The Memory Collage:

A Mosaic of Perspectives and Emotions

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ABSTRACT
Information capturing devices are used in a social gathering environment to capture images, sound, discernable events, and guest input. We see the need for a system that creates an augmented social environment where devices enable one to capture information about a social gathering (e.g. pictures, audio recordings, written thoughts and expression). This system would allow a user to move around a collection of images and drawings, hearing sounds and conversation. Our paper describes and evaluates the Memory Collage and the devices used to capture information. The findings suggest that participants enjoyed having an enhanced method of capturing their memories of the event, moving pictures around in a collage arrangement, as well as listening to sounds recorded with the picture. Our findings provide guidance for the design of tools that display photos in a novel fashion.

Keywords
Ubiquitous computing, capture and access, context-aware computing, augmented environment

1 INTRODUCTION

Over the past decade, researchers of human interface technologies have been motivated to investigate novel types of interaction that may occur from computer systems being integrated into our everyday lives. The focus of attention is changing as these technologies become more commonplace and more implicitly perceived for everyday use and experience. Weiser [21] used the term ubiquitous computing to describe a vision of technology being designed that is pervasive, yet invisible within the environment.

The emergent themes within ubicomp are: context-aware computing, (e.g. Active Badge [20]); automated capture and access, (e.g. MyLifeBits [8]); and natural interfaces (e.g. Ishii's Tangible Bits [13]). Context-aware computing [5] involves systems which are able to sense and respond to aspects of their environment. Automated capture and access [10] are systems that capture and preserve memories of live situations which can be later retrieved. Natural interfaces [1] support natural forms of communication using computer technology. These themes can all be applied to a common space, the social gathering environment. This environment is defined as a physical place where more than one individual meets to communicate, and/or celebrate in a recreational manner. The questions that one may pose are: What are the components of a social environment? How may contextual information be used? What information can be extracted from the environment? How should technology be used in the environment to support natural interaction? What is the purpose of information extracted from a social environment?

2 RELATED WORK

We discuss how the process of taking pictures, digitising them and later sharing or accessing them has been incorporated into current projects. Possible areas of concern are highlighted. A summary of what we perceive should be designed when developing a system that captures the context of one's environment is provided. This system would offer the advantages of a camera, audio recorder, notepad, and store the digitised information in an interactive digital photo collage.

Vannevar Bush [3] outlined his vision of a system called memex (short for "memory extension") that stores personal information such as photographs and hand-written notes that occur as everyday activities. Through continual annotations, links between stored artefacts become meaningful, resulting in a dynamic cognitive aid for stored memories.

Sumi, Matsuguchi, Ito, Fels, and Mase [18] have begun to explore how to collect human behaviours and interactions by integrating multiple sensors, both wearable and ubiquitous, to capture user experiences from multiple perspectives simultaneously. They refer to this integrated process as an "interaction corpus". Although, this system can capture social interactions, it does not allow participants to personalise their video summaries after receiving them, nor is there a way to capture written notes or memos.

Being able to personalise video or photographs may enhance one's feelings for sharing them. With the abundance of networks and bandwidth there is the opportunity to present information in a cohesive unit that enables sharing between individuals and conveys a sense of presence, beyond a static photograph (see [15]). People have a strong desire to share their memories with others as evident by blogs, message boards, and other commercial and web-based tools for storing digital photographs and related annotations. Examples include the ability: to record and share meaningful messages between separated family members [12], to capture, store, and share spontaneous images [12], and to share photos that were annotated with personal stories [2]. The activity of sharing and reminiscing using digital photos can evoke feelings of happiness and nostalgia in the recipient. However, the memories shared are unable to capture spontaneous moments or events from social gathering that may be situated in one's periphery.

This brings to light a problem with photography at social events. Significant activities that occur spontaneously are not always in the centre of attention, but rather in the periphery, thus restricting the completeness of information representing some memory of the social gathering. It could be possible to capture this information in a more holistic way. The Eavesdropper camera [16], a context-aware device, captures spontaneous moments. It takes pictures of people when triggered by sounds such as laughter or voices.

To present photographs with additional contextual information, sound can be used for annotation. Audiophotography is a domain that studies the value and practice of capturing and recording sound with still photographs [7]. Frohlich and Tallyn [7] suggest that ambient sounds-of-the-moment enhance photos and covey richer, associated memories. These sounds may play a key role in providing a context when reliving personal moments at social gatherings.

The Interactive Party Textiles Project [17] is one example that focuses on enhancing the guests' experiences in an augmented party environment. This type of information capture is similar to that which is accomplished using a simple camera. However this project does not capture information from the environment which can be accessed at a later date.

There is a need for presenting information in a displayable format that can be easily accessed and viewed. What these previous examples show is the existence of projects that attempt to capture, preserve, and/or display memories, but usually not all at once. What would be useful is a system that can capture the holistic aspects of a party, preserve the moment, and display this information in a manner that allows the recipient to re-experience them.

3 MOTIVATION

We see the need for a system that creates an augmented social environment where devices enable one to capture information about a social gathering (e.g. pictures, audio recordings, written thoughts and expression). The information would be presented in a manner that enables users to access it as well as manipulate the content. This should allow people to recall aspects of the event and promote opportunities for sharing.

These ideas have been explored and implemented into our prototype system – the Memory Collage. The goal of this system is to provide novel means by which information in one's focus and periphery at a social gathering can be stored as a memory. It provides the viewer context through recorded sounds and written annotations. We want the users to have memories pertaining to what they experienced directly, experienced by the group, as well as retain an awareness previously unknown activities.

The remainder of this paper discusses our system. The following section describes the prototype, explains how it attempts to meet our objectives, and outlines the methodology used to collect information. The findings of informal usability tests are presented. The implications for these findings are explored for recorded environments and potential areas of concern are discussed. The conclusions and future work sections offer suggestions for designers of similar systems and provide ideas under consideration for future versions.

4 INFORMATION CAPTURE

Information represented by formats chosen to create a holistic memory of an event captured were: images, sound, discernable events, and writings. Different types of devices were used to capture information pertinent to these formats.

Images

Digital cameras were used to capture images. One digital camera was equipped with a Sony ICD-P17 digital voice recorder for voice annotation (Figure 1). Most digital cameras already have an audio annotation feature but the digital voice recorder allows audio information occurring prior to a picture being taken to be captured. Leaving the voice recorder on for the duration of an event, one can later create audio clips from the recorder output by extracting the audio data before and after a photo was taken. The photo timestamps, voice recording start time, and the

duration of the resulting audio file are all used to create the audio file for each photo.

Sound

Besides the digital voice recorder, two Audio-Technica AT4050 omni-directional condenser microphones and two APEX162 mini stereo unidirectional condenser microphones were used to capture sound. The omni-directional microphones were connected to an M-Audio Audiosport Duo USB audio interface where the sound could be recorded directly onto a PC in the environment. Two mini-disc players recorded sound captured by the unidirectional microphones. The mini-disc players allowed portable sound recording – they could be carried around by an individual or placed in crowded areas dynamically – whereas the omni-directional microphones remained stationary.

Figure 1: Digital camera with digital voice recorder mount.

Events

Touch sensors were embedded in four blocks of clay, shaped to fit inside a hand and decorated brightly (Figure 2). An application on the PC managed the touch sensors through a Phidgets [9] interface. When the sensors were touched, a "cat's meow" was played for feedback and the time of touch was recorded. The application allowed a user to give each touch sensor some definition or meaning. For example, squeezing the sensor created a different sound dependent on which of the three were touched. This provided the opportunity for "cool", "That was funny" or "What was that?" reactions. A collection of time stamps could later be referred to as instances of some event, given the definition of the sensor. Although this form was chosen for the sensors, we believe that other forms exist and should be chosen based on the type of social environment and what the sensor definitions are.

The sensors could be used in objects sometimes found at a party such as glasses, coasters, hats, and music systems. Party goers could initiate an intentional action such as raising a glass off a coaster and then unknowingly set off its sensors as they interacted with this common everyday object.

Guest Input

Thoughts and messages were obtained from guests by placing paper and markers around the environment. Colour markers were chosen as they are fun to draw and scribble with. A Kurta IS/ONE 12"x17" tablet was used for user input. It was connected to the PC enabling guests to write and draw using Microsoft Paint.

Figure 2: Fun event capturing touch sensor.

5 INFORMATION PRESENTATION

All the information was digitised. This includes: the digital photos, photos of the guest drawings and writings, audio from the mini-disc players, omni-directional microphone recordings, and audio from the digital voice recorder.

Post-Party Processing

A two-stage process was involved in processing the information captured from the social gathering. The first involved extracting the JPEG photos' timestamps from their EXIF (Exchangeable Image File) data. After extracting the timestamp of each picture, audio clips associated with those timestamps were created. This was done using a simple Visual Basic application. The audio clips were made from sounds captured five seconds preceding and five seconds following the taking of each picture.

Memory Collage

The Memory Collage is the culmination of all the writings, recording and images from an event, displayed to the user in the form of an interactive photo collage. Written as a

stand-alone Java application, users can interact with the collage by manipulating the photos, moving them to fit an arrangement of their choosing, as well as changing the size of each photo using the mouse's scroll wheel. The audio data extracted from the post-party processing stage is utilised to present the user with the appropriate sound clip that was recorded at the same time index during the party.

Figure 3: Memory Collage Screenshot

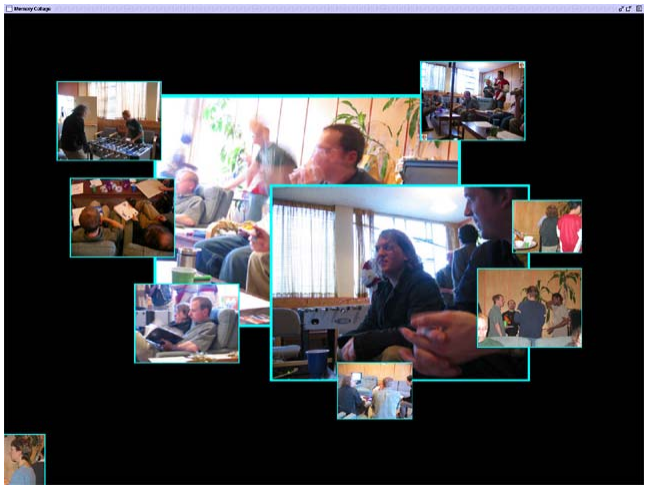

Figure 4: Scaled photos placed in a personalised arrangement

We are currently exploring several directions regarding the presentation of images and sounds beyond the current collage representation. These include providing users with a richer set of tools for navigation, such as the ability to zoom out for a global view of the entire arrangement, or being able to traverse the set of photos in chronological order. Looking even beyond the local collage paradigm, we are interested in potentially developing the collage into a distributed collaborative photo sharing system. This path could offer many avenues of research including: investigating the personal connection associated with photo sharing; and the role that sound, physical arrangements, and personal annotations have on feelings of intimacy and belonging.

6 METHODOLOGY

We designed the Memory Collage over the course of a three months graduate level class. We conducted a user-testing party to gather data and some of these participants evaluated our system providing information about their attitudes and behaviour.

User Testing Party

The participants were recruited from a pool of professors, researchers, and graduate students. To provide a forum for our testing, a party was held to evaluate the effectiveness of these devices within a room. Users were informed they were being recorded and all agreed to the signing of a consent form to that effect. Questionnaires were also distributed to the twenty-one participants to gather initial feedback regarding issues such as privacy and general feeling about a recorded environment.

Memory Collage Testing

Participants interacted and played around with our system on a PC. For our informal interview, participants were observed interacting with the pictures and talking out loud. Observation of user interaction helped to identify features of the interface which functioned successfully as well as those that confounded the user, and provided ideas for future directions.

7 EVALUATION FINDINGS

We evaluated the participants' experience with the devices at the party; some of these participants tested our Memory Collage. The goal of the evaluation was to:

- Discover if a significant percent of the participants felt the information capturing devices were an invasion of privacy.
- Get feedback and ideas on our system.
- Determine if the users liked the collage metaphor and found the information presented valuable.
- Evaluate the interactive navigational methods.

Party Experience with Devices

The two most relevant issues identified from the questionnaire were the feelings related to the interactive devices (touch sensors, drawing tablet) and privacy.

The interactive devices such as the drawing tablet and touch sensors seem to have positive reactions as participants were observed continually interacting with them. Participant feedback suggests they especially enjoyed playing with the touch sensors which activated a "cat's meow" response. The overall impression suggests that these devices were fun and provided a focal point for

people to gather around, play, and socialise with. One of the participants commented that "[Those touch sensors] become the starting point of conversation or interaction with others in a very natural way."

Responses	Percent
Yes	15.4
Yeah, a little	38.5
Had not thought about it	15.4
Don't care	23.1
Not concerned, knew ahead of time	7.7
Total	100

Table 1: Are you concerned that the recording devices at this party are an invasion of privacy?

Privacy was a concern among a majority of the participants that used the party devices. As Table 1 shows, a majority of the respondents felt the recording devices invaded their privacy to some degree. There were mixed opinion among the participants of the Memory Collage evaluation as to whether security or privacy would be a concern. For example, if these recording devices were at a party, then one should be made explicitly aware beforehand. This would allow people to make a choice as to whether they wanted to attend. In addition, it would be useful to have a 'recording-free zone', in which people could have a private space without being recorded (although this may detract from the overall effectiveness of our system).

Memory Collage Observation of Usage

User Navigation

Participants were observed creating their own arrangement of the photographs, double-clicking for sound, zooming in and out using the mouse wheel, and moving the collage structure in a desired direction. Of note, participants were observed naturally arranging the photos tighter together in either a collage style format or in a symmetrical arrangement. One participant commented that he was not particularly happy with having to continually use the mouse to move the photos. He suggested a global view feature be provided that would enable visibility of all the pictures at one time.

The ability to zoom photos in/out using the mouse wheel was not observed as being particularly intuitive, but was seen as a "neat" feature by a participant after discovering this feature. Thereafter, it was continually used throughout his session. It was suggested that it may be beneficial to have photos zoom to a standard size, rather than be able to zoom photos as large or small as desired. This would then provide a sense of symmetrical order in the visual perspective.

Meaning and Significance

One of the participants suggested that they be able to isolate their content in our system. For example, they desired to see a collection of photos of themselves within, or have visual indication of photos that contain sounds relevant to them. Another of the participants, who preferred a slide show format, wanted to be able to have photos organised by theme so that a search engine could be used to find a particular photo. This idea could be expanded upon to that of an interactive family browsing application that could be a communal display. One respondent felt that the ambient sounds may only be useful if a significant event occurs such as a joke. It is unclear how one could differentiate between photos that have significant events with those that do not. Would this only be based on memory? What is defined as a significant event?

Sounds

During a photograph mouse-over, the collage gives visual feedback regarding whether sound can be activated from it. Three issues of concern include: users wanted an easier way to play back sound without double-clicking; some users got the impression that clicking on a photo would play a movie; and users expected the sounds played back from the photo would be representative of the content.

Sharing and Collaboration

One of the participants suggested photos be grouped by similar themes as sub-clusters in the same way he highlights digital photos of his party or vacation. A subset could then be extracted from the Memory Collage and shared in some format, such as a slide show or email.

Perceptions of Time and Space

Participant feedback suggests acceptance of the randomised arrangement using partial overlapping. It may be that our system is perceived not just as a collection of photos, but is seen by what Harrison and Dourish [11] refer to as a "sense of place". Our design may influence behaviours and expectation of the people that interact with it.

It was suggested that our system be separated into an area that arranges photos in temporal order first for easy retrieval and then a collage area that affords freedom of arrangement. Another participant recommended that the Memory Collage be appended by those using it. Videos, photos and sounds from the user's experience could be integrated into the display to provide additional information.

As the pictures were not arranged by default in a temporal order, it was suggested that each picture could provide functionality so that participants could be moved to the previous or next picture in the time sequence, independent of its location. As people are moving across the Memory Collage in a linear form, being able to jump from one photo to the next may confuse users. Hence, a feature that

enables users to navigate in a temporal order may be beneficial.

8 CONCLUSIONS

In this study we have presented our findings from two evaluations of the Memory Collage. An evaluation of feelings and concerns regarding the recording devices used at the party such as privacy, and feedback, ideas and areas for improvement from the evaluation of our prototype. Our main findings show the usefulness of a system that captures information from a social environment that can be presented later in an interactive display.

This paper has focused on a number of themes related to ubiquitous computing that will be further elaborated upon here. What are the components of the social environment? How may contextual information be used? What information can be extracted from the environment? How should technology be used in the environment to support natural interaction? What is the purpose of information extracted from a social environment?

When considering, a dynamic and unpredictable environment, deciding where to place recording devices, such that useful contextual information can be captured is a difficult problem. At a party, one may have music, loud noises, or lighting issues that negatively impact the value of the recordings. The uncertainties of a social event make it difficult to plan for all these contingencies.

For a social event, there may be different ways in which the contextual information may be used. Understanding how context should be represented will help in the design of systems such as ours that use recording or sensing devices. For example, a formal social occasion should employ a different form of sensor perhaps in a coaster or a punch bowl, rather than use of a touch sensor with a "cat's meow" sound.

The type of information that can be extracted from the environment is dependent on the context and the people present. Behaviour, feelings and attitudes may change if the devices are visible or even if people become aware of them. There were privacy issues and concerns regarding the recording devices. This may not be unusual as people are sometimes apprehensive about being recorded. Providing a private space as a recording-free zone is one option being considered.

These issues of privacy and security may make participants wonder how information from recording sensors would be used. Would it be anonymous? What are the purposes of taking this information? Do the recording devices have to be active all the time? Although the purpose of this paper was not to focus on privacy and security issues, they are of concern. There is a delicate balance between information access and security. It is up to designers to ensure that there are valid reasons for the capture of people's personal information.

We found that our touch sensors were able to support natural interaction because the shape and form mirrored the informal nature of the party. Looking at fuzzy shaped creatures that emitted a "cat's meow" noise did not seem out of place. It added to the excitement and added an element of surprise for our party. One could say that the affordances of the touch sensors supported interaction and reactions. The intriguing nature of the sensors encouraged users to be inquisitive of their usage and explore the responses of all of them.

9 FUTURE WORK

An ethnographic study of how people would use our system in their everyday lives would provide useful qualitative findings. As well, additional quantitative studies with larger, more representative samples would be able to provide us with additional insights into our future research direction. Based on the suggestions from the Memory Collage evaluation, a number of changes are being considered or have been implemented. What are the implications of using a larger screen? How would multi-user interaction influence its evolution as more people use it? How can we find a way for shared access among a large number of people, perhaps using a web-based platform?

This study concentrated only on individual use of our system. As the number of co-located participants increase, one wonders how this would influence the dynamic nature of the display. Would collaborative interactions create different types of clusters? It would be useful to further this research area by studying teams and groups that collaborate perhaps on a larger display such as a SMART Board (see www.smarttech.com) or an immersive large screen facility. A larger screen would also show all available pictures in an enlarged format, providing different perspectives of scale. A SMART Board may enable people to annotate existing pictures or create personalised, collaborative collages. Collaborative screenshots could be saved and shared among participants.

Shared access would provide a new form of interaction, especially if a web-based platform were possible. Should there be a chat window in which one could communicate with remote users? If family members could all interact with one another within the Memory Collage, a family collage could be created based on a reunion or anniversary that each member could save as a keepsake. Through the Internet, distances would be irrelevant and the need for synchronous interaction may be unnecessary if asynchronous functionality existed. Users could arrange photos during times of convenience. We see many potential opportunities for our Memory Collage as a collaborative tool, shared online space, and as an immersive display.

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