

Photos on the Go: A Mobile Application Case Study

Mor Naaman, Rahul Nair, Vlad Kaplun
Yahoo! Inc.
Berkeley, CA, USA
{mor, rnair, vladkap}@yahoo-inc.com,

ABSTRACT

We designed and iterated on a photo browsing application for high-end mobile phones. The application, Zurfer, supports viewing of photos from the user, their contacts, and the general user population. Photos are organized using a channel metaphor, driven by multiple dimensions: social, spatial and topical. Zurfer was deployed to over 500 users; extensive user research was conducted with nine participants. The data from the deployment and the study exposes general themes of mobile application use, as well as requirements for mobile applications in the photos domain, mobile social applications, and entertainment-driven mobile applications.

Author Keywords

Mobile, photographs, mobile applications, user study, photo sharing, photo browsing.

ACM Classification Keywords

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

INTRODUCTION

In recent years, mobile phones are finally breaking beyond their traditional use for phone calls and messaging. Exceedingly, mobile devices are network connected, support a high-resolution screen, and are capable of providing media-rich entertainment and supporting new types of social applications. The most popular phone applications still cater to communication and information needs (e.g., email, search [13] and local information). However, other mobile devices (like Apple's iPod) are focused on personal entertainment -- music, video [20] and sometimes photos. Increasingly, these trends merge into a single device that can play media as well as support information needs. However, practices and needs around mobile applications are still not well understood. What role will these devices play in our daily life? How and why would people use these applications? We provide some answers to these questions with our study of Zurfer.

Zurfer (Figure 1) is mobile software prototype that enables comprehensive photo browsing on the go. Zurfer is a first step towards priming the mobile phones in everybody's pockets to become the future 'photo wallet' – one that can provide access to not just a few select photos, but to all the world's media. Previous mobile photo-browsing applications focused on personal photos and on optimizing access [10,14,20,29], or on viewing photos with limited

interaction and screen space [18,24]. In contrast, Zurfer is designed to be playful and simple to use, while providing personalized, comprehensive and customizable media access. Using Flickr [1] as a backend, Zurfer can support many tasks including entertainment (browsing photos for fun), social contact (looking at friend's latest photos) and other tasks (e.g., access to the user's own Flickr photo collection).

A public deployment of Zurfer to over 500 users, and extensive user research with nine of these users (that included two separate interviews and was grounded in the user's actual Zurfer activity) teach us about mobile applications, mobile entertainment use and needs, mobile social applications, and, of course, requirements for mobile photo browsing applications. Our contributions also include an outline of an interview method grounded in mobile activity logs.

We begin by providing additional details about the Zurfer application; we then describe the study method and discuss our findings. But first, we discuss important related work.



Figure 1. Zurfer screenshots: channel view (left) and full-screen view (right).

RELATED WORK

We describe related work in the area of digital photographs; these studies mostly focus on personal photo collections, yet some examine sharing environments. We also address related work on mobile photos and social mobile applications, as well as studies of mobile application use.

There is a large body of work [4,5,9,16,17,27] studying personal and social factors in use and management of personal photos. Bentley et al. [5] studied how people search and browse through collections of personal photographs (and music collections). In [9], researchers

conducted an ethnographic study of photo consumption practices involving both digital and print images, with the goal of informing the design of future photo-sharing systems. Often leading to photo sharing, [16] examined people's activities around photographs after capture, in preparation to end-use. Work in [4] described a system that allowed for sharing and storytelling around photographs on a handheld device. We report here on some similar themes of photo consumption on a mobile device. We incorporated many of these papers' findings into our design.

The social relevance of personal photographs has been another avenue of research. Self-representation and relationship maintenance were found in [27] to be two of the most important aspects for users of Flickr. Lerman and Jones [17] analyzed flickr data and showed that browsing the images produced by the user's contacts is one of the primary ways in which users find new images; similar trends inform the design and are apparent in the study of our system.

Enabling image browsing on small-screen devices has also been the topic of several research efforts [10,14,19,22,23]. Unlike our work, most of these efforts assume that the mobile images are stored locally on the mobile device, or the existence of a fixed image collection that the user can browse (e.g., the user's personal image collection). The focus of [10,14] was the interaction and visualization techniques, while [19,23,26] focused on automatic analysis of the data to facilitate mobile browsing; these papers do not study the use of such systems in the wild. Veering away from personal collections, work in [22] used location-aware technology to navigate a public, location-enhanced photo collection on a mobile device. That system allowed users to explore their surroundings virtually, but did not include personal photos and other concepts of social interaction or topical interest. Another research path in small-screen photo browsing looked at detecting the 'salient' features and areas in an image and using that knowledge when displaying the image on small devices [18,25]. Most of these image browsing techniques could potentially be added to Zurfer; we focus here on a general system that allows us to investigate general properties of mobile application use.

Systems such as MobShare [24], MMM2 [8] PhotoRouter [2] and mGroup [12] have studied the social behavior around the sharing of images from a mobile device. However, work in [2,8,24] concentrated primarily on the capture and sending aspects rather than consuming and viewing images as we do here. The mGroup project studied the collective creation of mobile media but focused more in the instantaneous messaging and communication aspects rather the browsing of images.

Flipper [7] was an experimental system designed to enable lightweight photo sharing using both web and mobile components. Flipper was designed using a group model for picture messaging, rather than the publishing model used in Flickr (and Zurfer). The Flipper evaluation was based on a

short term, limited deployment and, unlike our work here, focused on measuring social presence and levels of sharing.

Naturally, there is a significant amount of research around the usage of mobile devices. To mention a few, [13] studied the query logs from the Google Mobile search page and compared it to web search queries. Church et al. [6] analyzed the web usage logs of mobile internet users and found that users spend a large portion of their time browsing known resources and only a small percentage of users actively search for content. Finally, and perhaps most related to this work, O'Hara et al. [20] studied mobile video consumption patterns, specifically looking at the context of use, the type of content that was viewed in different situations, and practices around getting and viewing such content. Most of the content discussed in [20] is not personal/social – it is commercially produced content (e.g., television and movie content). Nevertheless, their findings overlap with some of our findings below.

ZURFER: PHOTOS ON THE GO

Zurfer¹ provides personalized and customized access to photos from Flickr [1], a photo-sharing website. Using the Flickr backend, Zurfer can potentially accommodate many categories of photo content, starting from the user's own photos, to photos from the user's contacts, to public photos from the user's current location and more. We briefly report here on Zurfer's key features.

Our design goals for Zurfer included enabling simple and easy access to the most salient dimensions of Flickr, namely the user's own photos and their contacts' photos. The design also aimed for intuitive and playful interaction with the basic content, while providing mechanism to drill down into the "long tail" of unexpected content needs.

In the process, we developed and studied a hi-fi prototype of Zurfer (using Flash Lite Actionscript), attempting to discover main requirements and interests of users of the application. We ran a series of interviews in lab settings with this functional prototype. In the interviews, we had five different users interact with the prototype that was personalized for their use. Our findings, even within the small group of users, showed that many divergent requirements and interests exist. We therefore iterated on the design and architecture of Zurfer, verifying that some basic common interests are met, while making the navigation between various items of interest even easier than before. We improved on the interaction and navigation, as well as the image-loading scheme, in accordance with this early feedback.

Zurfer is designed to be playful and simple to use. A channel metaphor (see Figure 1) is used in Zurfer to allow the user to simultaneously and quickly browse media in key dimensions using the 4-way navigation key on the mobile

¹ <http://zurfer.research.yahoo.com>.

phone. The default channels, shown in the main view for every Zurfer user, include nearby photos (“Nearby” channel)², latest photos from the user’s contacts (“Contacts” channel), the user’s own photos (“My Stuff”), and highly ranked photos from Flickr (“Interesting”, using the Flickr “Interestingness” measure). Finally, a special “recent comments” channel allows the user to follow photo-related discussions on Flickr, by showing the user’s photos which were recently commented on by other Flickr users, as well as photos from others on Flickr that the user left comments on. The user can browse up and down between channel, and right and left to view photos in any one channel. To see photos in greater detail, the user can open any channel in “full screen mode” (Figure 1). A temporally-driven sorting scheme for media items in the different channels allows quick and easy access to items of interest by recency.

A Zurfer user can add custom channels using a simple web-based configuration page. Possible custom channels include photos from a specific Flickr contact; photos tagged with a certain tag of interest, and photos from a Flickr group. If added, custom channels are shown together with the default channels upon startup, in the main application view.

Beyond the main navigation elements, Zurfer includes extra features such as marking photos as favorites and posting comment on photos. For ad-hoc tasks, we extended Zurfer with keyword search to deliver the long tail of images: the user can search any of the channels using text queries.

The Zurfer application was implemented in Java and runs on Nokia Series 60 phones and other Java-enabled phones. For more details about the Zurfer features and implementation, see [1].

METHOD

To learn about mobile application use, we looked at Zurfer usage data and conducted extensive user interviews. We describe the data collection and report on the interview recruiting and process. In this paper, we refer to three groupings of users for the various studies: all the users of Zurfer, the most active users (used Zurfer more than 10 times) and the interview users. Zurfer has been deployed as a publicly-available prototype for over three months (at the time of writing). As of September 2007, Zurfer was installed and used at least once by more than 500 people (“all users”). At the time of writing, 69 “active users” have used Zurfer over 10 times. To give the reader a sense of Zurfer use, we use the number of active days per users: Ten users have used Zurfer on more than 20 different days; 33 users have used Zurfer on 10 or more different days; and 97 users started Zurfer on at least five different days. It should be noted that most, but not all, of the Zurfer users were self-selected early adopters of technology.

During deployment, we collected detailed data regarding the usage of the system. This data includes details regarding Zurfer channel and photo views for individual users, the set of user-generated custom channels, and other general usage data. We have instrumented logging on the Zurfer client, periodically sending information about the user activity (including channel and individual image views) to our server. While some logs were lost due to implementation issues, we estimate that over 90% of the activity of Zurfer clients was captured, such that major trends and relative usage data are reflected in the available logs.

Based on usage logs, we have identified active Zurfer users and approached them directly via email to participate in interviews. We also recruited participants via a special Zurfer channel that was shown (in a span of two weeks) for all users of the application, soliciting their participation in the study. We recruited a total of nine participants (P1-P9) for the study, they are identified below as “interview users” or, more simply, “participants”.

The decision to recruit existing users instead of equipping and supporting a group of “random” users was due to the nature of the application. Since Zurfer is not an “essential” application, and is also dependent on a user’s Flickr use, such open-ended recruitment would pose the risk of participants that would not use Zurfer naturally, but rather, simply use it for the purpose of the study. We might have ended up with a small subset of the recruited users that actually used the application. For instance, in a concurrent related study, we recruited over 20 users, yet only three of them used Zurfer to any significant degree (these user’s Zurfer feedback was considered, and greatly overlaps with our participant’s input; we do not explicitly report on these three participants in this work).

The user study consisted of two structured interviews with each participant. In the first interview, we followed a structured interview format, asking the participants about their Flickr and Zurfer usage. We also asked them about other photo-viewing applications used on their mobile device. One such application that was used by most participants is the Nokia Gallery application, which is pre-installed on all Nokia phones and allows viewing of photos stored in the phone’s memory.

A second interview was used to ground the participant’s self reports on their Zurfer use in actual usage data. At the end of the first interview we asked the participant’s permission to perform detailed logging of their Zurfer activity through the second interview date. In the second interview, roughly a week later, we used a visualization of the participant’s activity to discuss their Zurfer usage. The visualization included a complete breakdown of the participant’s activity since the first interview, displaying every occurrence in which they ran the application, organized by date. For each run, the system displayed the names of the channels viewed, and thumbnails of the photos the participant viewed in each channel. By default, the interviewers could

² If the location is unknown, users could enter it manually.

not see the visualization details (the photos themselves, and channel names), but the participants could "grant" the interviewers that full view; all interviewees chose to do so. Due to various technical constraints, we conducted second interviews with five of the nine participants. All participants received a \$25 reward for their time.

The log-based interview method, while not as accurate as diary studies, is more suitable for many types of user research. While immediate feedback on the user's actions and motivations in situ is not available, the short time period (i.e., roughly one week) allowed users to relatively easily (but not always) re-construct their context and motivations of use for most log events. With automatic logging, the users are not burdened and are not made self-conscious regarding their daily use of the application, two potential drawbacks of a traditional daily or per-use diary study. Our interview method resembles other non-intrusive "elicitation" techniques [3,28]. Such methods attempt to elicit memory and discussion about the context of use from actual artifacts of usage.

We interviewed a total of eight men, and one woman. The participants ranged in ages from 26 to 56; the average age was 35. The study's international scope was quite significant: the 9 participants reside in 5 countries and represent 5 different nationalities. The study participants were all active users (more than 10 runs), using Zurfer on between 7 and 80 different days (mean= 26, SD =22). The participants used Zurfer an average of 3.3 times per week during the study. We believe that the magnitude of use patterns and practices exposed in the study, as well as the geographic scope and participant age span compensate for the fact that Zurfer users were largely self-selected.

FINDINGS

As expected from the initial study, the public deployment to over 500 users (69 active users) and the subsequent user study with nine of them revealed varied, divergent use patterns of mobile applications in general, and mobile photo applications in particular. In the sections below, we report on the major findings. When appropriate, we use both log data and the interviews to demonstrate each point.

Context of Use

Our participants reported using Zurfer in various contexts

Quote 1.1 (P2). "I had already shut down the computer and was more convenient to show it on the phone."

Quote 1.2 (P3). "Very often I want to check up pix... this is something I do when I put my kid to sleep... almost every evening."

Quote 1.3 (P1). "Some times [my girlfriend] won't look at stuff on the computer because I call her over to look at stuff constantly... but if it a mobile device that's right there it's more natural."

Quote 1.4 (P8). "I am lazy enough to check it from my bed... more comfortable... than go down and check the desktop."

Quotes 1.1-1.4: Scenarios of Zurfer use at home.

and environments. Zurfer was used in stationary and mobile situations, in a various types of locations, and in different social contexts. In terms of the mobile and stationary categories, we had four participant accounts of Zurfer use on public transport, or generally on the move (one participant apologetically reported using Zurfer while driving). All participants had used Zurfer while stationary, in regular or ad-hoc locations: at home, at the office/work, while waiting in line, in the cafeteria, etc. In fact, some participants strictly used Zurfer via a wi-fi connection, in fixed places, instead of using a costly cellular-based Internet connection.

Out of the location types, most surprisingly, although verified by other studies [20], six out of nine participants have reported using Zurfer at home (despite having Internet access on laptop or desktop computers). Key reasons we identified for use of Zurfer at home were *ease of use*; *multi-tasking*; *social interaction* and *physical convenience*. *Ease of use* (Quote 1.1) reflects that fact that for some tasks (e.g., checking on contacts' latest photos), using Zurfer was much more efficient than heading over to the computer, starting it, launching a browser, browsing to Flickr and navigating to the relevant page (or even any subset of these tasks). *Multi-tasking* was mentioned by one participant (Quote 1.2) – a mobile device requiring a single-hand interaction and little attention to input (only using the 4-way navigation key) is easier to use while, to borrow an example from one participant, putting the kids to sleep [21]. The *social interaction* reason for home use reflects the want of users to stay in present company and not interfere with the social interaction by leaving (Quote 1.3). Finally, *physical convenience* (Quote 1.4) reflects the fact that a mobile device can be used flexibly, and be moved around easily, including use in places where it is not practical to use a desktop or even laptop computers (one participant apologetically reported using Zurfer in the bathroom).

In terms of social context of use, participants reported using Zurfer in private but also in social situations. Interestingly, Zurfer was used both in shared-social situations (i.e., sharing photos with others using Zurfer, which we discuss in the Tasks section below) as well as unshared or solitary use in social context: looking at photos despite the presence of known or unknown others [20]. These cases of solitary use in social context with known others included work, home (as mentioned above) and other settings.

Type of Use

Three overall "modes" of mobile application use emerged from the Zurfer interviews, which we call *Task Time*, *Down Time*, and *Killing Time*. The Task Time mode of use is characterized by being goal-driven: the user starts the application to accomplish a specific task (e.g., share a photo with a co-present friend). The Down Time use mode is more casual, and perhaps longer in duration: a user seeking a break from other activities by starting Zurfer with no specific tasks in mind, perhaps pursuing their regular set of

Zurfer interests (e.g., looking at latest photos from contacts while at work – Quote 2.1). Finally, Killing Time (Quote 2.4) describes a mode when the user is devoid of other tasks or activities, and starts Zurfer to alleviate their boredom (e.g., checking out Zurfer while waiting in line). Sessions of Killing Time activity could be arbitrarily long, and the Zurfer functionality is not critical for this mode but rather a choice (i.e., other applications, if available, could be used).

Quote 2.1 (P6). “I use it as a break... when I need a break from work or writing... I use programs like Zurfer to spend a few minutes... get a break from what I’m doing and then go back.”

Quote 2.2 (P8). “I was just waiting for my breakfast, for my toast to come out of the toaster.”

Quote 2.3 (P1). “If I am looking for comments I launch the app and see if there is a new comment and that’s it... if I am there already... if the network is fast I’ll give an extra second and look at something else.”

Quote 2.4 (P5). “Pressing the Zurfer button and getting images... was the fastest thing between Point A: boredom and Point B: just spending time looking at some things.”

Quotes 2.1-2.4: Using Zurfer in different modes.

We do not maintain that there is a clear division between these modes of use, but rather that these modes should be considered as a continuum. Also, these modes of use should not be confused with tasks; often the same tasks are performed during different modes of use. Often, sessions that started as “task time” activity turned into “down time”, and so forth (Quote 2.3). Figure 2 proposes an informal, tentative model for mobile application use modes.

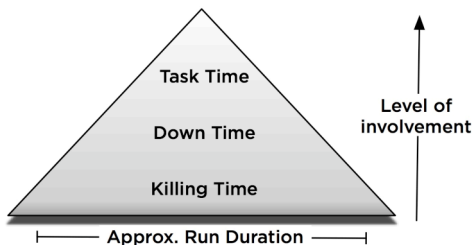


Figure 2. A model of application use modes.

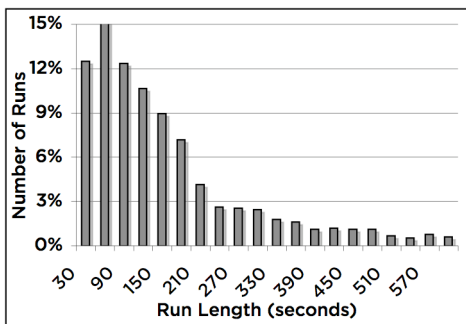


Figure 3. Distribution of Zurfer run durations (all users).

Figure 3 uses log data from all users of Zurfer to show the histogram of Zurfer run durations, demonstrating Zurfer’s use in multiple modes. For example, the left-most bar indicates that users quit the Zurfer application within less than 30 seconds from launch in 12.5% of the total number of roughly 1200 Zurfer launches in our logs. Note that 30

seconds are indeed sufficient to accomplish some key Zurfer tasks (see Quote 2.3). Aggregating the first four bars indicates that in 50% of the time, Zurfer runs were shorter than two minutes. On the other hand, the long tail of usage was also quite substantial: 11% of Zurfer runs exceeded 10 minutes (not shown). We suggest that these numbers indicate Zurfer’s use in various modes, from focused tasks to “killing time”, as mentioned above.

Tasks

The Zurfer application is quite flexible and comprehensive, allowing the user to perform a varied set of tasks. A clear division for Zurfer, mentioned above, is between personal and social context of use. Indeed, tasks could be roughly broken to *personal* and *shared* categories.

Shared Tasks

The shared tasks performed with Zurfer mostly manifested in co-present sharing of photos (as in [9]). The shared photos were not necessarily photos taken by the sharing user: in some cases, participants shared photos from their contacts or other photos that were found on Zurfer. Eight out of nine participants shared images using their phone with co-present others. Note that in several cases, participants opted to use the phone’s native Gallery applications, as the Gallery could show images in full-screen slideshow mode. However, Gallery could only be used for the user’s own photos that were still available on the phone. In many cases, co-present sharing involved photos that were already deleted from the phone or, more commonly, taken by other users or using a different capture device (e.g., digital camera photos uploaded to Flickr and available on Zurfer). We include the Gallery application usage in the summary of co-present sharing below.

We have identified a few different categories of co-present sharing instances:

- Story telling and illustration. Participants used Zurfer to share photos they have taken with co-present others to facilitate or instigate story-telling. As also reported in [16], these shared photos were often recent photos or photos from recent events.³ Four participants recounted such events, in which they used photos to tell a story (e.g., report on a recent vacation). In other cases, participants described sessions where photos are retrieved using Zurfer (or other applications) to illustrate a conversation or story-telling session that was not instigated by a photo sharing activity.
- Identity presentation. At least three participants discussed using Zurfer or other photo-viewing applications to share photos that represented the participant’s identity: photos that can be used to “describe me to other people”, as one participant put it. This use mostly involves photos taken

³ Since Zurfer’s photo presentation is driven by recency, this data point may be somewhat biased by the properties of the application (but is independently verified by [16]).

by the participants to facilitate both reminiscing (see below) and sharing. Note that this type of usage directly extends the idea of the traditional “photo wallet” of printed photos that many people carry around with them in their wallet or purse. Indeed, several participants generally discussed the problem of having their favorite photographic content available on (or from) the phone. Various methods participants applied or requested in order to address this availability issue were moving content to the phone, explicitly keeping photos on the phone, and even being able to save photos from Zurfer to the phone’s memory. While Zurfer included a PhotoWallet feature that could potentially help with these tasks, the feature was quite hidden and only discovered by two participants; another participant started using the PhotoWallet feature after the first interview.

– Social information sharing. At least three participants used Zurfer to share photos taken by others. This type of sharing was sometimes driven by a discovery of interesting photos by the user’s contacts. In other cases, the participants looked for and shared specific photos they knew existed and are accessible from Zurfer to show to co-present others.

– Serendipitous discovery. At least one participant shared relevant or otherwise interesting photos discovered on Zurfer with co-present individuals.

While co-present sharing proved to be a popular activity amongst our participants, the solitary (or rather, personal) tasks represent the bulk of Zurfer use.

Personal Tasks

Personal tasks in Zurfer were those performed privately, not driven by sharing content with others. Personal tasks were mostly information tasks, where the users seek (or simply view) a set of photos. We classify the types of information available on Zurfer and used by our participants into five categories. These categories are listed below, including comments on the salient properties of use in each category.

– *Social* (e.g., the contacts channel, recent comments channel, or a custom channel created for photos from a specific contact). The *social* category of information was the primary use case for most participants. Analyzing the interview scripts, we identified the social interest as the primary use of Zurfer for five out of nine participants. Three additional participants were heavily engaged with social aspects of Zurfer, but we could not determine that social activity was the main driver for them. The Participants attested to using the social channels to keep in touch with friends (often geographically dispersed around the world), monitor contact’s activities, and follow conversations in the comments around their Flickr photographs (Quotes 3.1-3.4). The usage data from all user as well as active users of Zurfer also indicates that social aspects (mostly viewing contacts’ photos) were the main driver of activity in Zurfer. The social channels’ views accounted for 40% of the total photo views and 44% of all

fullscreen image views for all users. In addition, we performed an analysis on Zurfer’s active users (69 users with 10 or more runs), to check if there is a positive correlation between the number of contacts for a Zurfer user, and the user’s average number of daily Zurfer channel views. Indeed, a significant correlation was found (N=69, $r=.240$, $p<.05$). Interestingly, a stronger correlation was found between the *number of photos* uploaded by a Zurfer user’s contacts and the user’s daily channel views (N=69, $r=.332$, $p<.01$), meaning the more active the contacts are, the more likely a user is to use Zurfer. These numbers re-affirm the strong social element in Zurfer use.

Quote 3.1 (P2). “I was just opening it up and actually I was trying to see my children’s photos... see those contacts, what are there...”

Quote 3.2 (P6). “I will see this friend of mine next week, and I know he posts pictures quite frequently... so I was checking what he’s up to... I do this pretty regularly... 2 or 3 times a week.”

Quote 3.3 (P1). “Lately it’s just been my contacts. I just finished school and everyone is all over the place living their new lives. I like how you can stay in touch with visuals. It’s low overhead but still intimate in some way....”

Quote 3.4 (P8). “Some of the contacts I am quite close to. My brother is a photographer... I know he uploads every second or third day... so I am just curious to see what he’s working on.”

Quotes 3.1-3.4: Examples of social-interest use of Zurfer.

– *Personal* (i.e., the user’s own photo channel). Three types of use emerged in this category, beyond co-present sharing (discussed above). First, at least two participants reported using their Zurfer “My Photo” channel (or the phone’s Gallery application) to reminisce or just kill time. A second use, perhaps more mundane, simply involved the task of verifying whether the participant’s latest photos were uploaded to Flickr, what the newly uploaded photos looked like on the mobile device, etc. Six participants reported performing such “verification” tasks; one of them also wished they could edit and annotate the photos, at the same time. Finally, we have seen some functional use of personal photos [15]: one participant reported taking and uploading a photo of a bottle of wine, knowing that the photo will be available on Zurfer when he looks for that wine at the store.

– *Spatial* (e.g., the Nearby Photos channel, custom location-driven channels). There was considerable interest in channels showing location-driven images, although certainly not from all participants. The interest was split between two main themes: “specific places” and “nearby”. First, many users were interested in *specific places*, and not necessarily photos from their current location. These specific places often included the participants’ hometown or other places that are dear to them for some reason (Quote 4.1). The custom channels data from all Zurfer users provides further evidence to this type of interest: Out of 210 Zurfer custom channels that are based on a group or a tag, 37 were place-specific (the group was dedicated to given place, or the tag was a place name – e.g., “Montreal”). The

second spatial information theme was user interest in nearby photos. In this category, interest varied amongst participants, but it also varied depending on the user's location (Quote 4.2) and context of use (Quote 4.3). Zurfer users created 25 custom channels marked to deliver only photos from the user's current location, one of Zurfer's channel configuration options (e.g., a "architecture near me" channel). For both nearby images and specific places the issue of location granularity played a role. Some users expressed interest in precise place (e.g., Quote 4.4); one participant commented that showing photos from Amsterdam, for example, is "too general", and if the location is set more accurately it would be more interesting. Several participants suggested another path for focusing or personalizing the location channels, surfacing more compelling content by looking for socially and topically-interesting content nearby (e.g., nearby photos from friends). To summarize, in the interviews, seven of our participants expressed some form of interest in location-based photos; at least two of these participants were primarily interested in specific, real-world places (and not necessarily the "nearby" images).

Quote 4.1 (P2). "The place we like the most, the so called ideal place... Every person has such a place somewhere in the world... It is very nice to see if somebody... at least from my contacts, has taken pictures..."

Quote 4.2 (P5). "Certainly Berkeley is a much more interesting town than mountain view..."

Quote 4.3 (P6). "When I travel I can see interesting pictures from that location... interesting wherever I am to see what other people found interesting in this precise spot."

Quote 4.4 (P1). "If my phone really knew where I was and there was that much content that wherever you were you could get something really relevant I'd be into it."

Quotes 4.1-4.4: Spatial interest in photos.

– *Topical* (i.e., creating and viewing a custom channel for photos with a specific tag or from a Flickr group). Three of our participants have reported following specific topics of interest on Zurfer. Those participants who created custom channels also reported commonly looking at them whenever they started Zurfer. The data from the Zurfer deployment also shows that topical interests were significant amongst all users; over 200 channels were

Quote 5.1 (P6). "I would be more interested in having 'friends' channel, not 'contacts'... if I look at the channel for contacts it's completely flooded with... picture of people I don't care about."

Quote 5.2 (P4). "I also got my family photos in different 'lines'... I added channels for all my favorite friends."

Quote 5.3 (P5). "I have one group... Stick Figures in Danger... I will check that on regular basis... any given time you see 5-6 pictures... will be kind of funny, something that you glance at... that's one of my Zurfer channels."

Quote 5.4 (P3). "Mostly random tags I thought interesting... I had set up Zurfer so that it would show two tags always..."

Quote 5.5 (P8). "I Look at the photo... for... visual inspiration. I have this theory that if you want to make beautiful things you have to look at many beautiful things in your life."

Quotes 5.1-5.5: Customizing Zurfer.

created to follow specific topics. We discuss customization in more detail below.

– *Random* (e.g., the "interesting today" channel). Zurfer's default channels include an "interesting today" channel that delivers highly-rated photos from Flickr, as well as photos tagged with a specific topic, chosen editorially by the Zurfer team. Use of this channel, as expected, was often connected to "killing time" use mode. One participant explicitly mentioned enjoying this channel. Most others were indifferent, although three of the participants admitted to look at this channel often, in "killing time" use mode (Quote 2.3). Two participants suggested better random content, perhaps drawn from the user's own photos or their social contacts, or otherwise generating more relevant content. It should be noted that the "Nearby Photos" spatial channel also often served as a source of almost-random photos participants could browse through. To summarize, random content enjoyed significant usage in "killing time" mode, but did not usually serve as a major attraction.

Customization

A major factor in the information tasks, as mentioned above, was the user's ability to customize their Zurfer experience: add channels of interest to follow photos from a contact, photos with a specific tag or photos from a certain Flickr group. Indeed, while not all users discovered the customization option, customization did play a major role in the system. A total of 128 Zurfer users have created 270 custom channels. As mentioned above, Zurfer users are often technologically savvy, and we do not expect such high customization ratios in deployment to a different user population. However, we can possibly learn about general customization patterns and trends. Out of the custom channels, 60 channels were created to follow a specific contact (created by 38 different users), 116 were "tag" channels (75 users), and 94 were "group" channels (49 users). While not all users added custom channels, the users that did add them heavily used these channels. Custom channels contributed to almost 15% of the photo views, and 20% of the full-screen photo views from the active Zurfer users.

A prominent theme in Zurfer's customization, which was also exposed in the interviews, was *social filtering*. Due to the constraints of the small screen, download time and attention, six participants voiced a need to be able to select and prioritize the display of photos from friends, family members (Quote 5.1) or social groups they especially care about (of the other three participants, one had no contacts at all, while two others had less than 10 contacts). Four of the participants used the customization feature for social filtering: two created custom contacts channels for close friend and family (Quote 5.2), and two created a channel to follow photos from a specific social group (e.g., their program at school). We hypothesize that the purpose of most custom *contacts* channel created by all Zurfer users was social filtering.

Customization based on Flickr groups or tags allowed users to more generally follow photos of various foci using Zurfer. To understand the activity around these custom channels, we examined an anonymized list of channels created by users and classified them according to emerging themes. We briefly report on the emerging high-level themes below, including personal interest, professional interest, photo/tech specific, and fun. Of course, some concepts were hard to classify, and there is an expected amount of overlap between the categories.

“Personal interest” channels are based on some well-specified concept like the tag “*Kraftwerk*”, “*UK Railway*” or the group “*Northern Westchester Pics*”. We have classified 74 out of the 210 tag/group custom channels as personal interest channel; 37 of these 74 channels reflected location-specific personal interest, following photos from a single location (e.g., following the tag “*Rochester*”).

Professional interest channels included well-specified work-related themes like “*infoviz*”. We identified 21 such channels. Tech/photo-related channels (32 total) are channels created around a specific technology (e.g., “*Nokia N95 User Group*”) or a specific photographic interest (“*Sigma 8mm*”). Fun channels (19 created) followed general concepts that may bring fun photos but do not represent a specific interest (e.g., “*beach*”).

In addition to these channels, and as expected [13], adult content played a role in Zurfer customization (30 channels). While Flickr’s default settings do not expose adult content in regular searches, such content can be found in (private) Flickr groups. Nine Zurfer users created 12 channels that were clearly meant to deliver adult content to their phone. In addition, 18 channels were created to deliver what might be classified as “fetish” photos, involving specifics of the human body and special clothing items.

The customization trends demonstrate the different use modes of Zurfer as a mobile application. Our classification of the custom channels suggests motivations for channel creation that span “task time” (e.g., show my favorite contacts quickly), “down time” (show me personal interest photos) and “killing time” (fun photos) activities.

To summarize, Figure 4 shows the distribution of photo views per channel category, amongst active Zurfer users. As expected, the social channels have the greatest number of photo views in both full-screen and thumbnail views (3267 full-screen views out of 7338 total photo views, 44%). Notice that compared to the other channels, a larger portion of photos in the custom channels is viewed in full-screen (1486 out of 2748, 54%). This fact could suggest more interest by the users in these channels that they created; only photo views that were results of search (right most column) had similar full-screen view ratio (56%). Also notice that users mostly view their own photos as thumbnails, a fact that could be due to users being able to easily recognize images that they have captured themselves,

and thus can easily browse through them to complete “personal” and co-present sharing tasks in thumbnail mode.

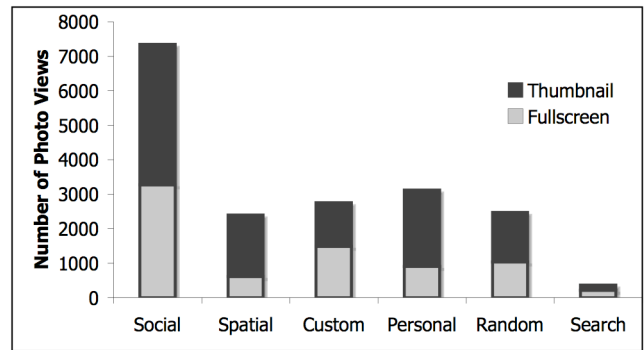


Figure 4. Photo views per channel category for active users.

Presentation and Interaction

The interviews surfaced a number of observations about themes of mobile and image-based applications. We discuss two of them here: first, simplicity and speed, and second, interacting with photographs.

Participants noted Zufer’s quickness and simplicity not only as good qualities of the application, but even, in “killing time” mode, as the sole reason to use it. Quote 2.4 perhaps demonstrates this trend best; other users also reported selecting to use Zufer over other mobile applications simply due to Zufer’s superior loading speed (P7 reported using Zufer on the train; to the question “why?” the answer was “quick app to use and easy to navigate”).

Of course, the speed, responsiveness and simple navigation were also appreciated in Task Time and Down Time modes, when participants had specific task in mind. On the other hand, at least one participant (using Zufer on a slightly older phone model) complained about speed and loading times, citing these as main reasons *not* to use the application regularly. To summarize, all participants felt strongly about quickness as a major determine for overall use, as well as individual application launches.

Another interview theme was the benefits and requirements from interaction with photos. First, participants noted the benefits of photo-based navigation as well as photographic content over text on the mobile device. Photos require less attention, are easy to recognize in a glance, and in short, are worth the hundred words (that can fit on a mobile screen). The findings of Oulasvirta et al. [21] emphasize the need for such attention-light interaction. Generally, most participants agree that the Zurfer thumbnail size (exact resolution varied based on screen resolution) was sufficient for navigation. However, participants unanimously proclaimed the Zurfer “full-screen” channel view (Figure 1) to be insufficient; as reported above, when possible, participants often opted to use the built-in Gallery application for a truly full-screen presentation of photos.

IMPLICATIONS

Our observations and analysis of Zurfer usage trends and patterns allow us to draw implications for the design of mobile applications including mobile entertainment, mobile social applications, and mobile photos.

If possible, create a mobile application that can support the three modes of use. If the users of your system have specific task-driven goals, make sure these can be accomplished in a short time. Even better, consider *creating* tasks that can be accomplished in a short time. However, think about an engaging experience that will help the user move from performing quick tasks to “downtime” use. Create or make sure there is access for a wide variety of options and content for “killing time”.

Help the user easily browse and discover content without requiring explicit or complicated input. Zurfer’s browsing only required the user to manipulate one 4-way key and get access to hundreds of pieces of content. The non-attention-grabbing information presentation allowed users to navigate, search for content and browse the application in both social and mobile contexts.

Speed, readiness and responsiveness may be the only criteria that users apply when making a decision to start your application. In mobile situations, users are looking for quick entertainment or to perform quick leisurely tasks. Use of slow-responsive applications may be hampered, despite any potentially compelling content.

Social content is one of the key drivers of mobile content and often prompts usage. However, mobile social applications need to design for social selectivity. While it’s easy to connect to dozens or hundreds of friends online, the mobile environment encourages (and even requires) users to perform “social selections”. Factors like limited time, attention, and interaction, as well as smaller screens and lower resolutions, contribute to the social filtering requirement. Make it easy for users to follow (or prioritize) their closest or favorite contacts.

Location based content can be engaging if it is targeted correctly. While nearby content is more interesting than random content, it is not sufficiently interesting to engage users in the down time or killing time use. In order to capture interest, the location-based content should either be of very high quality or it should take into account other drivers such as social connection (e.g., pictures from friends) or topical interest. Finally, the required accuracy of location varies per user: some users prefer very specific locations such as a city block while others are content with city level targeting.

More specifically than mobile applications, we suggest implications for photo application tasks: personal tasks, (including social, information, and entertainment), as well as shared photo tasks such as co-present sharing.

In personal tasks for mobile photos applications, Make social content available if possible as a main part of the

application; users do not consider looking at contacts’ photos as “wasting time” activity, a fact that makes “downtime” use more likely. While contacts photos are the main driver, other categories often sparked user interest. Ask people for their favorite locations and topics of professional or personal interest to serve relevant content. Even when serving otherwise “random” content, some attempt at social or topical relevance may improve engagement. A “random” set of photos can even be created from the user’s own past photos. As for “nearby photos”, accuracy of location is key; the users may be more engaged with socially-relevant nearby photos (e.g., from friends) or photos that convey information about the area.

For co-presented sharing tasks, we discovered four main implications. One, perhaps obvious, is using the mobile’s full screen resolution to enable “slideshows” of any photo content available through the application. Second, recency is a main driver for co-present sharing. Make access to recent photos or albums (regardless of the capture device) as easy as possible. Similarly, make it easy for users to assemble and access a “PhotoWallet” of their favorite photos, again, regardless of the capture device. Finally, use automatic metadata like date and location and simple organization structure (e.g., albums) to help users quickly find the right photos at the right time to show them off.

CONCLUSION

The mobile phones in everyone’s pocket are exceedingly capable of running media-rich, network-based and entertainment-driven applications, transcending the phones’ traditional use as communication and information hubs. As data plans for mobile Internet access become available, we expect to see a slew of mobile entertainment and mobile-social application and web pages.

We presented a study of mobile application use. Based on a significant deployment and an in-depth user study, we identify and discuss the use of the application in three modes, “task time”, “down time” and “killing time”. We discuss aspects that make an application compelling for use in the different modes.

Zurfer is a sample mobile application that is both a social application and a photo application. While the *physical* social aspect of co-present sharing is an important task for such applications, *virtual* social interaction drove most of Zurfer’s usage. However, many other types of photo and content have proved to be useful. Indeed, when killing time, sometimes even random content sufficed. Finally, the channel metaphor for content delivery was successful, and customization, while not discovered by all, played an important role.

ACKNOWLEDGMENTS

We’d like to thank Amy Hwang, Shane Ahern, Simon King, Jeannie Yang and Dean Eckles for their contribution to developing Zurfer.

REFERENCES

1. Flickr (Yahoo! Inc). <http://www.flickr.com>
2. Ahern, S., King, S., Qu, H., and Davis, M. 2005. PhotoRouter: destination-centric mobile media messaging. In *Proc., MULTIMEDIA 2005*. ACM Press (2005), 209-210.
3. Ames, M. and Naaman, M. Why we tag: motivations for annotation in mobile and online media. In *Proc., CHI 2007*. ACM Press (2007). 971-980.
4. Balabanović, M., Chu, L. L., and Wolff, G. J. Storytelling with digital photographs. In *Proc., CHI 2000*. ACM Press (2000), 564-571.
5. Bentley, F., Metcalf, C., and Harboe, G. 2006. Personal vs. commercial content: the similarities between consumer use of photos and music. In *Proc., CHI 2006*. ACM Press (2006), 667-676.
6. Church, K., Smyth, B., Cotter, P., and Bradley, K. Mobile information access: A study of emerging search behavior on the mobile Internet. *ACM Trans. Web* 1, 1 (May. 2007), 4.
7. Counts, S. and Fellheimer, E. Supporting social presence through lightweight photo sharing on and off the desktop. In *Proc., CHI 2004*. ACM Press (2004), 599-606.
8. Davis, M., Van House, N., Towle, J., King, S., Ahern, S., Burgener, C., Perkel, D., Finn, M., Viswanathan, V., and Rothenberg, M. MMM2: mobile media metadata for media sharing. In *Ext. Abstracts CHI 2005*. ACM Press (2005), 1335-1338.
9. Frohlich, D., Kuchinsky, A., Pering, C., Don, A., and Ariss, S. Requirements for photoware. In *Proc., CSCW 2002*. ACM Press (2002), 166-175.
10. Harada, S., Naaman, M., Song, Y. J., Wang, Q., and Paepcke, A. Lost in memories: interacting with photo collections on PDAs. In *Proc., JCDL 2004*. ACM Press (2004), 325-333.
11. Hwang, A., Ahern, S., King, S., Naaman, M., Nair, R., and Yang, J. Zurfer: Mobile Multimedia Access in Spatial, Social and Topical Context. In *Proc., MULTIMEDIA 2007*. ACM Press (2007), 557-560.
12. Jacucci, G., Oulasvirta, A., Salovaara, A., and Sarvas, R. 2005. Supporting the shared experience of spectators through mobile group media. In *Proc., GROUP 2005*. ACM Press (2005), 207-216.
13. Kamvar, M. and Baluja, S. A large scale study of wireless search behavior: Google mobile search. In *Proc., CHI 2006*, ACM Press (2006), 701-709.
14. Khella, A. and Bederson, B. B. 2004. Pocket PhotoMesa: a Zoomable image browser for PDAs. In *Proc., MUM 2004, vol. 83*. ACM Press (2004), 19-24.
15. Kindberg, T., Spasojevic, M., Fleck, R., and Sellen, A. I saw this and thought of you: some social uses of camera phones. In *Ext. Abstracts CHI 2005*, ACM (2005), 1545-1548.
16. Kirk, D., Sellen, A., Rother, C., and Wood, K. Understanding photowork. In *Proc., CHI 2006*. ACM Press (2006), 761-770.
17. Lerman, K., and Jones, L. Social Browsing on Flickr. In *Proc., ICWSM 2007*.
18. Liu, H., Xie, X., Ma, W., and Zhang, H. 2003. Automatic browsing of large pictures on mobile devices. In *Proc., MULTIMEDIA 2003*. ACM Press (2003), 148-155.
19. Naaman, M., Song, Y. J., Paepcke, A., and Garcia-Molina, H. Automatic organization for digital photographs with geographic coordinates. In *Proc., JCDL 2004*. ACM Press (2004), 53-62.
20. O'Hara, K., Mitchell, A. S., and Vorbau, A. 2007. Consuming video on mobile devices. In *Proc., CHI 2007*. ACM Press (2007), 857-866.
21. Oulasvirta, A., Tamminen, S., Roto, V., and Kuorelahti, J. (2005). Interaction in 4-second bursts: The fragmented nature of attentional resources in mobile HCI. In *Proc., CHI 2005*. ACM Press (2005), 919-928.
22. Pauty, J., Couderc, P., and Banâtre, M. Using context to navigate through a photo collection. In *Proc., MobileHCI 2005*, vol. 111. ACM Press (2005), 857-866.
23. Pigeau, A. and Gelgon, M. Building and tracking hierarchical geographical & temporal partitions for image collection management on mobile devices. In *Proc., MULTIMEDIA 2005*. ACM Press (2005), 141-150.
24. Sarvas, R., Oulasvirta, A., and Jacucci, G. 2005. Building social discourse around mobile photos: a systemic perspective. In *Proc., MobileHCI 2005*, vol. 111. ACM Press (2005), 31-38.
25. Setlur, V., Takagi, S., Raskar, R., Gleicher, M., and Gooch, B. Automatic image retargeting. In *Proc., MUM 2005*. ACM Press (2005), 59-68.
26. Toyama, K., Logan, R., and Roseway, A. Geographic location tags on digital images. In *Proc., MULTIMEDIA 2003*. ACM Press (2003), 156-166.
27. Van House, N. A. Flickr and public image-sharing: distant closeness and photo exhibition. In *Ext. Abstracts, CHI 2007*. ACM Press (2007), 2717-2722.
28. Van House, N. A. Interview viz: visualization-assisted photo elicitation. In *Ext. Abstracts, CHI 2006*. ACM Press (2006), 1463-1468.
29. Wang, M., Xie, X., Ma, W., and Zhang, H. 2003. MobiPicture: browsing pictures on mobile devices. In *Proc., MULTIMEDIA 2003*. ACM Press (2003), 106-107.