MemoryLane: Reminiscence for Older Adults

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ABSTRACT

Reminiscence plays an important role in the lives of older adults [8]. Many perfect the art of storytelling and enjoy its social benefits. The telling of stories of past events and experiences defines family identities and is an integral part of most cultures. Losing the ability to recollect past memories is not only disadvantageous, but can prove quite detrimental, especially to many older adults. In this paper we introduce MemoryLane, a Personal Digital Assistant (PDA) based application being developed to enhance the reminiscence capabilities of older adults. Using *abilities* and *preferences* as a basis, MemoryLane employs Artificial Intelligence (AI) techniques to adapt its multimodal interface to accommodate the needs of differing older users and to compose and recount user life-cached multimedia as *memory stories*.

Categories and Subject Descriptors

I.2 **[Artificial Intelligence**]: I.2.1 Applications and Expert Systems.

General Terms

Algorithms, Measurement, Design, Human Factors.

Keywords

Artificial Intelligence, MemoryLane, Multimodal, Older Users, Reminiscence, Storytelling, Usability.

1. INTRODUCTION

The population count of older people is steadily increasing, especially in the more economically developed countries of the world. In Ireland the census of 2006 recorded an increase over the previous ten years in excess of 54,000 in the number of persons aged 65 years and over [4]. Cognitive decline is an inherent part of the natural ageing process ensuring that the number of cases increases steadily as the older population grows. This varies among individuals, affecting abilities such as memory and planning, and often impeding reminiscence. Assistive technologies exist which support older adults with memory impairment and act as reminder systems that often liaise with carers [25]. Research is being conducted into developing systems which dynamically generate interfaces which adapt to a user's preferences or situations [19]. However, in addition to developing memory prompts for current activities it is of equal importance to support such older adults in their pursuit of reminiscence. This research describes the use of Artificial Intelligence (AI) techniques which, based on user *abilities* and *preferences*, will (a) govern how a mobile application adapts its multimodal interface to accommodate older users' differing abilities, and (b) compose and recount user life-cached multimedia as *memory stories*. A Personal Digital Assistant (PDA) based application, MemoryLane, is being developed as a test-bed platform to implement these techniques. The research will address any HCI and usability problems encountered, and will enhance the reminiscence capabilities of older adults.

2. LITERATURE REVIEW

There are several bodies of literature which relate to this research: reminiscence, HCI for older adults and usability studies and the measurement instruments employed in user evaluations and testing. In this section we briefly discuss relevant key literature.

2.1 Reminiscence

Research is being conducted into various aspects of reminiscence. Chaudhury [5] explores the reminiscence of personally meaningful past places among both cognitively intact and impaired residents of nursing homes, advocating that place-based reminiscence is a viable means of recollecting a rich narrative of lived experiences and is an opportunity to enhance the quality of life of older adults. Butler [2] first coined the phrase *life review* and suggested that all people coming near to the end of their lives, and therefore older adults in particular, become involved in a process of looking back over their lives in an attempt to identify and come to terms with events which are unresolved at the time. 'Life review' is a psychological preparation for death and forms part of the natural process of human development as a person becomes older. Reminiscing is then the means by which the material for 'life review' is generated [17].

2.2 HCI for Older Adults & Usability Studies

Developing technologies for older adults is an exacting science, often varying from established HCI research processes. Zajicek [24] identifies certain areas in which this type of research differs significantly from other research disciplines. The requirements of older users are habitually disparate and researchers increasingly strive to find new methods of designing in this field. Newell and Gregor [16] developed their User Sensitive Inclusive Design (USID) methodology which focuses on universal usability. Myriad HCI usability studies are conducted into older adults' interaction with computers, but substantially less are conducted into the interaction between older adults and mobile devices. Avid researchers [9] within the area have highlighted the benefits of developing mobile technologies for older adults. An initial PDA usability study conducted by Siek et al. [20] examined the differences in the interaction patterns of older and younger users with PDAs.

2.3 Measurement Instruments

Many research tools, metrics, instruments and scales have been developed in an attempt to measure the intangible emotions, feelings, opinions and well-being of older adults.

2.3.1 Measuring Reminiscence & Social Well-Being

Haight [10] developed Life Review and Experiencing Forms (LREF) to measure life satisfaction and psychological well-being. Webster [23] devised and validated a Reminiscence Functions Scale (RFS), a 43 item questionnaire to assess the functions of reminiscence among older adults. Webster distributed the 43 questions across seven factors: Boredom Reduction, Death Preparation, Identity/Problem Solving, Conversation, Intimacy Maintenance, Bitterness Revival and Teach/Inform. This scale has since been widely used in reminiscence research [3]. Havighurst and Glasser [11] applied a scoring method to the questionnaires used in their exploratory study of reminiscence. The results from this study formed the basis for their *scales* for Frequency and for Affect, which can be used in correlation studies. Osada and Osada [18] adapted Havighurst and Glasser's scales for their own research and devised a reminiscence scale consisting of 8 questions. Lawton spearheaded the development of geriatric assessment tools used widely by clinicians and researchers. These include the PGC Morale Scale [13] and the Observed Emotion Rating Scale [14]. Ando and Shiihara [1] used both Havighurst's and Glasser's scales and Lawton's Morale Scale in their reminiscence study.

2.3.2 Measuring Technology Acceptance

Since its inception in 1986, Davis' [6] Technology Acceptance Model (TAM) has been widely used as a theoretical model in behavioural psychology. Simply put, TAM states that the 'perceived usefulness' and the 'perceived ease of use' determine the behavioural intention to use a system, and this behavioural intention predicts the actual use. Lee et al. [15] examined TAM's accomplishments and limitations in a study which traces its history, investigates its findings, and predicts its future trajectory. Venkatesh et al. [22] examined all existing models and presented a new model, the Unified Theory of Acceptance and Use of Technology (UTAUT) which includes demographic factors previously omitted in other models such as age and gender.

2.3.3 Measuring Enjoyment

Heerink et al. [12] explore the concept of enjoyment as a possible factor in influencing acceptance of robotic technology by older adults. The findings of the study were in accordance with the assumptions made in the TAM. Sweetser and Wyeth [21] developed a rigorous scale to assess user enjoyment of e-learning games. They drew various heuristics together to form a concise model of enjoyment in games that is structured by *Flow*, a widely accepted model of enjoyment. Fu et al. [7] based their work on Sweetser's and Wyeth's framework and developed a newer scale. The scales are recognised as effective tools for evaluating the level of enjoyment provided by e-learning games to their users.

3. REQUIREMENTS ANALYSIS

Two ethnographical studies were conducted to elicit requirements to assist in the design and implementation of MemoryLane. Due to the known benefits of reminiscence among older adults [8], the objective of MemoryLane is to assist older adults in recalling their own past life events and memories as they experience the natural cognitive declines associated with the ageing process. MemoryLane uses AI techniques to dynamically produce an adaptive multimodal interface and to construct memory stories based on users' abilities and preferences.

3.1 PDA Usability Study

The first study conducted with a sample of 15 participants aged 65+ investigated current PDA usability levels among older adults. Each participant was interviewed in familiar surroundings in a one-to-one structured interview format. Questionnaires were employed to record the participants' opinions of and preferences for different colours, sizes and number of interface components. Participants were given a demonstration of how to interact with a PDA by a researcher, followed by observation of their capability in attempting to complete pre-set interactive PDA tasks as depicted in Figure 1.

Figure 1. Participant interacting with PDA

While the study afforded a rich insight into the preferred sizes and colours of on-screen buttons and text, it became clear from the outset that the participants found the PDA extremely complicated to use and had difficulty even knowing where to start with no one finding the interface instinctive or intuitive. This was evidenced by the level of assistance requested and given. Despite the functionality of a PDA being demonstrated beforehand, not one of the participants could carry out even the most basic of tasks unaided, participants all referred to 'not knowing what to do next', and many frequently objected to cluttered screens and complex menu structures. In addition to this, participants who had poorer levels of vision or dexterity often complained of cumbersome scroll bars and impracticable text and button sizes. However, the potential and portability of a PDA appealed to the majority of participants who remarked on it being 'small enough' to fit into a

handbag or breast pocket. However, most referred to being 'too old to learn how to use one now'. This would imply that many older adults possess a genuine interest in engaging with mobile technologies and that a PDA has a certain appeal. However, due to complex interfaces many choose not to experiment with such devices. These findings suggest that adopting AI approaches to both create intuitive applications which guide user navigation and which would dynamically adapt their interfaces to support varying user abilities would certainly provide older users with a more fruitful PDA interaction experience.

3.2 Reminiscence Workshops

The second study was designed to investigate the reminiscence capabilities, patterns and preferences of older adults. The findings from this study influenced the choice of *reminiscence topics* selected for MemoryLane to ensure that it produces topical and pleasing memories for users. Informal focus groups were conducted with older adult samples which examined both episodic/autobiographical[1] and procedural[2] memories and elicited valuable oral histories. We examined how older adults recalled their past experiences singularly in isolation, socially in groups of their peers and also with younger people, such as family members. Reminiscence discussion was initially conducted without the aid of props to investigate participants' powers of (un-aided) recollection of past events. This *independent* discourse was followed by further reminiscence sessions during which users were encouraged to consider various cultural probes, e.g., artefacts, photographs, newspapers. and a specially compiled *Memory Scrapbook* as pictured in Figure 2 to investigate if this improved their reminiscence experience.

Figure 2. Memory prompts

Participants found the sessions both stimulating and enjoyable, and all agreed that their powers of reminiscence were richly enhanced, many evoking long-forgotten histories, when using the memory prompts. This provided a strong argument for the popularity and usefulness of developing MemoryLane as a portable memory companion. The results of the study found that in the main, genders frequently wished to reminisce and discuss similar *gender specific* topics. However, there were some topics which seemed to be of universal interest to both genders. The more popular reminiscence topics are listed in Table 1. These results inspire the category options from which the user can select the topic for a memory story.

[1] Personalised memories of events, times, places and associated emotions.

[2] Long term 'how to' memory of skills and procedures.

Table 1. Reminiscence preferences by gender

Female	Male	Both
Parents/Siblings	Work/Farming	Own Childhood
Own Children	Travel	Marriage/Spouses
Women's Role	Cars/Vehicles	Tradition/Hobbies
Housekeeping	Animals/Pets	Culture/Heritage
Handicrafts	Jokes/Humour	Remedies/Cures
Music/Dancing	Local History	Religion/Faith

3.3 Methodology

MemoryLane design follows the USID methodology [16] and is underpinned by the findings of the two previously discussed ethnographic field studies. The development process is iterative in nature, requiring repeated evaluations with older adult samples.

4. MEMORYLANE ARCHITECTURE

MemoryLane is a hybrid system which incorporates the AI techniques of Case-Based Reasoning (CBR) and Rule-Based Reasoning (RBR) for decision making, generation of data and also to address the usability problems encountered by older adults when using mobile devices. The data flow of MemoryLane's architecture is given in Figure 3. User abilities and preferences are input to the system to form a unique user profile and the information stored in this profile is consulted for all future decision making for the duration of that user's interaction. MemoryLane has two primary objectives: (1) multimodal interface configuration, and (2) dynamic generation of appropriate and entertaining memory stories.

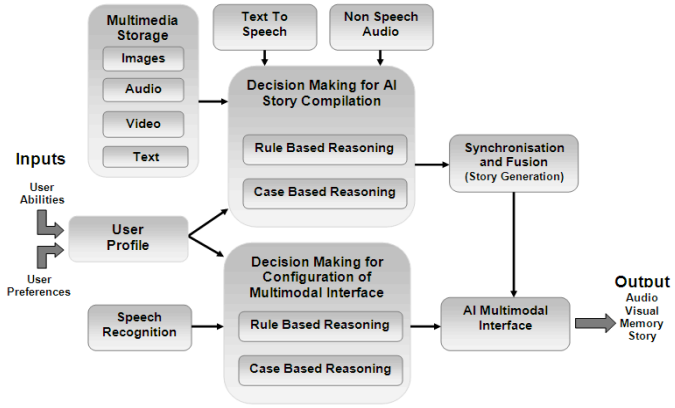

Figure 3. MemoryLane architecture

4.1 Multimodal Interface Configuration

The first intelligent aspect of MemoryLane is concerned with configuring the interface on the basis of its current user's preferences and abilities, thus tailoring to individual needs, e.g. a visually impaired user would be compensated with an audio enriched interface. To achieve this, the user is required to enter a rating for their perceived ability for four different modalities: *hearing*, *vision*, *speech* and *dexterity*. Users must rate themselves as having *normal*, *reduced* or *very poor* levels of these abilities. The four ratings entered by the user are stored as part of that

user's unique profile and are linked with the interface input and output elements. Hearing determines the volume level, speech, the usage of automatic speech recognition (ASR), vision governs the use of text to speech (TTS) and frequency and sizes of text and images. While both vision and dexterity govern the size and choices of on-screen buttons and menus available to that user. As seen in Table 2, there are three possible categories (*default*, *enhanced* and *superior*) for each modality. Each of these categories has a pre-set interface specification. In this way the interface can be adapted to suit the varied needs of older adults. For example, a user profile purporting normal hearing, very poor vision, normal speech with reduced dexterity as shown in the shaded cells of Table 2, would be provided with a tailored interface that would accommodate his/her needs. The default hearing specification would provide a default volume level for all audio and TTS, the default speech specification would involve default levels of ASR. The superior vision specification would ensure that TTS would relay all on-screen prompts aloud and display all on-screen text, images at the maximum size. However, in this instance, because vision was rated as very poor, the enhanced dexterity specification would be upgraded to superior, thus ensuring that all on-screen buttons and menus were of an appropriate size. All system default levels are based on the results of the prior PDA requirements analysis.

Table 2. Interface formatting

User Modality Weighting	Multimodal Formatting			
	Hearing	**Vision**	**Speech**	**Dexterity**
Normal	Default	Default	Default	Default
Reduced	Enhanced	Enhanced	Enhanced	Enhanced
Very Poor	Superior	Superior	Superior	Superior

4.2 AI Memory Story Generation

The second intelligent aspect of the system is concerned with intelligently generating dynamic 'memory stories'. The user's life-cached multimedia items provide story content and are output in accordance with the user's preferences and abilities. The system offers the user a choice of categories such as family, holidays, weddings or history from which they can select the topic for the new memory story. Once a selection is made, the system locates all stored multimedia objects which are tagged as (a) belonging to that user, and (b) belonging to the chosen category. Appropriate multimedia items, based on the likes and dislikes of the user, are selected from this pool for inclusion in the memory story. This multimedia, including TTS and non-speech audio if deemed applicable, are synchronized and fused into a memory story for simultaneous output through multithreading.

5. MEMORYLANE IMPLEMENTATION

MemoryLane is deployed on a PDA which equips users with the ability to re-live bygone days, and the portability to relay them to others. MemoryLane operates across a Client/Server architecture on a bespoke local area network (LAN) as seen in Figure 4. The user's client PDA stores the multimedia items and hosts the MemoryLane application. This application connects to a hosting server which provides system functionality through the public and private web methods of a web service. The server also hosts a back end database which stores user profiles and system information and the web service facilitates interrogation of this database. A speech engine also located on the server provides a TTS facility for the production of speech synthesis from string variables. This supports multimodal interaction in the utterances of on-screen prompts to assist the user if required and in the conveyance of stories. To further enhance multimodal user interaction MemoryLane will also incorporate ASR. MemoryLane may be deployed using the Internet for communication at a later phase. At this stage a LAN is required for user evaluations in areas which do not currently have Internet access.

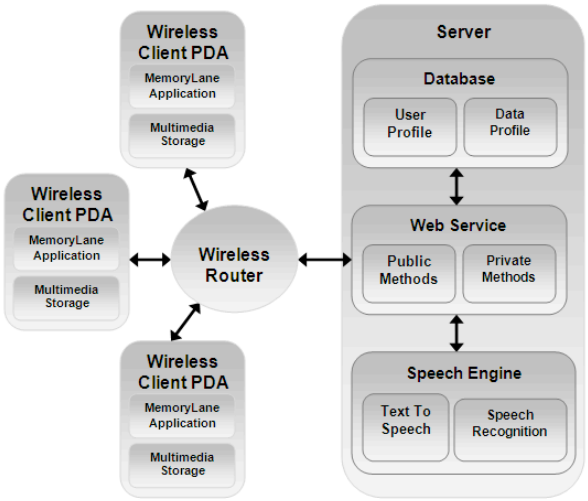

Figure 4. MemoryLane implementation

In accordance with the findings of the previously conducted pilot studies, the initial interface for MemoryLane is designed to be both intuitive and instinctive to the user while also being of visual appeal. The layout is consistent, deliberately plain, avoiding scroll bars or ambiguous clutter. The default colour scheme is of neutral tones. The interface has minimal screen objects at any one time and yet provides full functionality. The sizes of the screen objects (e.g. buttons or text) are decided by MemoryLane to suit the needs and preferences of the user. Iterative evaluations of MemoryLane with target user groups will improve and enhance this initial prototype.

5.1 Log-in Screen

The user is greeted with a welcome screen as shown in Figure 5(a). To log-in the user must select (press) their photo from a set of photos of six potential users. MemoryLane then establishes which user has logged on and immediately retrieves the stored profile for that user. The interface is then adjusted to reflect the profile details, tailoring it to the abilities and preferences of that user. The user's image is displayed in the top left of the screen throughout the duration of their interaction and personalised messages are displayed. The logged on user proceeds to either view memories or edit their profile. A *Help* button is continuously available in the bottom right of the screen and explains any ambiguities with on-screen text, and speech if deemed applicable. The user can exit MemoryLane at any time via the *Exit* button in the bottom left of the screen. This button is replaced by a *Go Back* button positioned in the same location on all subsequent screens which provides the user with a means of navigating through MemoryLane and return to the Exit button to leave.

(a) (b)

Figure 5. (a) 'Log-in' screen, (b) 'Change profile' screen

5.2 Change Profile Option

In Figure 5(b), we can see that 'Nellie' has logged and has chosen the *Change Profile* option. She is now presented with the choice of editing her *preferences* or *abilities* held in her recorded profile. The preferences option facilitates control over certain interface options such as choosing a preferred colour scheme or skin for the interface, or perhaps opting for the use of icons and symbols instead of text. The abilities option allows the user to change the level recorded for their hearing, vision, speech and dexterity, as previously discussed in section 4.1., the user can select from normal, reduced or very poor for each ability. Changing the level for an ability will instantly be reflected in the multimodal interface, e.g., increased or decreased font size, button size, volume levels or amounts of ASR and on-screen text read aloud to the user.

5.3 Start Option

The user begins the reminiscence experience and is offered the option of viewing a previously seen and saved memory story from the stored *album*, or creating a new memory story using combinations of their stored multimedia, e.g., photographs, video clips, music, sounds, letters or poems. If the user chooses to view a memory from the album, they are presented with a selection of thumbnail images where each image represents a stored memory in the album. Selecting (pressing) an image causes it to be played in full. The *new memory* option allows the user to select a topic for the new memory story as seen in Figure 6(a) and previously discussed in section 4.2. The user can then view the ensuing memory story via the bespoke user interface as shown in Figure 6(b). Memory stories last anywhere between one and three minutes, during which the user has the options to pause, stop or replay the memory, and to also maximise the viewing screen if desired. The options to rate a memory story and save to the album are offered after each showing. An example memory story might simultaneously include background music, a series of rotating photographs and a voice over narration.

(a) (b)

Figure 6. (a) 'Memory topic' screen, (b) 'Play memory' screen

5.4 MemoryLane Intelligence

MemoryLane will learn from the user during interaction and record this information as part of the user's profile. Should the user express dislike for a particular story then MemoryLane will learn to avoid this particular multimedia combination for future memory stories. Similarly if the user rates the memory story highly MemoryLane will learn that this is a popular combination of multimedia and increase further usage of these items in future memory stories. For example, a memory story may choose to exclude a particular topic which could cause discomfort, e.g., the mention of a recently deceased loved one. Similarly, MemoryLane could highlight positive events, a wedding perhaps and also devise historical stories based on known topics of interest to its user. In addition, if the user repeatedly requires help at the various stages of the interaction, MemoryLane will become pro-active and will begin to automatically offer help in problem areas for that user. MemoryLane will also record how often favourite saved memory stories were retrieved from the user's album and viewed again. As a user interacts with MemoryLane over a period of time its knowledge of that user will increase accordingly. MemoryLane can then offer more precise and accurate memory stories in a way that the user finds entertaining using interface components that the user finds easy to understand, navigate and control. The more the user interacts with MemoryLane the more it will learn from him/her.

6. CONCLUSION & FUTURE WORK

This research introduces a hybrid method of decision-making specifically for a mobile platform applying AI techniques in the development of a multimodal PDA-based application called MemoryLane. MemoryLane accommodates user-specific abilities and preferences for multimodal input and output, and also performs fusion and synchronisation of life-cached multimedia for story generation. MemoryLane provides older adults with an intelligent, portable memory device to enhance their reminiscence experiences. The MemoryLane prototype is currently being implemented and will be enhanced and improved with iterative evaluations with target user groups. The final prototype will be rigorously tested with a fresh sample of end users. This will eliminate the possibility of any prior knowledge of, or familiarity with the system, and therefore give an accurate account of the intuitiveness of the interface and MemoryLane's usability. This final testing will also use real data (i.e., the users' own multimedia

items) to effectively measure (a) the appeal of MemoryLane (its functionality and usability) and (b) the support that it offers to older adults whilst reminiscing. Some of the measurement instruments and tools previously mentioned in section 2.3 will be employed in this testing to measure and validate the success of MemoryLane. Detailed analysis of the ensuing results will follow.

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