs highlighting the explored areas



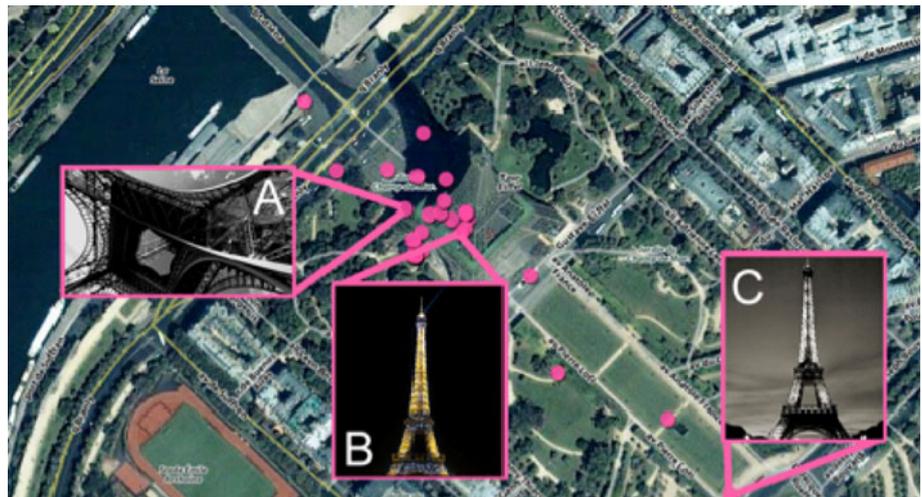
To know where a user has travelled, we thus store which map tiles the user request during this mode in a database. When the application in turn requests tiles for the user when in browsing mode, the server checks whether the requested tile has been explored before or not using a simple database lookup. For more zoomed out tiles, the tiles are subdivided and rendered properly. This solution requires no further computations on the client side and only a database lookup (which is fast using proper indexing).

3.4.1 Issues in using geotagged photographs

In order to have a set of photographs in the system from the start, we decided to use an existing database of geotagged

photographs. Even though there are issues with using existing geotagged photographs that are not tailored or suitable for our intentions, it is interesting and relevant to see what issues arise when using real world data, rather than a specially (re)purposed data set. Columbus, therefore, uses photographs found on Flickr. These photographs are geotagged in different ways: manually by users or automatically by their camera devices. When using automatic tagging, the photographs are always tagged at the location where the camera was when the picture was taken. When pictures have been manually tagged, this is not always the case. People may tag their photographs in the same way and tag with the location they were standing while taking the photograph. They might, however, also use the location

Fig. 2 Different ways in which photographs are tagged on Flickr



of the object in the photograph. An illustrative example is the tagging of photographs on Flickr of the Eiffel tower (Fig. 2). Some have been geotagged using the exact location of the Eiffel tower (photographs A and B), but most of these are taken from far away (photograph B). There are photographs that are actually geotagged from where they are taken but still showing the Eiffel tower (photograph C). Neither of them can be considered “wrong.” When looking for a photograph of the Eiffel tower, you will probably look for photographs geotagged with the location of the Eiffel tower. It might, however, be difficult to figure out where and from which direction a photograph was taken when finding the photograph while walking around the area. Additional issues arise when taking into account for example research on automatic geotagging from textual descriptions and tags [20]. The motivations behind a tag or description may have not been geared at all for the purposes for which you are using the tag. Thus, when using databases of geotagged photographs, it has to be considered how geotags and placement may affect local user experiences.

4 Trials

In order to evaluate the system, we performed two consecutive trials. The first trial was performed as a preliminary study to investigate technical issues and to gather first insights into the use of the application. This study informed the second larger study, in which we further investigated the user experience when using the application, experience of localized content, and the meaning of photographs together with place.

These trials also resulted in insights into the differences between experiences involving localized content in familiar and unfamiliar locations (which will be addressed in the

discussion section). During the trials, we investigated what kinds of photographs the participants found most interesting, how they chose which photographs to look at in specific areas, and their behavior within the environment they were exploring. As our initial concept for the application was to allow users to explore the world around them, we also wanted to see whether and how the application allowed for such exploration and what general insights could be derived from the localized experiences in our trials.

The data from the trials analyzed were transcripts from each participant and notes of observations when walking with the participants. The data were clustered in order to find the themes of investigation.

4.1 Trial 1: preliminary trial

The first field trial was performed in a familiar location. The participants were three people: the first two (man and woman, 28 and 23 years old) used the application together (P1 and P2) and the other (man of 25 years) used it solo (P3). The pair and the solo user used the system at different occasions. They were all accustomed to using mobile phones, but not particularly technically savvy. The location in which this trial took place was the city center of a mid-sized city of Sweden. The three participants lived in the city and were familiar with the location of the study. The participants used the application while walking in the city for about an hour, looking at photographs and the environment while discovering new things, and were asked to reflect on things they discovered. A researcher went with them and took notes on how they used the application and what they said. They got one phone each, a Nokia N95, with the program running, and were given a short introduction to the application. All of the important elements were explained such as the difference between browse and

explore and what the dots on the map meant. They were then asked to walk around the city and look at photographs that they found interesting. After walking around for about an hour, we sat down to discuss their first impressions. The pair and single user were interviewed separately.

4.1.1 Results

Immediately as the participants started to use the application and looked at the first photographs, they expressed a surprise that the photographs were actually from the location they were at. Despite the fact that they had been told that this would be the case, experiencing it by themselves came as a surprise. As they had no idea what kind of photographs they would expect, they picked the first photograph randomly. They then tried to map the photograph's location provided on the map to where they thought it was actually taken and explored the difference. This is when they commented about some photographs being tagged at the location of the person (or device) taking the picture and other photographs tagged at the location of the subject of the photograph. This kind of experimentation trying to figure out where a photograph was taken would later reoccur when what they expected and what they experienced differed, with reactions varying from joy to disappointment. As they gained more and more experience with the application and seeing more and more photographs, they invented search strategies instead of picking the photographs randomly.

4.1.1.1 Searching for photographs The participants searched for photographs based on their previous experience and knowledge of the locations they were in. P1 reported that while walking by the place where she worked, she wanted to see whether there were any photographs taken and tagged inside her store (she worked in a small shop). P2 knew the system used Flickr photographs and wanted to see whether any of his colleagues used to upload and geotag their photographs around his workplace. When walking in an area with many bars, they looked for photographs “of drunk people.” This shows that their knowledge of the area they are in reflects in their expectations of what photographs they want to find. This also steered their route through the city when, e.g., P1 wanted to walk by her workplace to see photographs from there.

Another instance occurred when the pair of participants was walking by a big hotel. P1 became excited and suggested that they should start looking for “*hotel-porn*.” They envisioned that people in the hotel would have taken some personal and intimate photographs and tagged them at the hotel. This resulted in the pair walking closer to the hotel and looking at all photographs, hoping to find what they wanted. However, by default, Flickr shows only

photographs safe from content that may be offensive. They were therefore unable to find what they were looking for.

While walking by bars and hotels, P3 also wanted to see things that had happened inside. He would therefore look for markers on the map that were placed on top of buildings, hoping that the pictures would then be from the inside. During the discussions after using the application he figured, it would be a nice way of learning about new places, by being able to look inside before going in. At the same time, he enjoyed looking at photographs that seemed to be away from clusters of other photographs. He figured these would be more unexpected and would therefore appreciate them more. Many photographs that are in clusters often show different pictures of the same things. Instead, the isolated photographs can be showing anything, as there are no photographs around to be compared with. This may be explained by an interest in the unknown and can be seen as exploring.

4.1.1.2 Serendipity In some cases, finding something that did not match his or her expectation ended up provoking serendipity. An example of this was when P3 was looking for a photograph of a statue he noticed in “the real world.” He found a photograph of a statue by looking through the thumbnails near its location. The photograph he found, however, was of another statue that was located somewhere else. Apparently, the person who tagged the photograph mistook the statue for the other one and geotagged it at the wrong one's location. After P3 noticed that it was the wrong statue, it actually made him aware of the other statue. This in turn caused him to further explore that area and find new photographs.

4.1.1.3 Locality The participants appreciated the way the explore mode only showed photographs close to you, and P3 even wanted to zoom in further. This was especially the case when there were a lot of photographs at one place, and the markers created big clusters. She expressed that the photographs “felt more local” and “more interesting” when they were close to the center of the screen and thus close to her.

4.2 Trial 2: exploring an unfamiliar location

In the first, preliminary trial, we noticed how the use of the application was affected by the participants' previous knowledge of the area they were in. To extend our understanding of the user's experience, we performed the second larger field trial with participants unfamiliar with the location.

In this study, we had eight participants. Their ages ranged from 22 to 28 years (mean age, 25; three were women and five men). They participated and walked

individual routes. The setup was similar to that of the first study, except that the researcher set the route since the participants had no idea where one could go in the area. Their task was to look at photographs during their walk and to seek out interesting places and interesting photographs. In the end, they were told to be able to choose the top five photographs when the route was completed. This was done to ensure that they paid attention to the photographs and to see what criteria they would provide for choosing a photograph. As in the first study, we explained the most important aspects of the application to each participant, and a researcher walked next to the participant observing what they did. After completing the route and the participant was satisfied with looking at the photographs at this location, the session was ended with a short interview talking about their impressions of the location of the study, which were the top five photographs, and general comments about the experience and the application. The routes took an average 25 min, with the longest 40 min and the shortest 15. They started the route at the exit of a shopping mall that they arrived at by subway so they did not get to go through the area beforehand.

4.2.1 Results

We distinguished four emerging themes on use and experience of the application. These are *exploring the world*, *issues with geotags*, *attitudes towards photos of inaccessible places*, and *photographs of interest*. We will begin by giving some general findings and then present these specific findings.

Several of the participants began by aligning the phone screen so that the map would match the real world. One participant a few minutes after starting to walk around found a photograph showing something nearby her current location and identified it. The geotag for this photograph was correct, and the participant commented that she now understood the map. She later commented that it was not until she found this photograph that she was able to orientate herself. It seemed that this action took place more often than in the previous study and led the participants to learn about the place from the photographs, something that did not happen in the first study except as a reminder to P3 of where he was.

4.2.1.1 Exploring the world Despite not being used by the researcher when presenting the application, the participants often used the word “explore” when taking off in new directions, saying either that they want to see whether there were any photograph “over there” or that they want to find a photograph showing something interesting they see in the real world. The way the participants were using the application and talking about it indicated that they were

exploring two worlds of the physical and the digital. At one point, a participant saw a dot in the periphery of the map but before he managed to move the cursor to it, the GPS moved him so that the dot disappeared outside the screen. He became curious about this photograph and therefore decided to seek it out by navigating toward it following the map. Unfortunately, for him, the dot was on the other side of a building, making it difficult to reach. Still he spent a couple of minutes trying to seek it out until he eventually managed to walk around the building and to find the picture. Unfortunately, the picture was misplaced and showed a view of the building from where he originated. Despite this, he later described his actions as a “treasure hunt” pointing directly to a sense of exploration verifying the initial design idea.

One photograph was taken from a window at high altitude in one building but at a location that was more or less unreachable. Because of the high altitude, it was not directly clear exactly from where or from what direction the photograph was taken. Therefore, one of the participants spent a few moments pondering from what window and from what direction it was taken and when he found out he was very happy with himself: “look, it was taken in this way!”. This same photograph caused a similar behavior from most participants.

4.2.1.2 Issues with geotags In contrast to the first trial, the participants in the second study took more interest in the actual location of the tagged photograph than in the first one. Where the participants in the first study could more easily tell where a photograph was taken when seeing an already familiar landmark, no such landmarks existed for the participants in the second study. Instead, the participants took time to look around, making sure that the motif in the picture matched what they saw in reality and made remarks about discrepancies of the tags and where they were actually taken. Others ignored photographs that they could not more or less immediately deduce its point of taking from. One participant even expressed that those pictures were “useless” because they could not give her clues of where she was or tell her anything about her surroundings.

The participants were sensitive to the variance in accuracy of where the photographs were tagged. One participant referred to it as the people who tagged them wrong were “messy.” However, the same guy was also forgiving if there were ready-made clues about where the photographs were actually taken (for instance, in the description of the photograph, or if there was a visible land mark in the picture). One example was when he found a picture of sushi. It was tagged wrong as it was placed in the middle of a street with no restaurants around. However, the description said where you could find the food in the image. He

stated that he really liked the recommendation with a picture of food (instead of a picture of the venue), but joked and said that it was weird that he had to go to the place of the photograph to get the recommendation of the food somewhere else: “*it is good that you can get this kind of recommendation, but stupid that you have to go all over here to find out about the place over there.*”

They were also generally less concerned with whether a photograph was tagged at the point of looking or point of taking. Instead, many participants found it quite problematic when the photographs were tagged at the wrong place, causing both disappointment and confusion. One big cluster of photographs at the end of the route was tagged at the wrong place showing different dishes of food, an interesting conceptual image of a radio tower, and some pictures of people and a dog. All eight participants looked at the photographs and tried to figure out where they were taken. However, the amount of effort to find them varied quite a lot. Some participants immediately understood that they were misplaced and did not go out to investigate how much they were misplaced. These people were the least concerned. Other participants, however, went to explore the area in more detail trying to figure out where the photographs were actually from. Despite being obvious that the geotag of the photographs was wrong once the location was reached, some participants hoped (some even assumed) that they were to be found nearby. When realizing that this was not the case, they were really disappointed, and one participant clearly annoyed jokingly explaining that he was really hungry and wanted to find the place with the photograph of sushi.

Finding a photograph close to its location of taking was highly appreciated when the view in the picture was easy to align to reality. In one instance, a participant finds a photograph in the application when standing right at the point on the map, which coincides with where the photograph was taken. He more or less immediately sees the motif in the real world as he is already aligned with the image and becomes obviously excited. This photograph (see Fig. 3) also becomes one of the top five photographs he finds, with the motivation that it was great finding it right where he was. The same kind of experience was noticed for other participants as well. Interestingly, one particular photograph (see Fig. 4) had this effect on several of the participants. It was a street lamp hanging in wires between two buildings, thus unnoticeable unless looking up. The photograph was taken from the ground pretty close to the lamp and therefore looked almost the same disregarding from which angle you look up at the lamp (it was round and symmetrical). The photograph was tagged quite accurately, and therefore, many of the participants looked at it when close to its location. As they looked around, and eventually up, they all expressed a delight of finding it at this location.



Fig. 3 Photograph from the top of some stairs that was found by a participant looking in the same direction



Fig. 4 Street lamp photograph chosen by 6 out of 8 participants

Six of the eight participants therefore chose this particular photograph as their top photograph. Though their motivations varied, most of them implied that it was due to the delight of spotting the lamp in reality and in the picture almost instantly and that they did not spot the lamp before seeing the photographs of it.

4.2.1.3 Attitudes toward photographs of inaccessible places While the participants in the first trial appreciated looking at photographs taken indoors, not all participants in the second study appreciated them. Some of the participants counted these photographs as useless. The reason for them to be useless was because they were not immediately accessible. Most participants were therefore interested in finding the location of the photographs in reality and when

the motif was inaccessible they therefore rendered them useless. However, this was not the case for all participants. Some of them instead expressed that it was “neat” to be able to find photographs from inside, even though they could not get there, because it gave them the opportunity to see how it was inside the buildings they were walking by, much like the motivations for the people familiar with their location.

4.2.1.4 Photographs of interest When asked about how they chose what photographs to look at, they all seemed to agree that the closer the photograph was tagged to his current position on the map, the more interesting the photographs. This caused them to in first-hand look at photographs close to them or on the path they were walking. Only when there were no more photographs nearby did, they look at photographs closer to the periphery of the map. As in the first trial, the participants in the second trial expressed that photographs closer to them were more “local” and therefore more “interesting.” When the participant who went looking for the photograph of the dot that got away due to the GPS, he expressed this behavior as deviance because he was “*playing treasure hunter.*”

There were some participants who at times ignored where a photograph was taken all together, unless the photograph was showing something of interest. For instance, one participant explained how he found a photograph showing a blooming tree and actively ignored looking up to see where the tree actually was in reality. Instead, he found a photograph of a sign with an esthetically pleasing background that he meticulously tried to find its place of origin.

After the walking session, participants were asked to pick the top five photographs that they saw and to motivate why these were their top picks. There were many different motivations for picking a photograph as one of the top five photographs but the most common ones were the following: the photograph was *esthetically pleasing*, it was a good *landmark for navigation*, and they were for photographs *from a different time*. The esthetics of a photograph was the most important aspect of a photograph for some participants, which is completely unrelated to the place. They all picked photographs that in some way were representational for the location they were in or that was easy to single out from the rest of the environment. Even participants who had a hard time finding it often picked the previously mentioned street lamp photograph. Participants enjoyed being able to view the area they were in from a different time period. While the study was carried out during winter with snow covering the streets, they enjoyed seeing how what the area looked like in summer time and made them remember warmer days. They used the photographs to get a better picture of the place they are in, from a time when they may not have been there before.



Fig. 5 The photograph of the red bull machine, picked by a participant to “ironically” represent the area it was in

When asked to say some words about their impressions of the area they explored, it was apparent that the photographs made a significant impression about the place on the participants. They mentioned that it was a place for work (which is true) with many companies (there were many photographs of company logotypes), a place where people enjoyed having lunch (“people seem happy and well dressed during lunch breaks”), but also a place for studying (taken from the description of a picture saying it was from inside a university building). They also expressed that there were not many people in the photographs and that they would have liked to see more about the life of people in the area. Considering that the time of the study was during a time when not many people were in the streets, the information (except for the company logos that was visible on the buildings) they referred to was only accessible from the photographs.

The impression that the photographs made on the place the participants were in was particularly prevalent for one participant. One photograph was picked as his top five, because of “irony” (as the participant himself called it). After walking around and seeing the photographs from the area, he quickly got the impression that the place was a place where many engineers worked. Due to his own assumptions about such people, he expected to find evidence of energy drink consumption such as cans and bottles. Instead, he found a photograph of a vending machine for Red Bull (a popular high concentration energy drink) and picked it solely based on the meaning for this participant (see Fig. 5). It is something “of interest” only because of its location and it “has meaning” only because of its local placement and local relevance.

5 Discussion

The two studies showed that the design concept behind Columbus to provide users with a sense of exploration when exploring geotagged photographs was indeed

supported by the application. It was striking that how participants used the application appeared affected by the extent to which they were familiar with the locations they were exploring; two patterns appear to arise. In very familiar locations such as the center of their home city, users appropriate the use of the application to look for things according to their previous experience with a place. They look for “drunk people” around bar areas and pictures of work mates around their work place. If completely new to a place, users instead will likely take a more exploratory approach to the application and the content it provides. One participant in our study for example even decided to set off on a treasure hunt for an escaped photograph.

Whereas the users in familiar locations do not explore the location as much as the photographs, they do seek out photographs in a quest for things they feel should be possible to be found. In contrast, users exploring unfamiliar locations appear more likely to explore both—the unknown location they are in, through the photographs of that location, and the photographs themselves. Where some participants let the photographs guide them, others let things in the reality guide them to what photographs to look for, but they still explore the location they are in and the photographs taken there.

Our studies focused on how people who use the application for the first time experienced the application and its content. We cannot yet tell how the application would be used in daily life or how the experience of being presented with localized content could change over a longer period of time. However, it does show that the places users have previously visited are reencountered through the system and that the systems let users further explore these in new ways. For new locations, the application’s content can provide users a starting point to learn about the places around them. The content can serve as recommendations to where to find interesting venues, explore, and find hidden gems, or simply “where to find food,” but can also tell users about the social relationships other people might have with the surroundings they are exploring [21].

5.1 Design recommendations

The studies resulted in recommendations on how to improve the application and other developers and designers of applications for using localized content. Participants in the first study wished they could zoom in even further to see more “local” photographs because they were said to be more “interesting.” Similarly, people in the second study looked at photographs that crossed their path and deemed them to be the most interesting ones. Thus, as we expected, photographs closer to you are more interesting than photographs further away. Even though care was taken when

designing the system to have only nearby photographs accessible, his might not have been local enough. A simple design improvement for Columbus would therefore be to “zoom in” more and restrict to even more local content or just provide the option for the user to zoom in further (just not further out). On a more general level, it shows that interest in content decreases with distance even if the distance is small to begin with. Of course, the question remains as to exactly what this distance should be and whether should be controlled by the user, something that is most probably very dependent on the context. We feel that this is something that requires further inquiry not just for the case of Columbus, but also for any location-based service that show content nearby.

While not designed to aid navigation, we did see the system being used for inspiration where to go. However, where some navigation tools can distract the users from what they are supposed to experience [6], Columbus did not. Instead in Columbus, what is to be experienced is both the physical world and the digital photographs in unison. Thus, instead of distracting, finding a photograph where it was taken created a complementing experience.

Interesting to note is that a number of participants in unfamiliar locations felt that when they could not deduce where a specific photograph had been taken and that this photograph was essentially useless to them. This implies they wanted to experience photographs in unison with their location; when that proved impossible, the photographs were of no use. In the design of systems that aim to support exploration and/or provide localized content, it is therefore important to consider how users may be supported in “placing” the content a system presents them with within their surroundings. In that light, it is also crucial to consider the way that content has been (or can be) geotagged and how this may affect users’ experience when the content is reencountered.

6 Conclusions and future work

We have presented an evaluation of Columbus—an application for exploring the world through geotagged photographs. We reported on two consecutive field trials where we let participants use the application in both familiar and unfamiliar locations. We saw how the participants in the familiar setting appropriated the application to look for photographs according to their previous experience and knowledge of the place, and we saw how participants in unfamiliar setting set out to explore the area they were in and got an impression of the place with the help of photographs. As future work, it would be valuable to do a longitudinal study, where people get to use the application for a longer time and see how their use and experience

differs. We are particularly interested in how the connection with the physical location and the photograph is made and whether it is valuable and appreciated.

The study of Columbus has shown how a photograph can be perceived and “used” when physically present at its associated location and has also shown how a place can be perceived and appropriated when experienced with accompanying photographs. We aim to further explore perceptions of place through locative media and how application concepts and design decisions can affect these perceptions. Comparisons between perceptions of places, effects on what constitutes a place for users, as well as the perception of other people’s social relationships to the surroundings at hand, are just a number of examples of the issues vital to explore—especially now as location-based applications are rapidly becoming commonplace. Our study has contributed to a better understanding of how both experience of place and media content are affected by the presentation of localized content and experiencing it “in place.”

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