Capturing and Reviewing Context in Memory Aids

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Abstract

Episodic memory impairments are common symptoms of many cognitive disorders including Alzheimer's disease. A cognitive memory aid using a passive, automatic context capture approach has great potential for compensating for episodic memory impairment. In this paper, we describe how such an approach can help a memory-impaired individual remember or generate a more complete account of past actions and require less direct user input.

Keywords

Memory aid, capture and access, Alzheimer's disease, context-aware, assistive technology, passive capture

ACM Classification Keywords

K.4.2 [Computers Milieux]: Social Issues – Assistive technologies for persons with disabilities.

Introduction

People with Alzheimer's disease suffer from impairments in episodic memory. They have difficulty remembering the details of their daily actions and often rely on outside memory aids such as a notebook, diary or caregiver to help them maintain an account of their actions. Technological memory aids such as NeuroPage [1], MEMOS [2], and OrientingTool [3] have been

developed to help people with compensating for prospective memory (the user's mental to-do list) by providing context-aware reminders.

However, reminder-based memory aids have two drawbacks. First, they necessitate explicit user interaction to set up and respond to reminders, which can be an obstacle to adoption by people who may be in denial of their acquired memory limitations. Especially in the early stages of Alzheimer's, people often are in denial of their condition as evidenced by cases of concealment and confabulation. Second, reminder-based memory aids only support prospective memory and cannot provide the user with accounts of unplanned or unscheduled activities. The challenge is thus to develop a memory aid system that can give the user a more complete awareness of their past actions without the need for explicit user input.

Passive Capture and Review

One such system is a passive memory capture system is one that uses sensors to automatically capture information about the user's actions without explicit user input. The user can review the passively captured information at some convenient time (e.g. at the end of the day) and regain an awareness of their past actions. Not only will a user with memory impairment feel more grounded in reality but also he will be able to use this awareness when making decisions and planning prospective tasks. A passive memory capture and review approach has the potential to give the user a more complete awareness of past actions with minimal user input.

Passive ubiquitous capture technologies and new methods for organizing and sharing captured information are becoming more available. In the patient monitoring domain, the Elite Care organization is building new retirement homes equipped with sensors that monitor elders' daily activities and provide their caregivers with feedback about their mobility, socialization and sleeping habits.

Aimed to help catalogue life experiences, the SenseCam from Microsoft Research is a wearable camera that automatically snaps photos and builds a visual account of the user's activities. It senses light, infrared and orientation to help it determine when an interesting event (e.g. walking into a new room, change in posture, etc) is occurring and snaps a photo of it. The captured photos are uploaded to a desktop application where the user can review them to regain an awareness of their past actions. Preliminary unpublished research by Dr. Emma Berry and Dr. Narinder Kapur at Addenbrookes Hospital in Cambridge, UK found that reviewing images captured by SenseCam is effective in helping people with memory impairment stimulate and retain memories of their experiences.

Capturing Context of Memories

Capturing memories automatically is difficult for a number of reasons. It is difficult to identify what elements of the user's experience constitute a memory episode. An active capture technique would require the user to either specify a memory before it occurs to set a reminder or explicitly tell the system what information to record in real time. Instead of explicit user input, a passive capture technique can use predetermined heuristics or machine learning to make sense of the collected data by aggregating and inferring episodes of the user's experience from the low-level sensor data. However, using heuristics can make the

system brittle and difficult to adapt to new situations. Machine learning, while making the system more adaptive, has the potential to infer erroneous memory episodes from the sensor data.

One possible workaround is to defer the problem of inferring higher-level memory episodes to the user instead of relying on error-prone computer vision or machine learning algorithms. The system can simply capture an account of the user's low-level context (e.g. location, people present, sitting/standing posture, etc) and present a summary of context to the user. The user can then infer higher-level memory episodes (e.g. "I talked to Bob yesterday", "I went to the doctor last Friday", etc) from the low-level context rather than relying on the system to make the inference. The user can review the captured low-level context information to help stimulate the recall of memory episodes and increase their awareness of what they have done. For example, using Microsoft's SenseCam, a user with memory impairment can review a slideshow of raw images captured yesterday and see the hospital lobby, the patient waiting room, and the receptionist. From these images that visually describe the context of a doctor's office visit, a user can infer a higher-level memory: a visit to the doctor.

This begs the question: do people with memory impairments have the ability to recall or reconstruct higher-level memory episodes from low-level context? For people in the early stages of Alzheimer's disease, there is evidence that presenting cues for memories can help stimulate memory retrieval. People with Alzheimer's can benefit from the Encoding-Specificity principle which states that the amount of overlap of information between the cues present during encoding and the cues present during retrieval directly influences how well a particular memory associated with those cues can be remembered. In other words, if the context present during memory encoding is similar to the context available during memory retrieval, then the memory will be more easily retrieved. This strategy was found to be effective and when combined with pharmacological therapies can improve overall memory performance and even delay the disease's progression into its later stages [4]. Furthermore, memory encoding and retrieval problems experienced by people with Alzheimer's is thought to be caused by a reduced ability to access the semantic, contextual information about their memories [5]. Therefore reviewing captured contextual information can help people with Alzheimer's overcome this specific limitation and improve overall memory performance. Clinical literature shows that people with Alzheimer's can benefit from the presentation of low-level contextual cues to aid memory retrieval.

Exercising Intact Cognitive Abilities

Especially for people with impairments that are reversible or whose progression can be slowed with "exercise" of intact cognitive abilities, technology should serve to compensate for impairments while at the same require the user to exercise existing cognitive abilities.

A system using an active capture technique does all the memorizing for the user. Information about events, names, and other information that would normally be stored in the user' memory is offloaded to the system. The user can forget about that information until the system sends a reminder. Whereas offloading memories is useful for people where memorization is

impossible, it may actually lead to faster decline in individuals who can still benefit from exercising their remaining memorization abilities such as people in the early stages of Alzheimer's disease.

A system that passively captures context information about the user's actions can give the user the opportunity to use the presented context to recall or reconstruct accounts of their past actions. In this case, the system aids the user's memory system rather than substituting for it. The act of reviewing context information and thinking hard to reconstruct a mental representation of past actions can have therapeutic value by strengthening the mechanisms involved in memory and slowing the progression of degenerative diseases such as Alzheimer's.

Adoption of Passive Memory Aid

The key to facilitating the adoption of a passive memory aid is to integrate the reviewing of context information into the routine of the memory-impaired individual. While it is difficult for people with Alzheimer's to memorize new information, their ability to learn new skills and new routines is preserved since their implicit memory system is relatively spared. We plan to conduct an ethnographic study to explore the routines of people with Alzheimer's and their caregivers to gain an understanding of how technology can be used to help compensate for deficits in episodic memory. The ethnography will also help us better understand the memory compensation techniques currently employed and their attitudes towards them. The results of the ethnography will help inform the design, implementation and evaluation of a cognitive memory aid that uses a passive capture and review approach.

Conclusion

A memory aid that passively and automatically captures context information about the user's actions and makes this information available for subsequent review has the potential to help stimulate the user's memories or help them form memories based on actual experienced context. Minimizing user effort and integrating the use of the memory aid are two important factors that contribute to adoption. In contrast to a more active, user-triggered memory capture approach, a passive, automatic capture approach can help a memory impaired individual remember or generate a more complete account of past actions including unplanned actions with less user effort.

References

[1] Hersh, N. and Treadgold, L. NeuroPage: The rehabilitation of memory dysfunction by prosthetic memory and cueing. *Neuropsychological Rehabilitation 4*, 3 (1994), 187-197.

[2] Schulze, H. MEMOS: An Interactive Assistive System for Prospective Memory Deficit Compensation. *In Proc. ASSETS'2004*, ACM Press (2004), 79-85.

[3] Wu, M., Baecker, R. and Richards, B. Participatory Design of an Orientation Aid for Amnesiacs. *In Proc. CHI 2005*, ACM Press (2005), 511-520.

[4] DeVreese, L. P. and Neri, M. Memory training programs (MTPs): efficacy on objective and subjective memory functioning. *In Proc. VIII International Psychogeriatric Association*, (1997), 141-145.

[5] Martin, A. and Fedio, P. Word production and comprehension in Alzheimer's disease: The breakdown of semantic knowledge. *Brain and Language 19*, (1983), 124-141.