Context-Coded Memories: "Who, What, Where, When, Why?"

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1. INTRODUCTION

Human memory is a powerful yet clearly fragile construct. Research in cognition and the psychology of memory suggests different kinds of memory from short to longterm, or working to iconic [2]. Regardless of the type of memory, we each suffer from difficulties in both retaining and recalling specific memories. We can remember the address and phone number of a friend from 15 years ago but we cannot remember where we left our car keys! Technology is developed to help us in our work and study, so why not strive to develop systems which augment our natural memory? [5, 10].

Of particular interest for our work is technological support for episodic memory to aid people in *story telling* or *reminisce activities*. Episodic memory refers to the memory of an experience, time, place or an event. A challenge when dealing with episodic memory is that, with time the fine details tend to decline or become more difficult to recall. Our approach is to explore the use of different recording mediums to capture digital artefacts which we annotate with "context-coded" details. For our purposes, we are interested in the "context" of the individual (entity) who is capturing the digital artefact (eg. a photograph). *Context* is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and application themselves [3] . Hence, a *context-coded* digital artefacts is a data item (such as a photograph) with the addition of context metadata collected during the data item capture, inferred from subsequent data analysis. Regardless of what the context is determined as it is stored with the data item and is hence context-coded.

Supporting Human Memory with Interactve Systems, workshop at the HCI 2007 (British HCI conference 2007), September 4th, 2007, Lancaster, UK

Providing user access to these context-coded artefacts allows people to have a reference back to the context in which the artefact was created, which we aim to show allows them to remember the past more clearly and with greater fidelity ([10]). For the purposes of this paper we focus on context-coded photographic collections although our techniques can apply to any digital artefact. In [12], one issue in associating location context data to pictures is that it often requires the user to do it manually. Some web sites like Flickr.com offer a convenient way to do it: just drag the picture and drop it on a map where it has been taken. We describe in this paper a simple method to automatically embed location data into a picture. This method only requires that after uploading on a computer her pictures and a file containing data location from a GPS device, the user executes a program which automatically synchronizes location and time information.

The broader motivation for this work stems from our past ethnographic research [9] and TableTop photo sharing studies such as [7] and [1] with elders. This work has suggested the social engagement achieved when sharing printed or digital photographs acts as a natural pathway for the exploration of episodic memories. Digital photography has changed the nature of story telling and reminisce activities in ways which are not yet well understood. A danger in the transition from physical to digital photography is that we will loose the rich story telling medium which the physical photographic artefacts provide.

Some people continue to print the majority of their digital photos which allows them to pass around a pile of their lat-

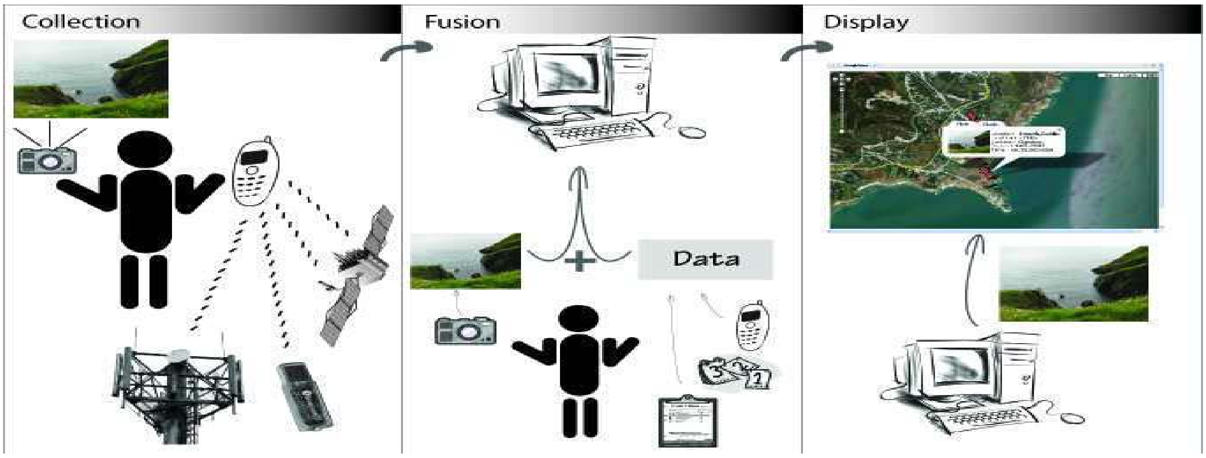

Figure 1: Context-Coding Process: Collection, Processing and Display

est holiday snaps with friends and family and to store them in a physical albums. However, many people are now transitioning to a world with thousands to tens of thousands of digital photographs stored on large hard disks. While this transition brings with it many possibilities in terms of copying, editing, publishing and printing it also brings challenges in terms of presentation, viewing and sharing photographs [1]. Consider for example one person aged 40 with a collection of 32,000 images. Spending ten seconds per image on a screen show, 1 hour per day would take this person 3 months to see all their pictures, just once. Further consider the 5.5 million photos available on a site such a flickr.com and the same process would see them complete a slide show around their 82 birthday. Clearly, people need methods to structure their use, exploration and access to large collections of digital artefacts. However, many of the digital artefacts we each collect form a very limited record of our life experience and are often only annotated with just time stamp data (which may be inaccurate) and cryptic names such as DSC00019.jpg as metadata. It's clear we wish to use, share and keep such collections for our own and others use. The problem is then, how can we provide access to such large collections while supporting episodic memory recall in the face of limited metadata and linear views of such data sets. Our approach here is to place such media in its correct context by processing the media itself and by correlating it with sensor, environmental data and data collected from each person's computational state (email, calendars). By combing these data sources one can offer recall technologies that assist people's memories in both the short and long term.

2. PHOTOS AS A SUPPORT FOR MEMORY

Pictures represent a very interesting means of remembering events or locations. Thanks to digital photo technology, many people take lots of pictures over the course of their lives. People possess hundreds and even thousands of pictures. Digital pictures can be stored as files with extra information (metadata) embedded (place and date the picture was taken, name of the people in the picture, etc). Because of the huge amount of pictures, it is not practically realistic for people to manually annotate each image with such extra information. Lots of metadata is automatically embedded in digital pictures but this default metadata is generally not relevant to common users, as it commonly refers to the make of the camera, the focal length, etc.

2.1 Context Coding Digital Artifacts

Our goal is to provide an approach we call context-coding which enables the automatic embedding of metadata (context) that is relevant to users. Context includes information from the environment (environmental state) and computational environment (computational state) that can be provided to alter an applications behavior, or is an application state which is of interest to the user. Context includes, though is not limited to, spatial information (location, speed), identity (users and others in vicinity), user model (profile, preferences), temporal (time of day or year), environmental (noise, light), social (meeting, party), resources (printers, fax, wireless access), computing (network bandwidth, login), physiological (hearing, heart rate), activity (supervision, interview), schedules and agendas.

Looking at pictures of places we were or people we know is clearly a good way to remember events. People's memories of photographed events can be improved by associating information with the pictures such as date, location, name of the people in the picture, etc. In this section we describe our approach to associating the collected information with the photographs. To achieve our goal, the person taking pictures not only carries a digital camera but also other devices: a GPS device and a mobile phone both embedding BlueTooth facilities. These assumptions seem realistic since digital cameras and mobile phones are common devices. Moreover, it is now possible to acquire a GPS device with no memory storage but with BlueTooth facilities for less than a 100 euros. All together, those devices allow the collection of pictures with associated date and location information. The principle is illustrated in Figure 1 and is described in the following paragraph.

Images are taken with an ordinary camera. The camera saves the images tagging them with a date and time[1]. Meanwhile, the mobile phone receives location coordinates from the GSM device and appends them to a file. It also keeps

[1] This is a usual feature of digital cameras.

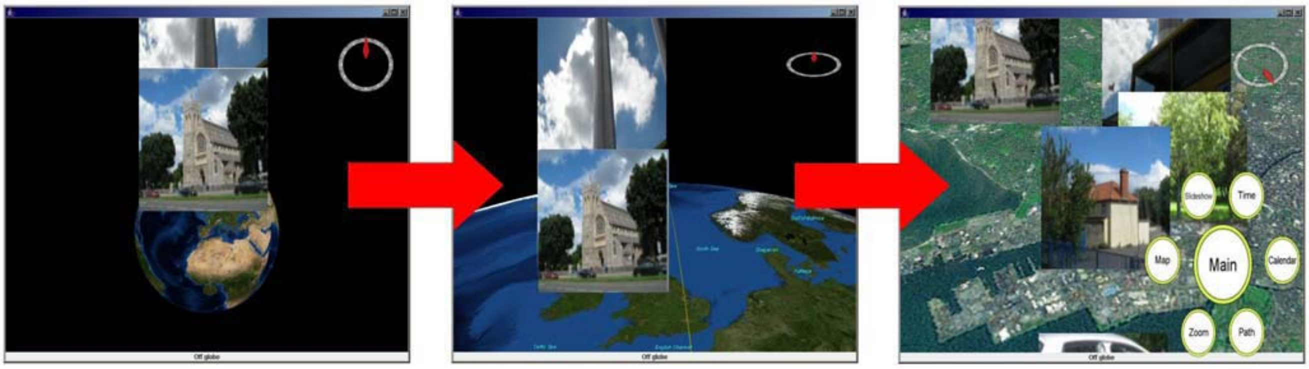

Figure 2: Visualization of pictures

track of the date and time the information location is saved[2]. All these features have been implemented via a mobile phone application. The mobile application can also access and save the calendar details and profile of the mobile phone. This provides information about the people you are with at a given time (colleagues for a meeting, family on holidays, friends at a birthday party, etc). The application uses a BlueTooth scan to determine the BlueTooth devices (and so people's phones) that are around it at any particular time. Note that the previously mentioned application can run in the background without affecting the users' normal interaction with the phone.

For our approach, the pictures with date information are stored in the camera and date and location information are stored in the phone. Data files can be uploaded from the mobile phone to a PC. The images can also be uploaded to the PC. We implemented an application to retrieve and synchronize the collected information. The synchronization is performed with respect to the time. The application considers the photos, the time they were taken at and then looks for the GPS and BlueTooth information that coincides with the closest time to the time the image was taken. The matching results are stored in the photo as metadata. Metadata is stored in the picture itself using the Exchangeable Image File Format (EXIF). If due to some unavoidable circumstances, (like the inability of the GPS device to connect to the satellite or mobile phone) it is not possible to collect data between two points A and B, then extrapolation techniques are used. Also, the frequency for collecting location information adapts to the speed with which the user moves at. For instance, if the user does not change her position for a while, then the frequency location information is collected at is reduced. In the same way, the frequency increases if the user moves very fast.

2.2 Visualizing data

Adding metadata to picture in order to help users' memory is only the first step of the process. To be relevant, the approach has to provide a meaningful way to use the information. Since we focused here on time and location information, we sought to provide the user with an insight into her memory through that information. For that reason, both spatial and temporal criteria are important for the design of an interface for browsing a users' photographs. This approach leads us to provide the user with a map and a time scale. She can then select a location and access all the pictures that were taken at that location. She can also select a time or a period and then access all the pictures taken during that period. Both parameters can be combined to help the user answer questions such as "Was Auntie Helen with us in mum's house in Dublin at Christmas two years ago?". The interface was implemented using the WorldWind software[3], which is a GoogleEarth like application. With the web application Flickr.com you can place pictures on maps to indicate where they were taken. Unlike Flickr, our application does not require any human intervention to place the picture. It uses the embedded location information instead.

The visual interface is a 3D representation of the Earth (see Figure 2). The user is able to select a location with this representation. Time is also a factor that is presented by an artifact resembling a clock which the user rotates to go back and forth through time. As they do this the images relating to the time appear on the surface of the Earth. To start the interface loads photos from the information in a the text file, then the user is presented with a calendar structure within which they can select time periods of interest. The calendar is scalable to show the days, weeks, months and years. When selected the Earth is shown with the relevant photos. The photos on the Earth can be selected and manipulated (e.g. resized or placed aside for future use).

3. CONCLUSIONS AND FUTURE WORK

The systems developed to date for the Context-Coded Memories support rudimentary contextual data collection and processing along with a map and globe based display. Natural extensions for this work include support for indoor location awareness, for example through the use of Ubisense technology to detect position coordinates, where the GPS is not able to receive sufficient coverage from the GPS satellites. In addition, we can add context details from our computer calendar and Google calendar to our images along with inferring activity from emails, documents, SMS and tele-

[2]Note that in some cases, GPS devices are not necessary to get some location information. Mobile phones can indeed save the nearest GSM cell tower id. This gives a rough idea of the location of the phone.

[3]WorldWind is a world map browser software developed by NASA, http://worldwind.arc.nasa.gov/

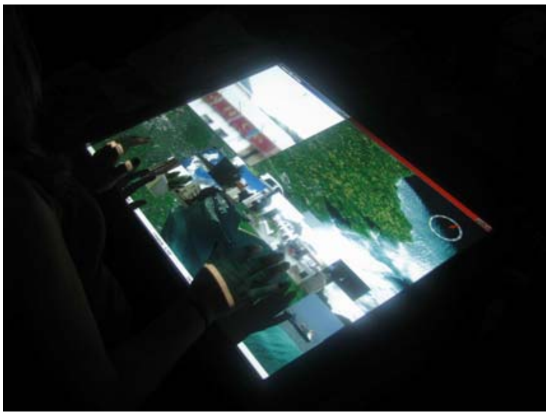

Figure 3: Interface running on a TableTop

phone calls. Image recognition technology can also be used to detect certain faces in your image collection coupled with the BlueTooth device names you were proximate to while you took the photo, which are stored in the images. Our planned future work will explore all of these options along with a visual interface which will be displayed on a multi-touch device such as the DiamondTouch[4], this will provide a gateway to more collaborative aspects of photographic memory aids.

People do not interact the same way with digital pictures as with physical ones. Physical pictures are more adapted to social sharing. For example, it is common that people who were on a trip together meet afterwards to look at the physical pictures they took and talk about them. In this social sharing, the discussion about the pictures leads to memories sharing and each person's memory can help in other ones to be refreshed as memories around photos are discussed. Unfortunately, this habit is disappearing with the use of digital pictures. It is now really easy to share pictures by publishing them on a web site for example. It would then seem interesting to explore retaining the physical tactical nature of pictures as a means of enabling people to socially reminisce. While also gaining important advantages by using digital photographs, easy automatic reorganization, etc. Finally, to provide a tangible link to your digital artefact's a link can be made between physical artifacts and the images displayed, such as souvenirs collected from a holiday. These souvenirs can have RFID tags attached. When a tag is read, the images related to the souvenir would be displayed providing a gateway to this source of information. Our current work seeks to address the need for support for episodic memory through context coded media and subsequent work will provide evaluations of our approach.

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