Demonstration of the AMPER System for Individuals with Alzheimer's Disease

Bruce W. Wilson
Heriot-Watt University
United Kingdom
bww1@hw.ac.uk

Mei Yii Lim
Heriot-Watt University
United Kingdom
m.lim@hw.ac.uk

Katerina Pappa
University of Strathclyde
United Kingdom
katerina.pappa@strath.ac.uk

Matthew Aylett
Heriot-Watt University
United Kingdom
CereProc Ltd.
United Kingdom
m.aylett@hw.ac.uk

Mario Parra Rodriguez
University of Strathclyde
United Kingdom
mario.parra-rodriguez@strath.ac.uk

Ruth S. Aylett
Heriot-Watt University
United Kingdom
r.s.aylett@hw.ac.uk

Abstract

We present a demonstration of the AMPER system: an Android application that guides individuals with Alzheimer's disease and their carers through reminiscence therapy with the use of a virtual agent. The application supports a novel method of reminiscence story selection, using material metadata, user data, and a spreading activation algorithm. This aims to present relevant material to the user, in an order that attempts to mimic a human autobiographical memory.

CCS Concepts

• **Human-centered computing** → **Interactive systems and tools**; • **Applied computing** → *Health informatics*.

Keywords

Virtual, Agent, Reminiscence, Alzheimer's, Android, Application

ACM Reference Format:
Bruce W. Wilson, Mei Yii Lim, Katerina Pappa, Matthew Aylett, Mario Parra Rodriguez, and Ruth S. Aylett. 2024. Demonstration of the AMPER System for Individuals with Alzheimer's Disease. In *ACM International Conference on Intelligent Virtual Agents (IVA '24), September 16–19, 2024, GLASGOW, United Kingdom.* ACM, New York, NY, USA, 3 pages. https://doi.org/10.1145/3652988.3696201

1 Overview

This demonstration shows the AMPER (Agent-based Memory Prosthesis to Encourage Reminiscence) system, which makes use of an intelligent virtual agent (IVA) to support reminiscence between a user living with Alzheimer's Disease (AD) and their carer, by linking stories based on theories of autobiographical memory [13].

The interaction begins with our IVA greeting the user and asking for basic user details. In the background, the application then selects the most appropriate collection of pictures, audios, or videos (henceforth collections are referred to as 'stories', and pictures, audios, and videos as 'material') from the re-categorised BBCRemArc [1] database, and displays a maximum of three stories for the user to select and reminisce with their carer, as shown in Figure 1. Selecting a story then displays material from the story, while the IVA narrates it. The IVA then asks a prompting question with each piece of material, encouraging reminiscence between the user and carer. Finally after reminiscing the available stories, the user and carer are asked for feedback by the IVA, which will be used to adapt the stories and material shown in subsequent interactions.

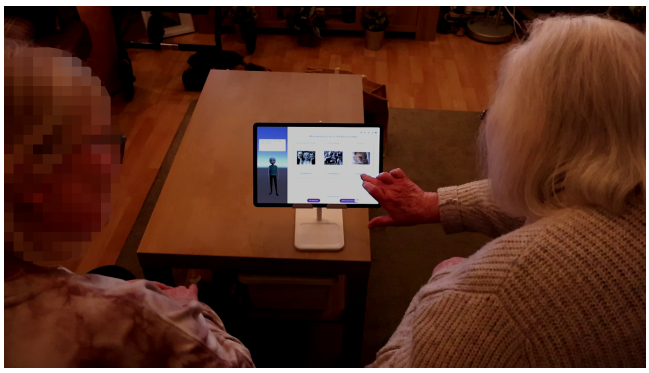

Figure 1: A healthy older adult and family member interacting with the AMPER app.

2 Background

The AMPER application aims to encourage reminiscence, an act that is more than simply regurgitating facts from the past, but encompasses emotion, selection, association, reconstruction, and adaptation to context [5, 7]. As a form of therapy for individuals living with AD, it aims to reinforce remaining cognitive capabilities, build positive social experiences, and improve quality of life [16]. While usually run in group settings, AMPER presents an opportunity for individuals with Alzheimer's and their carer to engage in one-on-one reminiscence therapy, guided by our IVA.

[1] https://remarc.bbcrewind.co.uk/

IVA '24, September 16–19, 2024, GLASGOW, United Kingdom

ACM ISBN 979-8-4007-0625-7/24/09
https://doi.org/10.1145/3652988.3696201

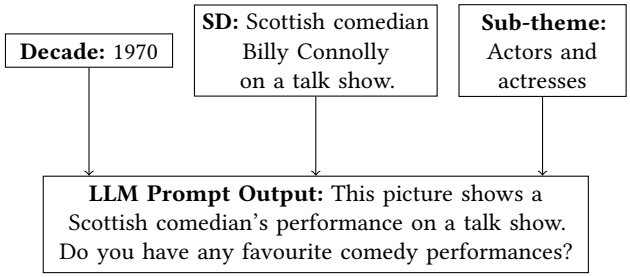

Figure 2: Diagram showing input decade, Semantic Description (SD), and sub-theme, and output from the LLM.

As the IVA is interacting with this vulnerable user group, it aims to be supportive and engaging, which is an important challenge when designing applications to support people living with dementia [1, 12]. Previous work shows that including an IVA as part of a user interface can offer increased functionality [10], make technology more accessible [6], and increase user satisfaction [15].

3 Technical Overview

The AMPER system runs as an Android application on a modern large-screen tablet. The application can be split into two parts: an activity which flows like a regular app, with screens to display material, buttons for the user to click, and text boxes for the user to enter information; and an embedded Unity [2] activity, which renders, animates, and synthesises voice of the IVA. We use Unity as it provides a more powerful rendering and animation environment, versus what would be possible using a standard Android activity.

Pictures, video, and audio (referred to as 'material') presented in the application are stored in a Room database[3], and are used with permission from the BBCRemArc database[4]. Metadata is provided alongside the material, which includes a semantic description, decade of capture, and theme (Animals, Childhood, Events, Leisure, Music, People, Sports, or TV and Radio).

To ensure a better mapping to memory categories, each piece of material from the BBCRemArc was re-categorised into twelve sub-themes by the AMPER team under the categories proposed by Catricalà et al [8]. A balance was ensured across sub-themes, material type (picture, video, or audio), and decade.

Using the new theme categorisation alongside decade and semantic descriptions of the material from the BBCRemArc database, full descriptions and prompting question are pre-generated using a Large Language Model (LLM), as shown in Figure 2. These full descriptions, after human verification, are then verbalised by the IVA, prompting discussion between the user and carer.

3.1 Virtual Agent

Users will be presented with a choice of four different IVAs. This will include two male and two female characters, aimed towards our target demographics, where characters were decided through a three phase design process involving co-creation with project stakeholders and healthy older adults. Discussed in [4] and [3], selecting a graphical agent for an interface is inherently different from standard GUI design, and the choice of agent is critical to ensure the application's effectiveness.

Our IVAs are embedded in the application by wrapping a Unity application in an Android fragment. This is achieved by exporting the Unity project as an Android library, and importing the exported library into Android Studio. This import process also allows communication between the AMPER standard Android activity and the Unity activity. Data integration points are setup with a Unity script, allowing the IVA to be directed as necessary. An example of this is displayed below, where the IVA is directed to speak and display subtitles after the user has successfully logged in, and material options are displayed:

```
UnityPlayer.UnitySendMessage("Canvas",
"ShowMessage", "Hello␣Username,␣what␣would
you␣like␣to␣talk␣about␣today?")
```

Speech synthesis is performed using CereProc[5] Text-To-Speech (TTS) technology. Using their Unity cerevoice engine, a range of compact cerewave voices can be verbalised. Additional XML tags are also added into the text input, enabling emphasis and variability at required points of the narratives. Our IVAs all have similar animations, with simple gesticulations during speech, and idle animations during times of user-carer discussion. Lip syncing will also be added to the IVA by monitoring the output of visemes from the cerevoice engine, and animating the characters mouth positions.

3.2 Story Selection

To display the most relevant stories to the user, a spreading activation [2, 11] algorithm is used which takes inputs of: user age (to calculate ideal decade for reminiscence bump - teenage years and early adulthood, 15 to 30 years [9, 14]), user interests, and material metadata (e.g. decade, sub-themes). By using this algorithm, semantically similar stories are presented alongside one another, attempting to mimic a human autobiographical memory.

For study purposes, and to ensure a comparable interaction experience for all users, they are presented with a maximum of three stories per session, containing three pieces of material each, and with a minimum of two sessions on separate days per week. Additionally, the media types of materials for each story in a session are also matched.

4 Future Work

The developed application will first undergo a pilot evaluation with healthy participants to evaluate the usability of the system with our target age population. After improvements are implemented, we will run a randomised controlled trial with 40 participants from our target population, measuring the impact of our application for user-carer reminiscence therapy as a basis for future clinical trials.

Acknowledgements

Support for this research was provided by EPSRC (AMPER: award number EP/V056131/1, EP/V05564X/1). With great thanks to Lesley and Sheila for starring in our demonstration video.

[2] https://unity.com/, last accessed: 05/07/24
[3] https://developer.android.com/training/data-storage/room, last accessed: 05/07/24
[4] https://remarc.bbcrewind.co.uk/, last accessed: 02/04/2024
[5] https://www.cereproc.com/, last accessed: 02/04/2024

References

[1] Astell AJ, Bouranis N, Hoey J, Lindauer A, Mihailidis A, Nugent C, and Robillard JM. 2019. Technology and Dementia: The Future is Now. *Dement Geriatr Cogn Disord.* 47, 3 (2019), 131–139. https://doi.org/10.1159/000497800

[2] John R. Anderson. 1983. A spreading activation theory of memory. *Journal of Verbal Learning and Verbal Behavior* 22, 3 (1983), 261–295. https://doi.org/10.1016/S0022-5371(83)90201-3

[3] Matthew Peter Aylett, Mei Yii Lim, Katerina Pappa, Bruce W Wilson, Ruth Aylett, and Mario Parra. 2023. Embodied Conversational Agents: Trust, Deception and the Suspension of Disbelief. In *Proceedings of the First International Symposium on Trustworthy Autonomous Systems* (Edinburgh, United Kingdom) *(TAS '23)*. Association for Computing Machinery, New York, NY, USA, Article 46, 3 pages. https://doi.org/10.1145/3597512.3597526

[4] Matthew Peter Aylett and Marta Romeo. 2023. You Don't Need to Speak, You Need to Listen: Robot Interaction and Human-Like Turn-Taking. In *Proceedings of the 5th International Conference on Conversational User Interfaces*. 1–5.

[5] Frederic C. Bartlett and Walter Kintsch. 1995. *Remembering: A Study in Experimental and Social Psychology* (2 ed.). Cambridge University Press.

[6] Timothy Bickmore. 2022. *Health-Related Applications of Socially Interactive Agents* (1 ed.). Association for Computing Machinery, New York, NY, USA, 403–436. https://doi.org/10.1145/3563659.3563672

[7] Robert N. Butler. 1963. The Life Review: An Interpretation of Reminiscence in the Aged. *Psychiatry* 26, 1 (1963), 65–76. https://doi.org/10.1080/00332747.1963.11023339 arXiv:https://doi.org/10.1080/00332747.1963.11023339 PMID: 14017386.

[8] Benedetta Catricalà, Miriam Ledda, Marco Manca, Fabio Paternò, Carmen Santoro, and Eleonora Zedda. 2022. Biography-based Robot Games for Older Adults. In *First Workshop on Care Robots for Older Adults at the 31st IEEE International Conference on Robot & Human Interactive Communication*.

[9] M A Conway and C W Pleydell-Pearce. 2000. The construction of autobiographical memories in the self-memory system. *Psychol Rev* 107, 2 (April 2000), 261–288.

[10] Kerstin Dautenhahn. 1998. Story-telling in virtual environments. In *ECAI'98 Workshop on Intelligent Virtual Environments, Brighton, UK*. Citeseer.

[11] Mei Yii Lim, Ruth Aylett, and Wan Ching Ho. 2010. Spreading Activation – An Autobiographical Memory Retrieval Mechanism for Social Companions. In *IVA 2010*. Springer, 1117–1118.

[12] Petra Maresova, Signe Tomsone, Petre Lameski, Joana Madureira, Ana Mendes, Eftim Zdravevski, Ivan Chorbev, Vladimir Trajkovik, Moriah Ellen, and Kasper Rodile. 2018. Technological solutions for older people with Alzheimer's disease. *Current Alzheimer Research* 15, 10 (2018), 975–983.

[13] Katherine Nelson. 1993. The psychological and social origins of autobiographical memory. *Psychological science* 4, 1 (1993), 7–14.

[14] David C. Rubin and Amy E. Wenzel. 1996. One hundred years of forgetting: A quantitative description of retention. *Psychological Review* 103, 4 (1996), 734–760. https://doi.org/10.1037/0033-295X.103.4.734

[15] Dylan GM Schouten, Agnes A Deneka, Mariët Theune, Mark A Neerincx, and Anita HM Cremers. 2023. An embodied conversational agent coach to support societal participation learning by low-literate users. *Universal access in the information society* 22, 4 (2023), 1215–1241.

[16] Etsuko Tadaka and Katsuko Kanagawa. 2007. Effects of reminiscence group in elderly people with Alzheimer disease and vascular dementia in a community setting. *Geriatrics & Gerontology International* 7, 2 (2007), 167–173. https://doi.org/10.1111/j.1447-0594.2007.00381.x