MemPhone: From Personal Memory Aid to Community Memory Sharing using Mobile Tagging

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***Abstract*—Human memory is important yet often not easy to be handled in daily life. Many challenges are raised, such as how to enhance memory recall and reminiscence, how to facilitate memory sharing in terms of people's social nature. This paper proposes MemPhone, a new system that addresses various human memory needs by using the mobile tagging (e.g., RFID, barcodes) technique. By linking human memory or experience with associated physical objects, MemPhone can *i)* augment memory externalization and recall, and ii) build object-based social networks (OBSNs) to enhance memory sharing. By embedding physical contexts into SNs, the OBSN can strengthen friendships by enabling serendipity discovering and nurture new connections among people with shared memories. Early studies indicate that our system can facilitate memory recall and shared memory discovery.**

Keywords- Mobile tagging, memory augmentation, object-based social networks (OBSN), serendipitious social interaction

I. INTRODUCTION

Memory is a complex cognitive behavior and it is quite important to our work and life. Some valued memories in our life include *details to aid taking care of daily errands* (short-term memory; e.g., remembering how to take the medicine), and *life history* (long-term memory; reminiscing happy events in the past) [1]. The aim of our work is to develop a unique and natural way to augment various human memory.

There are several challenges faced by human on memory. First, human memory is fallible. People often forget what have done and what to be done. In psychology, memory is the *processes* by which information is encoded, stored, and retrieved. Due to brain limitations, these processes often need to be externalized using technologies for reliable and efficient memory aid. This is particular useful for short-term memories. Second, human are by nature social animals. They live in different circles and communities, and often want to share their life memories (e.g., photos). It is facilitated with the development of social network services (e.g., Flickr, Facebook). However, some factors that are identified important for memory sharing, such as physical, mobile and spontaneous contexts, are not considered.

In this paper, we present MemPhone, an object-based memory augmentation system that enables users to associate their memory/experience data with various physical objects (places, mementos, belongings, books, etc.) through the mobile tagging technique. The memories are kept in a variety of *digital media* (e.g., photos, texts, videos, etc.) captured from mobile phones. Moreover, it enables the formation of object-based social networks (OBSNs) for context-based memory sharing. Through this system, a user can "enclose" and "disclose" his memory into/from any relevant object, and "connect" it with other people's common stories by merely scanning its tag (RFID, barcodes, etc.). MemPhone can augment human memory from both personal- and community-level, as illustrated in the following scenarios.

- *Memory externalization and recall*. Encoding memories to physical objects is a typical memory externalization process, which enables associative memory recall. For instance, elder people often forget the quantity of medicine to be taken. In MemPhone, they can simply associate it with a medicine case using a sound clip.
- *Daily reminiscence*. People are willing to recollect past events. Reminiscence is usually spontaneous and externally-triggered. Physical mementoes (objects) can be important triggers for reminiscing. For instance, people often collect physical mementos (tickets from a concert) and associate them with pleasant memories.
- *Experience sharing*. People appreciate sharing of their experiences. Mobile tagging initiates a new way to exchange experience through associated objects. For instance, young people can hear the experiences from their parents on cooking through tagged gas-ovens.
- *Serendipitous social communication*. People's physical activities and contexts could bring about shared stories among them. For example, different people can visit the same place or interact with the same object (e.g., a table in the office). This motivates us to develop OBSNs, which can facilitate context-based, spontaneous communication among people with shared stories ("renewing" friendships with serendipitous discoveries).
- *Nurturing new connections*. We tell stories of our past experiences to make friends. In OBSN, people can make connections based on their common memories (visiting the same places, similar experiences regarding to the same category of physical objects).

This paper explores the usage of everyday objects to augment memory externalization, recall and sharing. More specifically, it intends to:

- Propose a memory aid method using mobile tagging.
- Build OBSNs and leverage it for context-based memory sharing, community interaction, and friend making.
- Present early results from a user study. The study was conducted to validate the effectiveness of MemPhone on context-based memory recall and sharing.

II. RELATED WORK

This system draws on work about augmented memory and mobile social networking, as reviewed below.

A. Augmented Memory

There have been numerous studies about memory augmentation, falling into different dimensions.

Memory lapse is a common problem for human being, and there have been numerous systems developed to **augment memory recall**. Forget-me-not [2] uses a personal digital assistant to collect its user's activities in the form of texts throughout the day for future recall. MyLifeBits [3] is a lifelogging system that stores all the information (including photos, documents, etc.) about a person in a database. Both of them provide a timeline-based approach for past memory browsing. However, as people often forget the concrete context in terms of time, a timeline-based browser is often not enough for efficient data retrieval. As reported in memory-related studies [4], people often recount associated events or cues that go with the target item. Physical objects play a special role in human life, and often act as the cues in the process of remembering. Hence, in MemPhone, we build the link between physical objects and human memory to augment memory recall.

Another research direction is to **encourage reminiscing**, both for personal remembrance and memory sharing. MUSE proposes a method to revive past events by mining useful cues from email archives [5]. Olsson et al. have explored requirements for creating systems to share life memories, and have observed that such systems can be enriched by leveraging physical, social and emotional contexts in shared stories [1]. The design of MemPhone is in line with this finding, and it leverages physical objects and social relations as cues to trigger memory sharing. Bentley et al. have developed a location-based video sharing system to strengthen the ties across generations in a family [6]. Ubiquitous memories [7] is to our knowledge the most closest system of ours, which proposes an approach to transfer human memories into objects using RFID techniques. However, it focuses on personal reminiscence and does not consider the formation of OBSNs. Our work, in contrast, explores the usage of mobile tagging to assist friendship strengthening and serendipitous discovery making.

B. Mobile Social Networking

Mobile social networking (MSN) is rapidly becoming a new research domain to showcase the power of merging social networking and mobile computing. It is believed that MSN will not merely be a simple extension of traditional SNs, it will revolutionize them by embedding more and more physical elements into online communication. To date, location-based social networks (LBSNs) have become the dominant form of MSN, which bring unprecedented opportunities to study human friendship and movements [8]. Quite recently, event-based social networks (EBSNs) are growing as another genre of MSN, which try to build the link between physical and online events, and understand the interaction between online/offline communities [9]. The object-based social networks (OBSNs) provide a new opportunity to integrate physical contexts with SNs, which try to connect people and strengthen their relationship through their shared experience with physical objects.

III. THE MEMPHONE SYSTEM

The aim of our work is to explore the usage of everyday objects to augment memory recall and sharing. This section will give a general design of MemPhone.

A. System Requirements

Based on the scenarios described in the introduction, we identify the following requirements of MemPhone.

- Identification of physical objects through mobile devices, leveraging mobile tagging techniques.
- Enclose/disclose digitalized human memories in association with tagged objects.
- Build object-based social networks for common memory sharing and community communication.

B. System Architecture

Based on the above requirements, we have designed the MemPhone system. The whole system consists of two parts: the *local memory manager (LMM)* and the *community memory center (CMC)*.

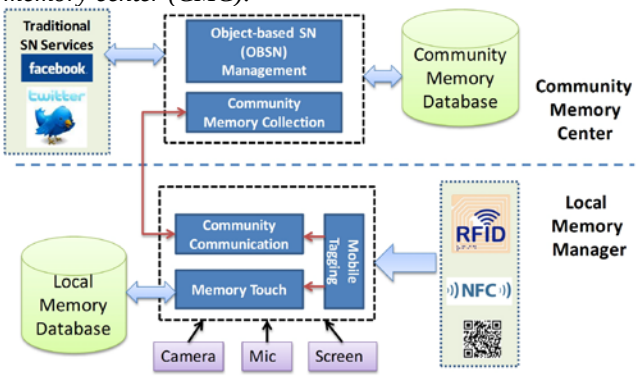

Figure 1. The system architecture of MemPhone.

The LMM is a mobile application, which is responsible for capturing, storage, and associative search of memories at mobile phones. It consists of several components.

- *Memory touch* captures human experiences and events to be remembered and transfers them into digital memories (photos, audios, texts, etc).
- *Mobile tagging* associates digital memories with objects, where various object identification techniques can be used, such as RFID, NFC, and barcodes.
- *Community communication* delivers the memories to be shared to CMC.

The CMC provides a browser-based mobile user interface for memory sharing and community interaction.

- *Community memory collection* collects the memories shared and indexes them with associated objects.
- The *OBSN manager* is responsible for the management of communities formed by people with shared experiences, in terms of physical and social contexts.

IV. DETAILED DESIGN

Having characterized its conceptual architecture, in this section we present the detailed design of MemPhone.

A. *Object-based Augmented Memory*

The LMM is a mobile application that supports memory recall and everyday reminiscence at the mobile client side. The work procedure of it is shown in Fig. 2.

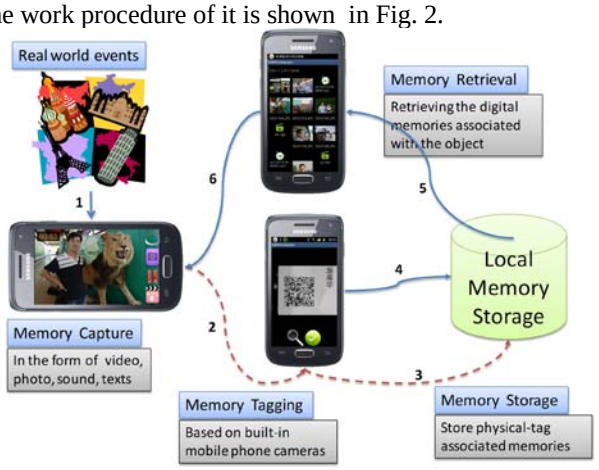

Figure 2. Object-based memory externalization and retrieval process.

1. A user experiences an event (e.g., remembering the venue of the meeting; travelling) in his daily life, captures it using mobile phones, and stores it as digital memories;
2. The user can associate the digital memory with a relevant physical object by mobile tagging;
3. The memory is indexed by the object id and stored;
4. When interested about the event again, the user can touch the object and read its id;
5. The memory is retrieved from the object by its id.
6. The user can re-experience the event (recalling its details; reminiscing the pleasant moment).

B. *Memory Sharing in OBSN*

We have developed the CMC, which allows users to post and share their memories in association with objects. With the CMC, users can also enhance community communication with the effects of physical and social contexts.

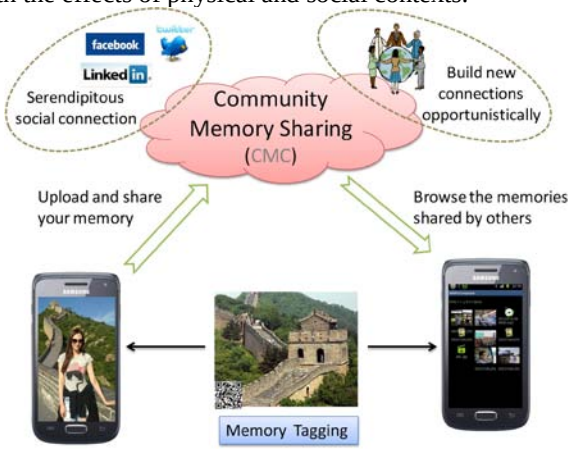

Figure 3. Community memory sharing in OBSN.

As shown in Fig. 3, the CMC supports two forms of social communication. First, it can "connect" a user with its online friends and "renew" their relationship by building seamless connection with traditional SN services (e.g., Facebook, LinkedIn). This is achieved by linking the shared memory with user ids in traditional SNs (e.g., using shared id in OBSN and Facebook), and obtaining the social structure from them (i.e., the social context). Second, it can form new communities with people who shared common stories in association with the same object (i.e., the physical context).

The two forms communications have distinct features: the prior one supports shared story discovery between relatives and friends in the *serendipitous style;* while the second one enables friend making in an *opportunistic style*. We can thus identify several important characters of OBSN: *context-based*, *serendipitous*, as well as *opportunistic*.

V. Implementation and Initial Evaluation

We have implemented a prototype of MemPhone and validated its performance from early user studies, as presented in the following subsections.

A. *System Implementation*

MemPhone is developed on the Android platform. The MeiZu M9 smart phone (with Android 2.2) is used for testing. For general purpose, QR codes are chosen as the tagging technology. The advantage of the QR code is that it is easily-recognizable and cheap-to-produce. We developed the QR code decoder based on ZXing (http://code.google.com/p/zxing/, an open source project of Google). Some user interfaces are shown in Fig. 4. The main entry is given in Fig. 4(a), where users can "record" the digital memory, "find" object-associated memories, and "view" retrieved memories. Fig. 4(b)(c) shows the interfaces for memory post and shared-memory browsing. Users can make comments to the shared memories via the interface shown in Fig. 4(d).

(a) (b) (c) (d)

Figure 4. User interfaces of MemPhone.

B. *The Effectiveness of Object-based Memory Recall*

One of the major characteristics of MemPhone is to augment memory recall by externalizing memory to physical objects. We validate its effectiveness by comparing it with two traditional methods: *human memory* and *digital memory*. The prior method does not rely on any memory aid tools; while the latter one can encode and store human memory as digital files and retrieve them with the aid of desktop search tools (e.g., the file search box on the Windows platform).

A total of ten memory tasks that are popular in our daily life was designed. As shown in Table 1, we category them into three types: study-, life-, and work-relevant. Eight subjects from our department were recruited to conduct this experiment. They were asked to remember the ten memory tasks within the 30-minute training stage. One week later, we asked them to recall the details of the ten tasks. Two metrics

were used for validation: *success rate* and *time-cost*. The prior one denotes the average percentage of the subjects who successfully recalled a memory task. The latter one refers to the average time cost for a memory task.

As shown in Fig. 5, both MemPhone and digital memory has high success rate; however, digital memory consumes much more time on memory search. This result indicates that object-based memory aid is more effective than traditional methods. It is effective for supporting memorization and recollection of contextual events.

TABLE I. THE TASKS FOR REMEMBERING

Type	Content
Study	Words; statistical data (Data), news report (News)
Life	Recipes (RE); bus routes (BR); shopping lists (SL); birthday date of friends (BD)
Work	Meeting minutes (MM); schedule (SC); organization structure (OS)

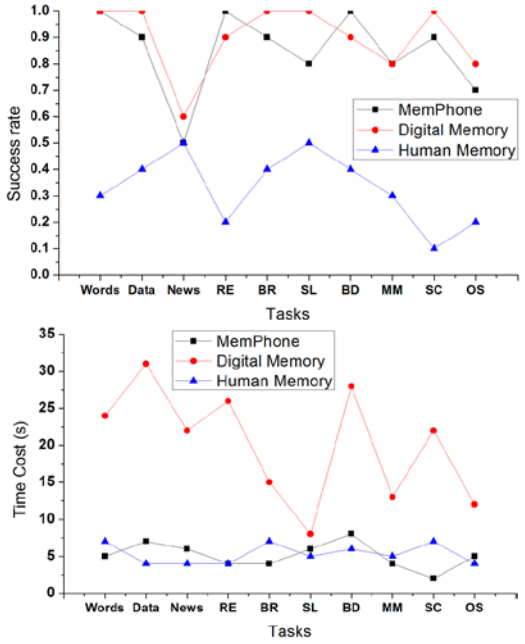

Figure 5. Experiments results to object-enhanced memory recall.

C. *The Usefulness of OBSN*

Another contribution of MemPhone is the proposal of OBSN for community memory sharing. The success of OBSN depends on several aspects: i) can it facilitate the retrieval of shared memories in contexts; ii) how people interact via OBSNs and what are their feelings about it? To answer the second question, a long-term user study should be conducted and analyzed. In the early study, we mainly test the effectiveness of OBSN on shared memory retrieval. As a new form of SN where people connect based on their links with physical objects, we compare OBSN with two traditional, yet popular SN services in China, Sina Micro-blogging and QQ Space.

In the experiment, we assumed that the subjects had a common friend *A*; he had shared his photo taken in front of a famous bridge in the campus of NPU via OBSN and the two other SN services. The subjects were unaware of this before the experiment, and they were asked to examine if they had shared stories with *A* by checking the three SN services.

The experiment results are shown in Fig. 6. It is clear that by using mobile tagging, the time cost on identifying shared stories is largely reduced (comparing with traditional SNs). By embedding physical contexts into SNs, OBSN can facilitate the discovery of shared memories among people.

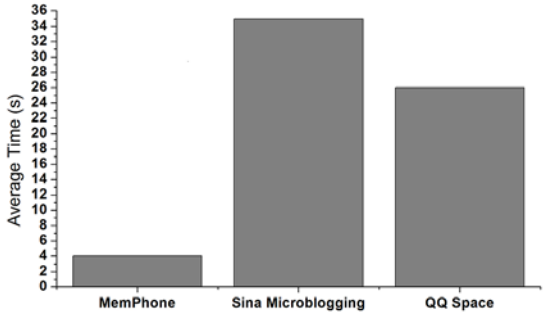

Figure 6. Discovering shared memory in OBSN and traditional SNs.

VI. CONCLUSION

In this paper we have presented MemPhone. By associating human experience with physical objects, it can enhance human memory from several aspects, including memory recall, reminiscence, and experience/memory sharing. Moreover, we have proposed the formation of OBSNs. By embedding physical contexts into SN, OBSN can strengthen friendship through serendipity discovering and new connection formation. As for future work, we intend to build a campus-scale testing environment and conduct long-term studies to understand human interaction in OBSN, especially for serendipitous community sharing and opportunistic community formation.

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