

How Do People Manage Their Digital Photographs?

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ABSTRACT

In this paper we present and discuss the findings of a study that investigated how people manage their collections of digital photographs. The six-month, 13-participant study included interviews, questionnaires, and analysis of usage statistics gathered from an instrumented digital photograph management tool called Shoebox. Alongside simple browsing features such as folders, thumbnails and timelines, Shoebox has some advanced multimedia features: content-based image retrieval and speech recognition applied to voice annotations. Our results suggest that participants found their digital photos much easier to manage than their non-digital ones, but that this advantage was almost entirely due to the simple browsing features. The advanced features were not used very often and their perceived utility was low. These results should help to inform the design of improved tools for managing personal digital photographs.

Categories and Subject Descriptors: H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems—*Evaluation/methodology*, H.3.3 [Information Storage and Retrieval]: Information Search and Retrieval, K.8.1 [Personal Computing]: Application Packages

General Terms: Human Factors, Experimentation, Design.

Keywords: Personal photography, digital photography, content-based image retrieval, image browsing, annotation.

INTRODUCTION

Digital cameras are now widely available and consumer surveys predict that their use will proliferate, resulting in large personal collections of digital photographs. Computer-based systems to store these collections, facilitating future browsing and retrieval, will therefore become increasingly important. Although others have studied personal photography from a sociological and anthropological point of view (such as Holland [5]), there has been very little research attention given to how people organise and browse their photo collections, whether digital or non-digital.

There have been some studies of general-purpose photograph

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libraries (such as [9]), but the users of such collections tend to be mostly unfamiliar with their contents. In contrast, the principal users of a personal photo collection are the photographer and his or her family, who are very familiar with its contents, especially because they relate to memories of life events. We therefore expect that the typical requirements and practices associated with a personal photo collection will be rather different to those already identified for unfamiliar, general-purpose collections.

This familiarity means that personal photos are part of the wider class of personal documents, and a number of previous studies have considered people's management of these. For example, Whittaker and Sidner [18] investigated workers' usage of electronic mail messages, and found that many of them had largely given up on filing their e-mail; the rough chronological ordering of the messages in the inbox was enough to find them again, if needed. Many of the findings from these studies are likely to be applicable to personal photos, but the latter tend to be used as part of leisure activities, not day-to-day work practices.

In this study, we were interested in finding out how people will organise and browse their digital photo collections, and how these practices will compare to those they use at present, for their non-digital collections. We also wanted to gauge the usefulness of different system features in this domain.

DIGITAL PHOTO MANAGEMENT SOFTWARE

There are many commercial standalone and web-based tools available for managing and viewing collections of digital images. For brevity, we will not discuss details of specific tools, but to a first approximation, all of them offer the same basic thumbnail-based features for organising, labelling, viewing, and editing digital images.

A number of researchers have developed prototype systems with innovative variations and extensions of these basic features. PhotoMesa [2] utilises novel layout mechanisms to make the best usage of screen space when displaying a photo collection, but relies on the user having already done some organisation of it. FotoFile [6] and PhotoFinder [17] both aim to provide improved support for creating annotations, which we discuss in more detail later in this paper.

PhotoTOC [13], and its predecessor, AutoAlbum [12], use clustering techniques to automatically partition a photo collection according to the image timestamps, assuming that

photos taken at about the same time are part of the same event. The browsers described by Graham and his colleagues [4] offer somewhat similar functionality but with a different user interface. Both groups of researchers evaluated their systems in small-scale experimental studies, by comparing them to a baseline (a simple chronologically ordered display of the full collection in thumbnail form). The studies had conflicting results, however, with regard to whether people could find photos more quickly in the new systems than in the baseline.

As far as we are aware, none of the commercial systems or research prototypes has been the subject of a published field study, and there has been no previous research into the issue of how people manage their collections of digital photographs. The Maypole study [8] concentrated on how people might communicate using digital images.

THE SHOEBOX SYSTEM

Shoebox [11] is an application for organising, annotating, indexing, searching, and browsing collections of digital images. It was developed at AT&T Laboratories Cambridge (the second author's affiliation at the time of the study) as part of a wide-ranging research effort in multimedia information retrieval [10] and is essentially a Windows graphical user interface on top of an object-oriented database designed specifically for multimedia indexing. In an initial study, described in an earlier paper [14], we asked a group of keen photographers about how they organised their existing collections of prints and slides, and the findings informed the design of Shoebox.

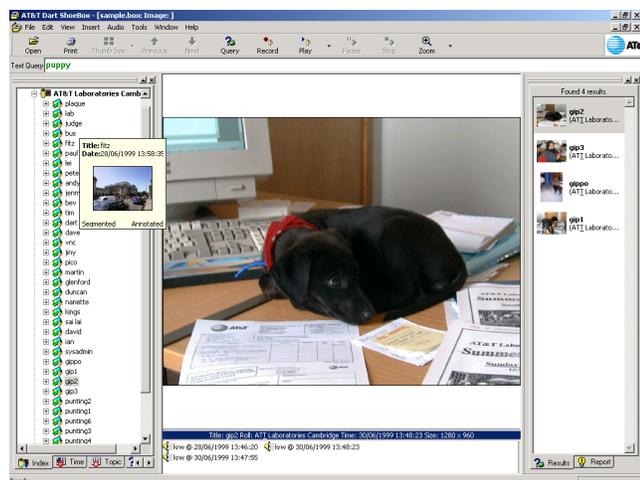


Figure 1: A Shoebox screenshot. The user has just entered the query “puppy”, and is looking at the results.

Like commercial systems, Shoebox provides a conventional thumbnail-based browsing tool for organising, labelling, and viewing photos. Thus, the observations and conclusions made in this paper with regard to the basic features of Shoebox should also apply to many other systems for management of personal digital photos. As a research prototype, it has some additional features distinguishing it from other systems:

- an audio annotation capability whereby users can speak about their photos, and attach these comments to individual images or groups of images. The annotations are stored for subsequent playback (e.g. during slide shows) and can be automatically transcribed, enabling subsequent text-based retrieval (as shown in Figure 1) where the user can search for photos based on what was said about them.
- image analysis and indexing tools which allow the user to search for photos based on their visual content. Shoebox has algorithms for segmenting images into regions based on colour and texture, and for indexing these regions. Users can then select a certain photo and search for other photos visually similar to it, or they can highlight one or more regions within a photo and search for other photos containing similar regions.

OUR STUDY

We had two major research questions:

- How do people organise and browse their collections of digital photos, and how do their practices compare to those used for their non-digital collections?
- Is advanced multimedia processing (speech recognition and content-based image retrieval) useful in the context of personal photo collections?

There were thirteen participants, eight male and five female, with an age range of 24–38. They were recruited from among the employees of AT&T Laboratories Cambridge, and volunteered to take part in the study. Eight were members of the research staff (all with first degrees, and most with PhDs, in computer science or engineering), two were support engineers, and three were administrative staff. Of course, this sample is highly unlikely to be representative of the population as a whole, but our goal (given the lack of existing research in this area) was to gain some initial insights into our research questions, not attempt to answer them definitively. The estimated size of the participants' existing (non-digital) collections ranged from 300 to 3000 pictures, with an average of about 1000.

The study was carried out over a six-month period in spring/summer 2000, when digital cameras were still relatively uncommon. The participants were therefore given digital cameras (to keep) and were asked to start taking photos with them. They received a version of Shoebox that was instrumented to record their actions in log files, which allowed us to measure how frequently different features were used. In addition, we interviewed them twice, at the beginning and end of the study.

The first interviews took place after about the first month of usage. Participants were asked about their existing non-digital collections, so that their organising and browsing practices could be compared with those subsequently adopted for their digital collections. They were also briefly asked for their first impressions of digital photography and Shoebox, and about

their fledgling digital photo collections. The set of questions was fixed, and answers were recorded in the form of notes. The participants also filled in two questionnaire sheets: one to indicate their level of agreement or disagreement with a series of statements about their non-digital photo collections, and another to indicate how useful they found each of a given set of Shoebox’s features. All questionnaire items used a seven-point scale.

In the second interviews, at the end of the study, participants were asked in more detail about their digital collections. The questions were based on the digital photography questions from the first interview, but were refined and expanded, based on the answers received then. Participants were also asked for their final verdict on Shoebox. These interviews were recorded on tape and subsequently transcribed. Again, participants were asked to fill in two questionnaire sheets. This time, the first questionnaire asked them to indicate their level of agreement or disagreement with a series of statements about their *digital* photo collections. Most of the statements were the same as those in the non-digital questionnaire, with a few digital-specific items added. The aim was to compare the participants’ opinions about their non-digital and digital collections. Then, participants filled in the same Shoebox questionnaire used in the first interview, to establish whether their opinions about its features had changed in the course of the study.

RESULTS AND DISCUSSION

Because of space constraints, in this paper we have chosen to concentrate on discussing our findings qualitatively, and offer only selected quantitative results; much more detail is available in the first author’s PhD dissertation [15]. Tables 1 and 2 summarise selected questionnaire responses, giving the mean and median rating (on a scale of 0 to 6) for each item. We used Wilcoxon signed-rank tests to compare the ratings between interviews; the tables include only the items where there was a significant difference between the first and second interview ($p < 0.05$), without Bonferroni correction. The quotes in this section are all drawn from transcriptions of the second interviews, and were chosen to be representative of participants’ opinions. The identifier next to a quote indicates whether the participant’s job is in **R**esearch, **S**upport, or **A**dministration.

Organising photographs

Almost all of our participants had attempted to organise their prints by putting them into albums, but often this is a low priority task, and the prints may be kept for a long time in their original packets. Usually only the “good” photos are placed into albums, separating them from the “bad” ones, which may be technically poor, or just boring. Some participants throw the bad prints away, but others keep them in the original packets. Prints in albums are looked at more often than those left in the packets. Albums are mostly classified by specific events, such as holidays, often with one album per event. Within an album, the photos are usually kept in chronological order, with perhaps some small adjustments

to make the layout more meaningful or aesthetic. Similarly, when left in their packets, prints are usually kept in the original chronological order, although this is often lost when the photos are browsed.

With digital photos, some participants separated them into folders (known as **rolls** in Shoebox) according to event, while others simply imported the entire contents of the camera’s flash memory into a single roll, meaning that the roll may contain photos of a number of different events, as is often the case with conventional film. By default, the photos within a roll appear in chronological order, using the time stamps on the files.

R2 I take a load of photos, and then I download them and I put them in a folder, and I label that with the date that I download it on, and that gives me as much organisation as I want, really.

Table 1 shows that participants said they were significantly more content with the organisation of their digital collections than their non-digital ones. From the interviews and log files, however, it did not appear that the participants had actually put any more effort into organisation. They simply feel more organised, because all of their digital photos are in one place, in folders that correspond roughly to events, in chronological order.

Statement		Mean	Med
“I am content with the way my photo collection is organised”	N	2.2	2
	D	4.5	5
“I browse my photo collection often”	N	1.8	2
	D	2.9	3
“When I am looking for something in particular, it is easy for me to find it”	N	1.9	2
	D	4.6	5

Table 1: Comparing participants’ opinions about their non-digital (N, from the first interview) and digital (D, from the second interview) collections.

With regard to annotation, some of the participants said that they occasionally write notes (such as names, places, or dates) on the back of prints, as a reminder, and for the benefit of other people who might inherit the pictures. Others will only write a broad title on the album or packet, to remind themselves of the whole group of pictures it contains. We were especially interested in finding out whether participants would be more likely to annotate their digital photos, given Shoebox’s ability to index their notes, enabling text queries. At the beginning of the study, many of the participants believed that this would be the case, and that they would create detailed annotations.

Within Shoebox, rolls and photos all have titles; by default these are the names of the directories or files from which they were originally imported, but can be edited. Almost all of the participants had changed the name of a roll, to help them identify the set of photos it contains. Only three had changed the name of a single photo, and in general this was considered

far less important than changing the name of a roll. Longer descriptions can be entered as text annotations, which only two participants had done, or recorded as spoken annotations, which eight had done.

As with prints, the participants said they used their annotations to record the names of people and places; they did not need to record dates, as digital photos are automatically timestamped by the camera. When the photos are recent, these details are still fresh in the photographer’s mind, and therefore recording them may not seem worth the effort, because the photos are self-explanatory, especially when seen in context.

R3 That’s [my wife] and [son] with some foliage behind them, and if I just saw that on its own, I wouldn’t have a clue where it was, it would need to be annotated, but because it’s after a picture of the two French friends, and before the picture of [my son] on the Normandy beach, then I know that this is the botanic gardens in Cherbourg.

This may help to explain why so few of the participants have annotated their photos in Shoebox: they are still too recent. Annotation may not begin to seem important until some time after the photos have been taken, when many of the details have already been forgotten (such as names of unfamiliar places). The bigger a collection gets, of course, the longer it will take to annotate all of the photos. In any case, most of the participants said that they would only ever want to annotate some of their photos, and that doing it for the whole collection would not be worth the effort.

Feature		Mean	Med
Speaking annotations to associate with a photo or group of photos	1	4.9	5
	2	3.2	3
Listening to spoken annotations	1	4.9	5
	2	2.7	3
Using a query to search for photos based on the text of your annotations	1	4.8	5
	2	3.0	3
Searching for other photos visually ‘similar’ to a given one of your photos	1	4.0	5
	2	1.6	1
Choosing a region or regions of a photo and retrieving photos with similar regions	1	3.8	3
	2	1.2	1

Table 2: Comparing participants’ ratings (in interviews 1 and 2) of the usefulness of selected Shoebox features.

Participants’ ratings of Shoebox’s features for recording and listening to spoken annotations fell significantly over the course of the study (Table 2). Opinion was divided on the usefulness of spoken annotations in principle: some participants definitely disliked the idea, saying that they would feel self-conscious about speaking to a computer, do not enjoy listening to their own speech, and would first have to plan what to say. Others expressed enthusiasm for the facility, saying that it was easier to speak annotations than type them.

It may be frustrating, however, if the speech recognition does not work as well as expected. Previous research has shown that text-based queries can still be reasonably effective even if spoken material is inaccurately transcribed [3], but all of the participants who tried Shoebox’s speech recognition facility felt that the level of inaccuracy was unacceptably high. This probably discouraged them from putting further effort into recording spoken annotations. Its rating did not fall significantly during the study, but this is perhaps because some participants still felt that the feature was useful in principle.

In particular, names of people and places are often wrongly transcribed, and may not even be in the vocabulary, but are usually the most important elements of the annotations.

A1 It gets the gist of most of it, apart from, the trouble is that you want it to recognise things like people’s names, and place names, because that’s normally the core of it.

Most participants considered it pointless to make spoken annotations without accurate speech recognition, but in a few cases participants felt they could be useful in their own right, especially for telling a story. Two participants mentioned that although they might not want to record spoken annotations for themselves, they could later be very special to children or grandchildren. Other researchers have identified the importance of story telling, with one group producing a handheld device specifically for recording stories using personal photos [1].

Browsing and querying photographs

The participants said that the frequency with which they look at their photos tends to decrease over time. Recently taken prints are kept handy for a short period before being put away with the rest of the collection. The same is true for digital photos; recent pictures are kept in the camera’s flash memory and shown to people using the LCD screen or a nearby television set. As with Polaroid cameras, the people who are present when a photo is taken can be shown it immediately. Table 1 shows that the participants felt that they browsed their digital photos more often than their non-digital photos; this is probably due in part to their recency.

Within Shoebox, the user can browse through photos in thumbnail form, selecting individual ones to be displayed at full size. She can also set up a slide show to display a series of photos one after the other. The slide show facility was used at least once by all but two of the participants.

When people want to search for older photos from a collection, there seem to be three basic types of requirement, given here in decreasing order of frequency:

- the set of photos from a particular event, e.g. a holiday
- an individual remembered photo
- a set of photos taken at different events, but all sharing a property, such as containing a certain person

With prints, finding the photos of a particular event, the most common requirement, is relatively easy whether or not the

collection has been intentionally organised, as long as they have at least been kept together. Participants said that they might remember the physical appearance of the right album or packet, and use this as a search cue. Occasionally, they want to search for a particular photo, and in this case they will first attempt to remember the event it was taken at. They might remember the rough date it was taken, and use that as a guideline to dip into the collection and then move backwards or forwards. Searching is made more difficult if the albums, packets, or photos are out of chronological order, or if photos have been given to other people, or filed away elsewhere. There may also be problems if a photo could be in a number of different albums or packets, for example if more than one visit has been made to the same holiday destination. Organisation involves effort, and the main motivation for doing it is not that it facilitates searching, but that it results in an attractive presentation of the best photos, for showing to other people, and then keeping as part of a family archive.

Digital photos do not usually have any of these problems, as they can automatically be sorted in chronological order, using their timestamps, and can be copied very easily. They are easy to divide into named folders, such as Shoebox's rolls, so that finding photos taken at a particular event is then simply a case of remembering which folder they are in, and clicking on it. They have the added advantage that systems like Shoebox can reduce the photos in a folder to thumbnail size, allowing a large number of them to be viewed at the same time, so that the user can scan them very quickly. Of course, our participants had a good memory of their digital photos and the way in which they were organised, because of their recency. Table 1 shows that the participants thought it was significantly easier to find what they were looking for in their digital collections than in their non-digital ones. This ease of browsing is another reason why participants felt that their digital collections were more organised than their non-digital collections.

A2 I wasn't organised at all before, and if I did have any photos in any kind of album [...] you'd have to remember maybe a particular colour: "oh yes, those photos, they were in that red album", or something like that. But here, obviously there's a little title to every roll: "Holiday in Italy", so you know. And then also when you click on it and then you see all the little thumbnails, just scroll down and you can pick out the photo straight away, so that's really easy. [...] I feel super-organised; I know exactly where a photograph is, and I can find it straight away, it's really good.

Having the collection in chronological order is helpful for locating particular photos or events, because it is usually easier to remember when an event occurred relative to other events, than to remember its absolute date and time [7].

R3 I'm browsing for an event, that I roughly know when it is, even if I just know relatively when it was compared with other events, I might not know the date, but I can quickly zoom through and find them.

The participants rarely wanted to find photos matching a more general requirement. Such requirements may be related to the presence of a particular person in the picture, and/or its perceived quality (e.g. to find a good photo of your mother). Satisfying this type of requirement is a tedious task in both non-digital and digital collections; chronological ordering or classification by event does not help much. The process usually involves repeatedly trying to think of a matching picture, and then looking for it. Again, this task is probably easier with digital photos, since a large number of thumbnails can be assessed at once. An exhaustive search (looking through the whole collection for *all* of the photos matching a requirement) would normally only be carried out in exceptional circumstances, such as following a death in the family.

A system for managing personal digital photos should, in theory, enable users to specify search criteria in a query, compare it to all of the items in the collection, and retrieve those that match. Annotations assigned to digital photos can be indexed, allowing the user to construct queries using words from the annotations, something which cannot be done with handwritten notes on the back of prints.

At the beginning of the study, we (and the participants themselves) expected that having text queries available would make the participants more likely to create annotations. However, as we have already noted, they made very few annotations (either typed or spoken), and without these, text-based queries were impossible. Participants' ratings of all of Shoebox's query facilities (text-based query, visual query-by-example, and visual region query) dropped significantly over the course of the study (Table 2), and its browsing facilities were used far more frequently. The six participants who had used queries all said that they had done so just to play with them. We believe that text-based indexing did not provide sufficient motivation to make the participants more likely to annotate their photos, because the type of requirement that can only be satisfied with a query is relatively rare; the most common requirements can easily be satisfied by browsing.

R5 I haven't queried them, because probably I don't have too many pictures, and they're in, to me, a logical-looking order. Getting back to them is quite easy.

R8 I don't know, even if I could say "find all the photos of [my husband]", which I probably can't, I wonder if I'd ever use that. I don't know, I've never thought, "oh, I wish I had that".

Like annotations, queries might start to seem more important as a collection grows, and the photos get older and less familiar. Also, because this type of requirement only occurs occasionally, the period of the study was probably not long enough for many of them to arise.

A3 They tend to be grouped in events, and we tend to show the photographs of the events, so we don't tend to search for, say, "show me everything with [my son]", it tends to be "this was this event, and these were the

photographs that we took". But I suppose that's because they're fairly recent events, and if it was further down the line, and we wanted to, say, look at all of the pictures of [my son] when he was a baby, then yes, you'd want to search for "[my son] as a baby", and they could span several events.

If only part of the collection has been annotated, queries will only return results from that part, giving a disappointingly low level of recall.

A2 I know that if I put some annotations in and then I call them up [with a query], I won't be calling them all up because I haven't annotated all of them. So then it annoys me.

Furthermore, as noted earlier, names in spoken annotations were often transcribed incorrectly, so unless the participants were willing to keep correcting the transcriptions, they had to get used to whichever names the system had chosen; for example, one participant noted that to find pictures of his friend Debbie, he had to type "deadbeat" as a query term!

Even if all of the photos in a collection have been annotated (and transcribed with high accuracy, in the case of spoken annotations), it is difficult for people to be comprehensive, and so it is unlikely that all of the photos that are relevant to a query will actually be retrieved. Names of people are likely to be common query terms, in order to retrieve all of the photos depicting them. But the annotator might neglect to mention names that are obvious to her and any family and friends (e.g. "this is us at our hotel in Venice"), or may use names inconsistently (David Smith might be referred to as "Dave", "David", "Dave S", etc). Like most information retrieval systems, Shoebox only indexes words, not entities, so a subsequent query for "David Smith" will not return any of the photos where he is named as "Dave".

The FotoFile [6] and PhotoFinder [17] research prototypes allow the user to explicitly define her own set of keywords, such as names of people or places, and then assign them to the photos to which they apply. The keywords then become virtual categories, so that when the user selects one, the photos that have been assigned that keyword are displayed. Retrieving all of the photos containing a particular person, then, is simply a case of selecting his or her name from the list. With such a scheme in place, free text annotations could then be used primarily for telling stories, rather than faithfully recording who and what is present in each photo. This approach has not yet been subjected to evaluation, however, so it is difficult to judge how successful it may be in encouraging users to create annotations.

Visual queries can be used to specify general requirements involving visual properties of photos, but the participants expressed little interest in this. At the first interview, many of the participants had still to try visual queries, and had unrealistically high expectations of them (for example, finding all photos of a particular person); Shoebox understandably did not live up to these, explaining some of

the drop in ratings for this feature. However, even participants who tried visual queries with more realistic expectations (based primarily on colour) found that the results were disappointing.

R6 What it considered to be similar was rarely what I considered to be similar. I deliberately, when I got my new car, I took a lot of photos of that, and I thought, right, it's blue, it's big, it's very obvious... and it missed loads of them, it only pulled up a very small handful of the car, which, I don't know anything about the subject, but it looked like quite an easy job to me. [...] I just found it to be pretty much useless, I'm afraid. But also, partly, I just didn't really know what was going on, and how I could improve on what I was getting.

Many of the participants simply realised that they had never wanted to use visual queries during the study (only five had tried using them), and lowered their ratings for this reason. When prompted, they could not think of occasions when visual queries might be useful to them, and so even if Shoebox's visual query tools had performed well for realistic requirements, they would probably not have been used much more often.

R2 I didn't think it would come up with matches that I would actually be interested in. There just seemed to be more obvious ways of finding photos.

Current image processing techniques cannot consistently extract enough semantics to be useful. Further advances in image understanding may allow photos to be automatically tagged with keywords indicating the presence of recognised objects, and if this could be done reliably, it would take some of the effort out of annotation. In particular, as mentioned by Kuchinsky et al [6], if the user could select a person's face, provide a name for them, and then have the system recognise and tag other photos in which that person appears, this could potentially be a very useful feature, integrating automation with the user's own annotations.

It is likely to be easier to use a browsing strategy to recognise a familiar photograph, than attempt to construct a visual query from memory. Techniques developed for content-based image retrieval could instead be used to support browsing, automatically organising thumbnails according to their visual similarity, using clustering or visualisation algorithms. In our previous work [15,16] we found that such layouts are a promising alternative to queries as a way of searching a general-purpose photo collection, but the participants in the Shoebox study found it difficult to imagine situations when they would want to look for personal photos in this way.

Taking and using photographs

We were also interested in seeing how participants' photo taking practices would be affected by switching to a digital camera, and whether they would use their photos differently.

The participants were much more prolific in taking photos after starting to use a digital camera. By the end of the study, the approximate size of participants' digital photo collections

ranged from 200 to 1000, with an average of about 500, already half the average size of their existing non-digital collections. Per participant, the proportion ranged from 20% to 200%. It costs nothing to take a digital photo, and typically many more images can be put into flash memory than on a film, so the participants often took several digital photos where they would only have taken one with a conventional camera. This perhaps made it more likely that they would obtain a good photo, but also tended to mean that they had a larger number of bad photos. Systems that can automatically group together multiple shots of the same scene may assist the user in selecting the best ones.

It is likely that with digital cameras, people are more willing to take “risky” photos (because if the picture does not turn out as intended, they have lost nothing) and “everyday” photos (because they do not have to save the film for a special occasion). Photos can be examined immediately on the camera’s LCD screen, and any which turn out badly can simply be deleted or re-taken.

A3 My daughter’s now got to the point where, if someone gets a camera out, [she says] “can I see the picture?” She hasn’t figured out that not all cameras can show you the picture now.

Many participants had taken only digital photos during the study, as they found them to be a perfectly adequate replacement for the snapshot-style photos they would normally take, and were happy to view them on a television or computer screen. Those participants who were used to an SLR camera, however, still preferred to use it when photos of higher quality than snapshots were required.

Personal photos tend to be of special events such as holidays or weddings, and are taken to help remember the events or people involved, and record them for posterity. The most important use for personal photos is the same whether they are digital or non-digital: looking at the most recent ones and showing them to friends and family, usually while describing what is depicted. Some of the participants also take photos as part of their work or hobby (for example, pictures of computer hardware, or motorcycles) and these are often kept with the rest of the collection, although their uses are different.

Copying a digital photo is trivial compared to copying a print, and this may make people more likely to share their pictures, especially as more of them gain access to the Internet, making physical distance irrelevant. Almost all of the participants had sent small numbers of photos via e-mail, and some had created special web pages to make larger sets available. (Three participants used Shoebox’s facility to publish a set of photos as HTML.)

All of the participants still wanted to have prints of their photos for certain purposes, for example to look at without having to switch on a computer or television, or to send to someone who does not own a computer. Four participants printed photos from within Shoebox, and others simply

printed the image files directly. Usually, they only wanted to have selected photos printed out, at the highest possible quality, to be added to their existing permanent collection of special photos. Several participants felt that not being forced to have a print of every photo was a definite advantage of digital photography.

Because they do not cost anything and can be seen immediately, digital photos may be used for short-term purposes, perhaps then being deleted rather than kept with the rest of the collection. For example, one participant had taken photos while shopping for new furniture, and then used the images to compare options later that day.

Digital editing was relatively uncommon; those participants who did want to edit their photos tended to use more specialised applications (such as Photoshop) instead of Shoebox’s basic facilities.

Shoebox

Being prototype software, Shoebox did crash occasionally, and this inevitably had some effect on participants’ opinions and usage of it. We feel that even if it had been completely reliable, however, they would not have invested much more time and effort in organising their collections. A number of participants said they were impressed by Shoebox’s speed and power, especially for fundamental functions like displaying thumbnails, and some said that they would continue using it for these reasons.

When asked if there were any extra features that they would like Shoebox to have, three participants said that it already had too many, suggesting that they would have preferred stability to be more of a priority than range of features.

CONCLUSIONS

The results of this study emphasise the importance of ensuring that the basic features of a system for managing personal photos are efficient, reliable, and well-designed. Two of the most important features can be provided very easily: automatically sorting photos in chronological order, and displaying a large number of thumbnails at once. Because people are familiar with their own photos, these facilities are usually enough to allow them to find what they are looking for simply by browsing. As a result, the availability of text-based indexing and retrieval did not provide our participants with enough extra motivation to invest the effort in annotating their photographs.

Shoebox’s more advanced multimedia features were not used very often, even though this group of participants were probably more confident about trying them than the general population would be. This may be due in part to the specific implementation of them in Shoebox, and/or the immaturity of the technology. To be more useful in this domain, speech recognition would need to be far more reliable (especially for names of people and places), and content-based image retrieval would need to give more meaningful results, for example by providing face recognition. In any case, our participants most commonly wanted to browse their personal

photos by event, rather than querying them based on more specific properties. We therefore feel that even with greatly improved performance, the advanced multimedia features would not be used much more often. Further studies (with different groups of users and different implementations of the features) would help to confirm this.

FURTHER WORK

Six months is a relatively short time in this domain, and future studies would ideally follow their participants over a longer period. An ethnographic study of how people use their photographs in the course of everyday life would yield very useful qualitative results, and more quantitative studies, with larger, more representative samples, would provide a rigorous test of the findings reported here.

This study concentrated only on the needs of individuals, although it did include members of the same household among its participants. It would be interesting to carry out a further study to focus specifically on the collections and requirements of couples and families, as in many cases a photo collection belongs to a household, not an individual. For example, different members of the family may take photos at the same event, and then want to contribute annotations about each other's pictures, but still keep track of who took which photo. Shoebox does not explicitly take account of multiple users.

Long-term storage of digital photos is a concern, and should be investigated further. Some participants felt that not having photos in physical form made them seem less tangible and easier to lose, but others noted that digital photos can be backed up, unlike prints and negatives.

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REFERENCES

1. Balabanovic, M., Chu, L.L., and Wolff, G.J. Storytelling with digital photographs. In *Proceedings of CHI 2000*, 564–571. ACM, 2000.
2. Bederson, B.B. PhotoMesa: A zoomable image browser using quantum treemaps and bubblemaps. In *Proceedings of UIST 2001*, 71–80. ACM, 2001.
3. Brown, M.G., Foote, J.T., Jones, G.J.F., Spärck Jones, K., and Young, S.J. Open-vocabulary speech indexing for voice and video mail retrieval. In *Proceedings of ACM Multimedia '96*, 307–316. ACM, 1996.
4. Graham, A., Garcia-Molina, H., Paepcke, A., and Winograd, T. Time as essence for photo browsing through personal digital libraries. In *Proceedings of JCDL 2002*, 326–335. ACM, 2002.
5. Holland, P. 'Sweet it is to scan...': Personal photographs and popular photography. In L. Wells, editor, *Photography: A Critical Introduction*, chapter 3, 103–150. Routledge, London, 1997.
6. Kuchinsky, A., Pering, C., Creech, M.L., Freeze, D., Serra, B., and Gwizdka, J. FotoFile: A consumer multimedia organization and retrieval system. In *Proceedings of CHI '99*, 496–503. ACM, 1999.
7. Lansdale, M., and Edmonds, E. Using memory for events in the design of personal filing systems. *International Journal of Man-Machine Studies*, 36(1):97–126, 1992.
8. Mäkelä, A., Giller, V., Tscheligi, M., and Sefelin, R. Joking, storytelling, artsharing, expressing affection: A field trial of how children and their social network communicate with digital images in leisure time. In *Proceedings of CHI 2000*, 548–555. ACM, 2000.
9. Markkula, M., and Sormunen, E. End-user searching challenges indexing practices in the digital newspaper photo archive. *Information Retrieval*, 1(4):259–285, 2000.
10. Mills, T.J., Pye, D., Hollinghurst, N.J., and Wood, K.R. AT&TV: broadcast television and radio retrieval. In *Proceedings of RIAO 2000*, 2000.
11. Mills, T.J., Pye, D., Sinclair, D., and Wood, K.R. Shoebox: A digital photo management system. Technical Report 2000.10, AT&T Laboratories Cambridge, 2000.
12. Platt, J.C. AutoAlbum: Clustering digital photographs using probabilistic model merging. In *Proceedings of the IEEE Workshop on Content-Based Access of Image and Video Libraries*, 96–100. IEEE, 2000.
13. Platt, J.C., Czerwinski, M., and Field, B.A. PhotoTOC: Automatic clustering for browsing personal photographs. Technical Report MSR-TR-2002-17, Microsoft Research, 2002.
14. Rodden, K. How do people organise their photographs? In *Proceedings of the BCS IRSG Colloquium*, Electronic Workshops in Computing, <http://www.ewic.org.uk>, 1999.
15. Rodden, K. *Evaluating Similarity-Based Visualisations as Interfaces for Image Browsing*. PhD thesis, Technical Report 543, University of Cambridge Computer Laboratory, 2001.
16. Rodden, K., Basalaj, W., Sinclair, D., and Wood, K. Does organisation by similarity assist image browsing? In *Proceedings of CHI 2001*, 190–197. ACM, 2001.
17. Shneiderman, B., and Kang, H. Direct annotation: A drag-and-drop strategy for labeling photos. In *Proceedings of the International Conference on Information Visualisation*, 88–95. IEEE, 2000.
18. Whittaker, S., and Sidner, C. Email overload: exploring personal information management of email. In *Proceedings of CHI '96*, 276–283. ACM, 1996.