Paper:

PHOTMOSPHERE: A System for Amplifying Connection Between Memory and Record

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Photographs capture information on situations or circumstances that give some clue about users' access to past activities. The photographs remind them of their personal experiences and of social events that took place at a certain time. Our research intends to use such information to help them recollect events and to acquire novel information by connecting memory and social records, for example, news reports. Toward this end, we propose a system called PHOTMOSPHERE that helps users recollect past events by connecting memory (photographs) and records (news). We conducted an experiment to observe the effect of showing news with photographs. Participants were shown either photographs alone that they had taken or both news reports and photographs they had taken. They were then asked to describe their recollections under both conditions. We found that, in many cases, news reports helped participants remember events, but not in some cases, for instance, when the subject of the photograph was a person or an object. On the basis of this result, we reformulate PHOTMOSPHERE design criteria.

Keywords: digital photograph, remembrance, recollection support system, interaction design

1. Introduction

People store information about events, experiences, and activities in a form of memory called episodic memory [1]. It is believed that memories from their own experiences and activities include feelings as well as temporal and spatial information. Digital tools are now widely used to support the capture and storing of such information. Advances such as the digital camera has made it easier to take photographs and save such memories. Since photographs capture information about situations and circumstances, they provide clues regarding past activities. Such the photographs remind them not only of their personal experiences and activities but also of social events,

e.g., news or fashion, and place, e.g., local festivals or sightseeings, that took place at a certain time. We hope to use such information to expand their memory, for instance, to help them recollect events and to acquire novel information.

As mentioned above, a photograph can be treated as a clue for remembrance. It sometimes fails, however, to remind people of events surrounding them. One of the causes is that the impact of the photograph and their feelings and thoughts about them fade over time. To solve this problem, we utilize other clues that remind them of events, activities, and experiences. These include life logs such as diaries, weblogs, webmail, and social networking services such as Twitter. Popular music from a period and news reported at that time are also sources of such information. You may, for instance, remember episodes or experiences on your travel with friends when rereading your diary or remember scenes from your graduation when listening to your favorite music. By focusing on such coincidential phenomena, we have developed a system called PHOTMOSPHERE that helps users recollect events and occurrences. To achieve this purpose, it couples "memory" of the user's experiences and activities and "records" of such information.

This paper is organized as follows: in Section 2, we conducted a user study as the basis of system design to observe how people recollect events and news. Section 3 describes a prototype version of PHOTMOSPHERE. In Section 4, we conduct a user study to observe the effect of simultaneously showing news with photographs. Through these results, in Section 5, we reformulate PHOTMOSPHERE design criteria.

2. Preliminary Study: How Do People Recollect News?

Prior to designing the system, to clarify characteristics of human memory, we observed how accurately participants remember when news happened. Our hypothesis was that they identified dates of news by correlating news with memories of personal events. To confirm this, we

Table 1. News events.

Question	What	When
1	Bovine Spongiform Encephalopathy (BSE)	Dec. 23, 2003 – Jul. 2004
2	*Socrates in Love*, Japanese novel and movie	Apr. (novel) & May (movie) 2004
3	Aichi World Exposition, Japan	Mar. 25 – Sep. 25, 2005
4	"Cardboard" meat buns	Jul. 8, 2007
5	"I'm different from you," Japanese Prime Minister's statement	Sep. 1, 2008
6	Lehman Brothers Holdings bankruptcy filing ("Lehman Shock")	Sep. 15, 2008

asked participants whether they knew of particular news events, when they believed they had happened, and why they thought so.

2.1. Procedure

In experiments, 41 participants (17 men and 24 women) between the ages of 16 and 58 were given a questionnaire that consists of 6 sheets. Each sheet contains a topic, e.g., BSE, from news events and a 100-word Japanese abstract about it. Participants were then requested to answer 6 questions about different topics sheet by sheet. **Table 1** lists the articles used.

The study procedure is detailed below.

First, we asked them whether they knew of a particular event. Second, we asked them when the event happened. Participants were requested to answer the date, even in cases where they only vaguely remembered the date. Along with this question, we also asked them to rate their confidence in recollection on a scale of 1 to 5, from 1, "I don't remember at all" to 5, "I remember exactly." Finally, in order to investigate why they chose a particular date, we interviewed them about reasons for their conjecture. We allowed them to describe not only the reason but also their thought processes while trying to remember the date.

Prior to experiments, participants were requested to choose the frequency with which they watched news in each medium, such as TV, radio, the Internet, and newspaper, on a scale of 1 to 5. This question was intended to determine the relationship between the accuracy of the date chosen and the frequency of watching news.

2.2. Results

Figure 1 shows the ratio of participants who (1) knew of a news event, (2) identified the year correctly within a year before or after the events, i.e., within three years, and (3) identified the year correctly, i.e., within one year.

Striped bars in **Fig. 1** show the ratio of participants who gave a particular answer to each question regarding each news event. "BSE" news (Q1) had the highest ratio, i.e., was the most widely known, among participants at 92.7%, and "I'm different from you" (Q5) was the least widely known at 46.3%.

Gray bars in **Fig. 1** show the ratio of participants who estimated a year within a year before or after the actual year. For instance, the year of Aichi World Exposition
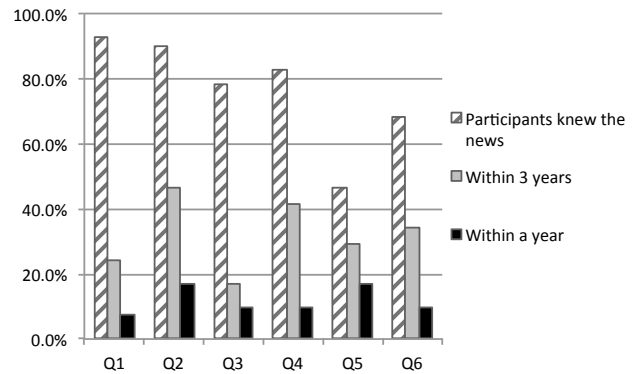

Fig. 1. Results for whether participants determined news time correctly.

(Q3) was identified by about 17.1% (the least known) and *Socrates in love* (Q2) by 46.3% (the most widely known).

Black bars in **Fig. 1** show the ratio of participants who identified the actual year. Results showed that the year of BSE occurrence (Q1) was recollected by 7.3% (the lowest) while 17.1% (the highest) was for when both "I'm different from you" (Q5) and *Socrates in Love* (Q2) occurred.

The percentage of participants who identified the year for "I'm different from you" (Q5) correctly was so high because this occurrence is associated with the time that the Prime Minister Yasuo Fukuda came into power, rather than with their own experiences. With regard to the Aichi World Exposition (Q3), those who attended the event identified the year correctly, but those who did not were unable to identify it. BSE (Q1) was the oldest of all news items, so, participants' memories of it were unclear. This implies that identifying the year for BSE (Q1) was rather more difficult than for other news. In instances where participants identified the year correctly, however, association was most likely made with their age.

From a holistic point of view, the average ratio of participants who knew of the event was 76.4%. Among them, 16.1% on average identified the year that the event happened correctly, judging from the black bars in **Fig. 1**, and 44.5% almost identified, i.e., less than plus or minus one year apart, the year on average correctly, judging from gray bars in **Fig. 1**. This result suggests that many participants could hardly identify the month and day, and even

though they were aware of the event, they often failed to remember the exact year when it happened.

According to responses to the question on why participants thought the year to be what they had guessed, those who failed to identify the event date correctly tended to respond with the date for no substantial reason, e.g., *"I just guessed"* or *"Somehow I just thought so."*

In the case of news whose date they identified correctly, many provided answers that pointed to experience, activities, or age, for example, *"I believe the news happened when I was a junior high school student"* or *"Maybe it happened when I was working at my previous workplace."* That is, participants try to remember the exact year that the news event occurred by connecting it with their experiences or age.

We observed some instances, however, when participants did not answer correctly, although they made the connection with experience. One reason is that the time that they recollected was different from the actual time of event occurrence, e.g., a participant who manages a hair salon assumed that the year of the opening of her salon was 2006, but the actual year was 2004, or the content of the news was only connected to their experience or activity, so the year did not form a connection with the time of their experience or activity.

We classified obtained results into two categories based on the contents of the interview: (a) the time an event was identified by referencing the participant's and family's or friend's personal experience or age, and (b) the others.[1] In short, 45 answers in total were clasified as (a) and 141 were classified as (b). The average confidence of (a) was 2.3 and that of (b) was 1.9. From a qualitative point of view, interviews in (a) contain much more varied content that relates to personal events, e.g., graduation, previous work, school days, than that in (b). We confirmed that the difference between them was significant in Welch's t-test ($t(85.2) = 3.3$, $p < .01$). This implies that connecting news or an event with one's own memory had a positive effect the confidence factor in recollection.

After experiments finished, we asked participants what they thought about the experiment. Many participants felt difficulty in remembering the exact time an event occurred.

"Because my days have been the same for the past several years, I did not pay attention to the year," one participant said, *"I am familiar with the news itself though."* Based on this opinion, we observed that a significant occurrence or a clear memory of the environment and the conditions surrounding an event are necessary to remember the precise time.

"I remember the person and the place that was mentioned in the news," another participant said, *"but I don't remember when the event took place."* Hence, it is necessary to connect news events to experience and conditions in order to help users remember correctly the time when the news happened.

Based on the above results, we found that those who

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1. Note that answers from participants who did not know the event had occurred were excluded.

Fig. 2. PHOTMOSPHERE.

succeeded in determining when an event happened tend to remember the year by connecting it to their own experience or age. A set of memories alone, however, is insufficient to connect social records such as an event or news to a time line. In addition, since many participants failed to determine the year that a news event happened, connecting the recollection of the exact time is regarded as a difficult task for the ordinary person. To reduce such difficulties and to amplify the recollection of past experiences, we developed a system for supporting a user's recollection of past events by coupling photographs and other clues that users remember to remind them of events, activities, and experiences. The next section presents the current prototype system.

3. PHOTMOSPHERE: A Prototype System

As mentioned in the previous section, we aim to help users recollect events by coupling photographs and other clues to prompt them to remember what they have forgotten, e.g., events, activities, and experiences. We utilize news events to connect photographs with memories associated with those photographs as clues, because users tend to have a vivid recollection of news about crime and disaster that had a strong impact on them. In addition, photographs contain personal and private information, while news events contain social and public information [2]. From this point of view, we assume that the news is the appropriate medium for complementing memory so that users can remember information that they are unable to recollect by simply looking at photographs.

Figure 2 shows the PHOTMOSPHERE, and **Fig. 3** shows its interface.

As the platform of the system, we utilize a 7-inch touch-sensitive display made by Magnetic Laboratories, Ltd. Since the display detects a user's touch, the user can easily and intuitively manipulate displayed photographs.

Figure 3 (1) displays a digital photograph and (2) displays news. To switch between photographs, users press the thumbnail index below the photograph as shown in

Fig. 3. PHOTMOSPHERE interface.

Fig. 3 (3). The thumbnails index is changed by pressing "prev," i.e., left triangle, or "next," i.e., right triangle, buttons next to the index. Our system displays a news event by the date of the displayed photograph; this is selected by touching the "display news" button, as shown in **Fig. 3** (4). In current implementation, three types of button such as domestic, international, and entertainment news are used. When these buttons are pressed, about 15 characters are presented per topic and news is sourced from a headline appearing on a Yahoo! JAPAN Web page. A summary of the news is presented so that image viewing is not hampered. Additionally, to ensure that there is no information overload and words are large enough to read, news is displayed simultaneously as 4 bullets and is constantly updated.

Figure 4 shows the system configuration. All interaction with a user is conducted via a touch-sensitive display. To identify the date of photographs, we use EXIF data that is embedded in the photographs [3]. We also use the Web API provided by Yahoo! JAPAN to get news. Our system presents not only the news happened exactly when the photographs were taken but within certain duration. The duration of news becomes longer if the news is older enough. Additionally, our system displays news that has been on Yahoo! JAPAN for the longest time. This is because we prefer not to use unimportant news for this purpose.

4. User Study: How Does Our System Encourage a User to Remember?

As mentioned in the previous section, the purpose of our proposed system is to help users remember events by presenting photographs with news. The purpose of this user study is to observe the extent to which details are recollected by participants when photographs are presented with news. For that purpose, this user study examines to compare two conditions: presenting photographs alone and presenting photographs with news.

4.1. Participants Selection

Before executing this user study, we administered a questionnaire to 28 students who were majoring in informatics. With this questionnaire, we investigated the frequency of news watching among participants, the categories of news that they watched often, and the frequency with which they took photographs. With regard to the frequency of news watching, we asked a question about each medium, that is, TV, mobile phones, newspapers, and the Internet. The categories of news used were domestic news, international affairs, economics, entertainment, sports, computers, and science. Concerning the frequency with which they took photographs, we asked a question with regard to each device, that is, digital cameras or mobile phones. We selected 8 participants (6 men and 2 women not affiliated with our laboratory) on the basis of their answers to this questionnaire. Participants in this user study were people who often follow news without distinguishing between the types of media and who also take photographs.

4.2. Procedure

We asked 8 participants to bring 30 digital photographs each, instructing them not to bring photographs that were downloaded from the Internet, processed size, and printed. Of the 30 photographs, 15 had to be of themselves or an acquaintance, and 15 had to be of objects, landscapes, buildings – anything except themselves or acquaintances. We asked them to bring two types of photographs because the extent of recollection may differ depending on the object in the photograph.

We then used 2 conditions in this user study. Under Condition I, we presented photographs alone, and under Condition II, we presented photographs with the news events. Each condition involved two phases: (A) the photograph phase, and (B) the explanation phase. **Table 2** shows the two conditions. The order of presentation of the two conditions was alternated between participants. We recorded this study with a video camera.

Before we conducted the study, we selected 8 photographs per condition; 4 of participants or acquaintances, and 4 of other objects. At this time, we took care not to overlap the date of photographs under each condition. Several news events were prepared for each photograph based on the time stamps on photographs.

Under Condition I, we presented photographs one by one to each participant in (A), the photograph phase. We did not control how long they looked at photographs. When they had finished looking at all of the photographs, we proceeded to (B), the explanation phase. In this phase, we asked participants to describe what they remembered after they were shown the photographs again. This time, we asked them about how detailed their recollections were regarding the date when they took photographs. If they did not mention the month, they were asked to identify the month. If they did not mention the day, they were also asked to identify the day. These questions were asked until they answered, "I can't remember" or "I don't know."
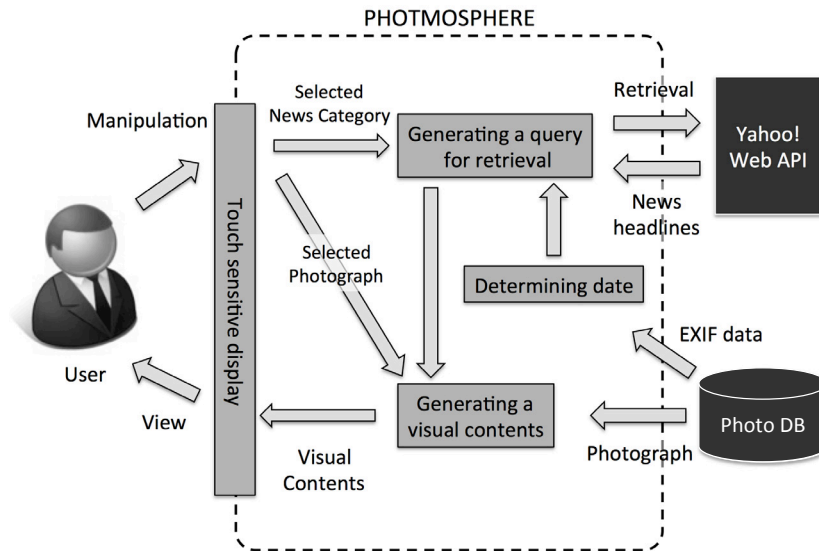
Fig. 4. PHOTMOSPHERE configuration.

Table 2. User study conditions.

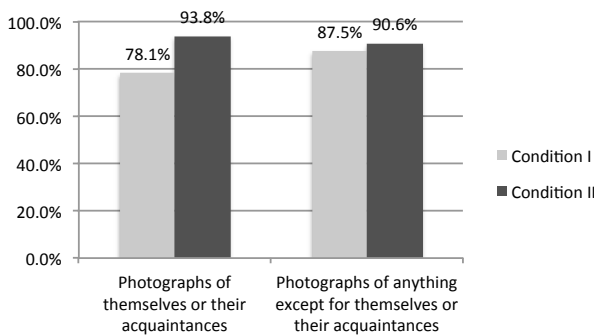|	(A) Photograph phase	(B) Explanation phase
Condition I	Photographs only	Photographs only
Condition II	Photographs with news events	Photographs with news events

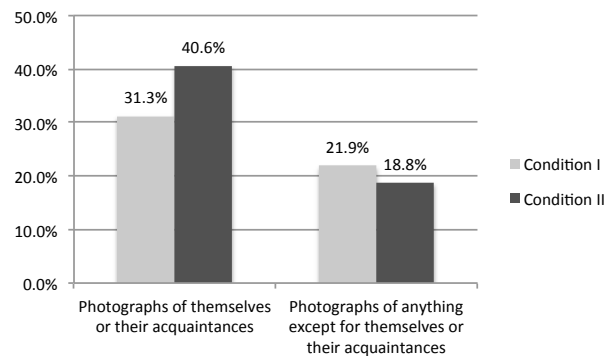**Fig. 5.** Average ratio of correct answers (month).

Fig. 6. Average ratio of correct answers (day).

Under Condition II, we conducted the same procedure as under Condition I but presented both photographs and news. Participants were examined under both conditions in random order.

4.3. Results

Figures 5 and **6** show the average ratio of participants correctly identifying the month and day when they took photographs of themselves and/or acquaintances, and of objects other than themselves and acquaintances.

Under both the month and day conditions, there was little effect from presenting news when objects in pho-

tographs were not of themselves or acquaintances. In contrast, when objects in photographs were themselves or acquaintances, there was a roughly 10% rise in accuracy on average in month levels ($t(50.0) = 1.8$, $p = .07$) in presenting both photographs and news.[2] This result suggests that participants remember rather easily when they took photographs because news affected their recollection about photographs of themselves or acquaintances. Photographs other than themselves or acquintances, however, e.g., scenery, gadgets, or buildings, seemed ineffective re-

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2. The statistical significance at 5% could not be verified because of the limited number of participants in this study.

garding recollection. These results dovetailed with the intriguing finding that pictures in the scenery category could be regarded as "unmemorable" [4].

After the user study, we gave a simple questionnaire to participants. Even though we selected participants who often watched the news, some of them did not anticipate that the presentation of news would have an effect on recollection. This result suggests that some news is not successively connected with memories of experiences or activities depicted in photographs, even though users are familiar with news content. That is, while users are aware of events in the news, the presentation of news itself is not effective in aiding recollection in some cases.

5. Discussion: Reformulating Design

Upon analyzing results, we found that, to support recollection, news needs to have an impact or be widely as well as strongly connected to people's memories of their experiences and activities. Clues that aid recollection, however, are not always included in news that is collected on the basis of the photograph date. PHOTMOSPHERE is based on the awareness that feelings and thoughts about photographs fade over time, but they can remind people of their experiences and activities. Through the user study, we found that news connected to experiences or activities is more memorable, so we will add a function to PHOTMOSPHERE that enhances memorization by connecting the "memory" of the event surrounding the photograph and the "record" of actual events.

PHOTMOSPHERE becomes a system that helps people improve memory by serving two functions: to memorize news by using photographs that are strongly connected to feelings, thoughts, and reactions, and to bring back memories of photographs that are weakly connected to feelings, thoughts, and reactions by using news. To achieve this end, we believe that it is necessary to establish strong connections between both "memory" and "record" but also "time." We therefore will design a system to extend memory by connecting "memory" of experiences and activities to "records" of events with "time."

6. Related Work

In this section, we review related work that utilizes photographs.

Many systems have been proposed that support browsing a large number of photographs by taking metadata of photographs into account.

PLUM [5] is a photograph browser that places clusters of photographs onto a map while drawing trajectories of photographers. PLUM clusters photographs based on place and time, and places representative photographs from the clusters on a map. By selecting one from the photographs, the system shows all photographs in a cluster that the selected photograph belongs.

MIAOW [6] is another photograph browser that clusters photographs event by event based on place and time. MIAOW arranges representative photographs of events in three-dimensional space where longitude corresponds to the X-axis, latitude corresponds to the Y-axis, and date and time correspond to the Z-axis.

Hearst et al. developed an interface for large image collections that allows users to navigate explicitly along conceptual dimensions that describe images [7]. The interface uses hierarchical faceted metadata and dynamically generated query previews [8], seamlessly integrating category browsing with keyword searches.

These systems are intended to make a user's browsing activity easier, but they do not take into account helping a user's recollection of past events intuitively.

Focusing on taking photographs and recording videos by mobile phone, Numa et al. aimed to change the mindset of users and redesign the relationships between users and information using mobile phones as tools for self-expression [9]. This study designed and produced a workshop program called *Keitai Trail!* to collect and connect participants' "stories." This study is similar to one that collects information related to experience and connects them. This study, however, focuses on helping people express, i.e., output, while our study focuses on helping people recollect, i.e., input.

Sumi et al. proposed the PhotoChat to encourage users to facilitate conversations about photographs among them and discover each other's individual interests by integrating photographs and notes [10]. This system can also be used to extend user's memory by combining visual and textual information. This system focuses, however, on communication and sharing with others, while our system is used by individuals working alone.

He et al. believe that "memories" consist of what was seen, along with time and location information, and also include expressions and actions [11]. This study therefore proposes the u-Cam, a ubiquitous camera system that records both the scene users are looking at and themselves at that moment. This study also suggests that it is important in order to remember experiences to provide both the photographs taken and also other information. In addition, they also integrate visual and textual information. This study focuses on location information in photographs. We wish to also adopt location information and provide users both time and place information to extend memory.

7. Conclusion

This paper has presented PHOTMOSPHERE, which displays photographs and news in order to extend memories by connecting memories of experiences and activities and records of events. To investigate the presentation of news with photographs, we have observed how detailed participants' memories can be regarding photographs. We have also conducted experiments observing how correctly participants remember when the news presented actually happened. On the basis of results obtained, we have con-

cluded that connecting three factors – namely memory, records, and time – is helpful in extending memory. In the future, we hope to develop and reformulate PHOT-MOSPHERE design based on our findings here and to confirm the usefulness of this system.

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