Design and evaluation of a tool for reminiscence of life-logged data

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Abstract—**In this paper we present a design, development and evaluation of a tool to facilitate the reminiscence of life-logged data intended for persons with dementia. Using off-the-shelf technologies such as a smartphone it is possible to effectively record and log a person's daily activates such as places visited and persons interacted with. We developed a reminiscence tool that visualizes life-logging data. The system was evaluated with six healthy participants aged between 24-46 years of age. They recorded approximately 2.5 hours of life-logging data that was later loaded into the developed tool. During the subsequent evaluation, the participant's gaze was tracked using eye-tracking hardware. Results show that the tool was easy to use and navigate through, facilitating the objective identification of events that may be useful for reminiscence.**

Keywords—Smartphone, Life-logging, Dementia, Social Interactions, User Interaction, Reminiscence.

I. INTRODUCTION

The world's population currently exceeds seven billion people [1] and with life expectancy expected to increase sharply in the next 30 years this inevitably means that age related impairments, both physical and cognitive are also likely to increase [2]. Such impairments can range from reduced dexterity, diminished hearing and vision to increased prevalence of chronic diseases. Within the next 10 years, it is predicted that the number of older persons, aged over 65, will outnumber the number of persons aged less than five-years old [3]. As a result, an increasing social and economic burden will be placed on healthcare systems [4].

There are many complications associated with increased prevalence of chronic disease with 75% of older persons having at least one chronic disease and 50% having at least two long term conditions [5]. The most common of these chronic diseases are dementia, cancer, diabetes, chronic heart disease and stroke. Worldwide, dementia has an estimated 35 million sufferers [3] with this number is expected to increase within the next 20 years to approximately 65 million people [6].

In this paper we present one component of an assistive technology, designated as R^3S (Real-time social Reminder and Reminiscence System), a bespoke tool harnesses mobile and wearable technologies to address the unmet needs of Persons with Dementia (PwD), specifically relating to *personalized information*, *social contact* and *perceived safety*. This work aims to answer the following research question: "which features/information, such as image, location, contact and time of day, recorded during life-logging are best suited for reminiscence services?".

II. BACKGROUND

Dementia is an 'umbrella' term that describes a number of neurological diseases and conditions that results in reduced cognitive function [7]. Lauriks *et al.* state that there are a number of unmet needs associated with PwD. These include [8]:

- the need for providing personalized information (e.g. appointments, medication reminders etc.);

- the need for support with regards to the symptoms of dementia. Support to enhance participation and supervision/guidance;

- the need for maintaining social contact and company;

- the need for monitoring to promote or maintain health and safety.

In the following Sections related research associated with reminiscence and visualization of life-logging data is presented, the proposed tool's technological components are described and the results of a user evaluation with six participants are presented.

III. RELATED WORK

The American Psychological Association defines reminiscence therapy as *"the use of life histories - written, oral, or both - to improve psychological well-being"* [4]. The

use of technological reminiscence aids has been shown to provide a natural conversation experience by reducing the pressure on caregivers to continually prompt the PwD [9].

Doherty *et al.* used the Microsoft SenseCam [10] to record life-logging information and segmented the daily data, approximately 2000 images, into more meaningful events within the context of a day [11]. They developed a 'SenseCam Browser' to allow users to review these segmented daily events. Users were able to annotate the segmented events with free text in order to personalize them. The developed browsers were evaluated with 9 participants. The solutions developed were not specifically designed though for reminiscence with PwD.

CIRCA (Computer Interactive Reminiscence and Conversation Aid) [12] was developed to assist PwDs with memory and reminiscence. Users are able to select, via a touchscreen PC, relevant video and music files. It was noted that the system prompted recall of memories and stimulated users who usually reacted poorly to other reminiscence aids to be more alert. It was reported that the users enjoyed physically interacting with the hardware.

Using three devices, voice recorder, GPS recorder and SenseCam [10], Lee *et al.* [13] collected life-logging data for persons with episodic memory impairment. A reminiscence system was developed that created a narrative of the life-logged data for daily events.

This work aims to evaluate one component of an overall life-logging and reminiscence system, and identify the most useful components of a reminiscence tool.

IV. PROTOTYPE

As part of the bespoke R^{3}S system (Figure 1) developed within this research, the reminiscence tool allows the data collected by the *miLifeCam* [14] component to be visualized in a more user friendly manner, by being presented on a larger screen with simple navigation and interaction modalities.
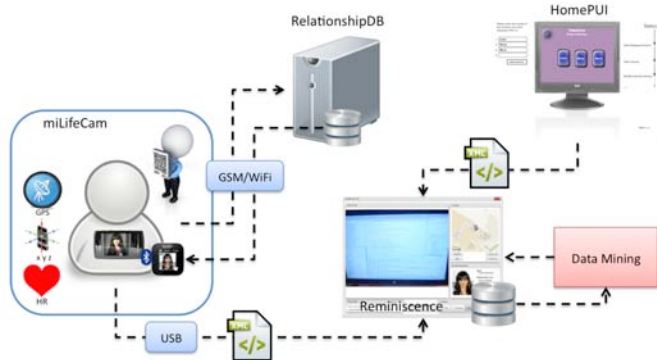
Figure 1. Architecture of the R^{3}S System detailing the information flow from the wearable life-logger (*miLifeCam*) to the database (relationshipDB) containing all social contact information..

The reminiscence tool was developed using ActionScript and can be deployed across all major Operating Systems using the Adobe AIR framework [15]. When the user has completed their life-logging they can connect the *miLifeCam* component (smartphone) via USB to their home computer and the information will automatically be transferred from the smartphone to the PC. This will also free storage space on the smartphone. When the application has successfully transferred all of the image data along with the metadata, such as GPS location, timestamp, accelerometer data and social interaction data, the user is presented with the screen shown in Figure 2. Each day's recording is automatically separated into events to be displayed in the reminiscence tool. The reminiscence software can be personalised in terms of its look and feel by using the HomePUI (Personalised User Interface) tool [14].
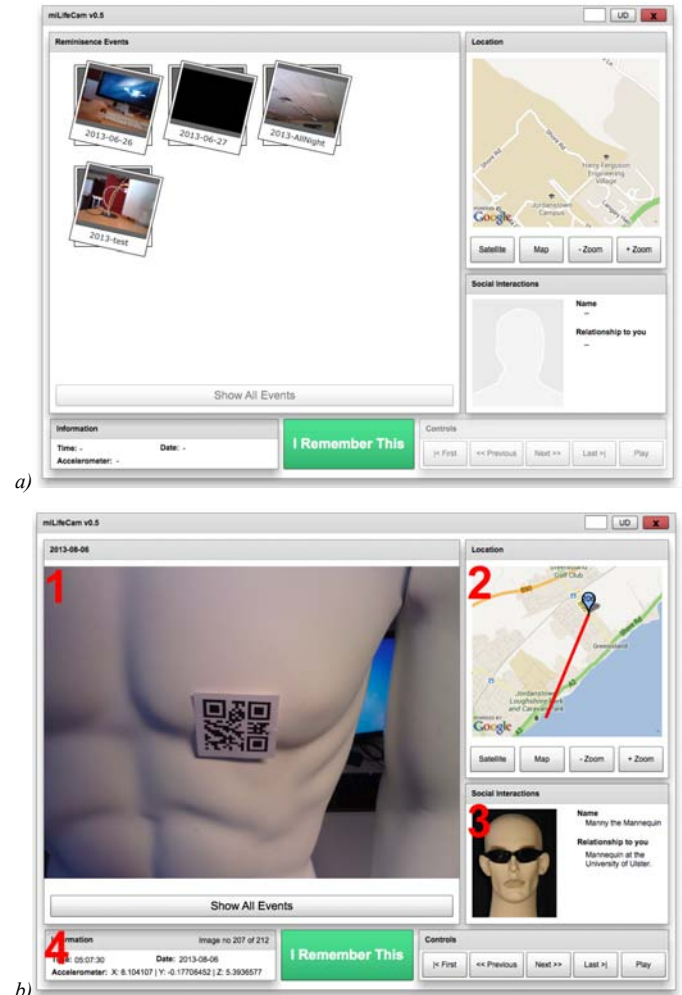
Figure 2. Screenshots of the reminiscence software developed to review the recorded data from the *miLifeCam*. This figure shows *a)* the homescreen with a visual representation of all of the recorded events and *b)* the recorded image data of a selected event (1) with the location of the image on an interactive map (2), social interactions information, identified by *miLifeCam* using QR codes (3), accelerometer and time/data information (4).

The user interface was optimized to be used primarily by older users who have little to no previous technical expertise, either with a mouse or using a touchscreen device, with all interaction buttons being more than adequate to cope with both interaction methods. The number of possible interactions on screen is kept to a minimum. The user can select an event to review, navigate through the data images either one at a time, skip to the first or last image in the event or play all of the images sequentially with a one second delay. If there is

something concerning the image that the user is looking at which promotes a feeling of reminiscence they can press the *'I Remember This'* button, which will flag that particular image.

V. TECHNICAL EVALUATION

In order to evaluate the reminiscence component of the R^3S system, specifically its user interface, each participant first had to collect life-logging data to be viewed. This was carried out by six healthy adult participants (*3 = Male, 3 = Female*), aged between 24-46 years of age all with above average experience with computing technologies. Each participant wore the *miLifeCam* system for approximately 2.5 hours and collected on average 313 images with metadata in the form of an XML file.

Following the completion of the data-recording phase using *miLifeCam* the participants were asked to upload their recorded data onto the reminiscence tool. During this phase, the participant's eyes were tracked using the Tobii Eye Tracking system [16] and each interaction with the software, such as button presses and timestamps were stored in an SQLite database. The participants were asked to navigate through their data in whatever manner they preferred, either going through each images individually or playing through them sequentially at one image every second. Participants were asked to press the *'I Remember This'* button if there were any specific images presented that sparked some form of reminiscence or emotion. This would in turn flag that image in the SQLite database for future analysis.

Upon completion of the review phase using the reminiscence tool, the participants were asked to complete a short questionnaire relating to the usability of the developed solution. In the following Section the qualitative feedback from the questionnaire data coupled with data obtained using the Eye Tracking system is presented.

VI. RESULTS

In this Section the results of the evaluation are broken down into three sub-Sections and presented. Section *A* details the results of the questionnaires relating to the usability of the reminiscence tool; Section *B* presents the results of the Eye Tracking component of the evaluation; Section *C* presents the additional free text feedback provided by participants.

A. Questionnaires

As part of the post-evaluation questionnaire, the participants were asked to answer some questions relating to the usability of the reminiscence tool. Participants rated the usability of the reminiscence tool to be '*Easy to Use*' (*n=5*) with one rating the tool to be '*Very Easy to Use'*. All participants felt comfortable using the tool ranging from comfortable (*n=2*) to very comfortable (*n=4*).

Participants were also asked what they deemed the most important piece of information displayed on the reminiscence tool's interface. Five participants thought the recorded images were the most important information onscreen with one participant saying they thought the controls were most important.

B. Eye Tracking

In order to ascertain the areas of the interface that obtained the most hits (the number of time the participants eyes entered that area of the screen), the interface was divided into several AoI (Areas of Interest). These are: *Controls*, *Images*, *Information*, *Map*, *Reminiscence* and *Social* and are shown in Figure 3.
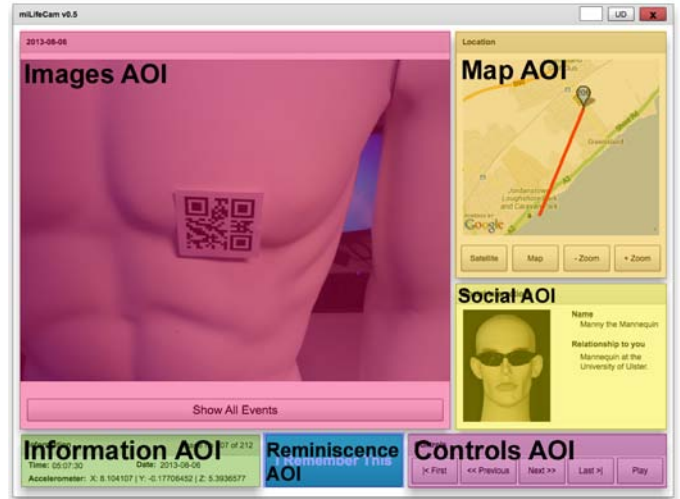

Figure 3. Screenshot of reminiscence tool's interface with areas of interest highlighted. Including, (Clockwise from top-left), Images, Map, Social, Controls, Reminiscence and Information.

It is not surprising that the most visited AoI detected for all participants was the *'Images'* area. The average time in seconds each participant's eyes were in the AoI related to *'Images'* was 319.68 seconds. The mean total duration visit (in seconds) of each participant's AoIs are shown in Table 1.

TABLE 1. PARTICIPANTS MEAN TOTAL VISIT DURATION IN SECONDS FOR EACH AREA OF INTEREST DURING THE REMINISCENCE TOOL'S EVALUATION.

p#	Controls (s)	Images (s)	Information (s)	Map (s)	Reminiscence (s)	Social (s)
1	20.07	340.22	2.68	3.60	20.98	5.15
2	9.51	272.14	8.83	3.66	8.96	8.89
3	3.63	396.23	3.86	40.17	5.40	3.76
4	8.09	291.37	23.27	29.48	2.18	5.60
5	4.40	326.31	57.77	23.15	15.76	3.91
6	2.96	291.82	9.86	12.19	16.92	5.50
Avg	8.11	319.68	17.71	18.70	11.7	5.46

The second and third most viewed AoI were the *Map* and *Information* areas respectively. While the Social Interaction AoI is important for the user, the limited number of interactions during the evaluation meant that this AoI was rarely updated and as such, did not attract the user's attention.

C. Additional Feedback

Participants were given the opportunity to provide any additional feedback on the reminiscence tool. The main outcome of this feedback was that the participant's felt that the images, when played sequentially, changed too quickly and

they would like the ability to change the speed in which the images changed. Male 34 *"Control the speed at which images appear."* Another comment was that the participants would like the ability to jump to a specific image and not just the first or last image. Male 32 *"...good to be able to goto frame/time in day or go to interaction with 'person'."*

VII. OBSERVATIONS AND CONCLUSIONS

During the evaluation it was noted by the researcher that some of the images recorded consisted of the participants eating food. While these image types may not be of great importance to the PwD the ability for a caregiver to know that their loved one had, in fact eaten lunch/dinner etc. can be considered as being highly relevant. This is something that is often overlooked by PwD. Based on this observation in addition to the short time between recording and reviewing, it may be useful to target the reminiscence tool for use primarily by caregivers. This would provide the PwD with an element of independent living and offer peace-of-mind to caregivers who in turn know where the PwD went, when, who they met, what they did and for how long.

In this paper we have presented the design and evaluation of a reminiscence tool for the visualization of life-logged data captured by six healthy participants. Results show that the system is easy to use and reveal the recorded images and location of image on a map as the two most important features for use with reminiscence software; this corresponds with other desired features for life logging [17]. Nevertheless, a limitation to this study was the lack of PwD participants and as such may yield different results.

Due to the large number of images recorded during the life-logging stage and the small number of brief interactions, the frequency in which the 'Social' area of the screen was updated was minimal. This may have resulted in the 'Social' AoI receiving significantly fewer gazes during the evaluation.

Based on the data collected and the feedback from the evaluation, the reminiscence tool may be better served as a 'Daily Review' tool for use, primarily with caregivers of PwD.

Following this technical evaluation, future work will consist of the same evaluation protocol, however, with a target cohort of users over the age of 55 years of age. The use of cognitively intact older people in the evaluation of technologies for PwD has been previously investigated [18].

An additional evaluation will be undertaken to assess the system's usability and perceived usefulness with caregivers of PwD as the ability to review, and have a record of, a PwDs activities throughout the day may offer additional peace of mind.

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