Designing a Map-Based Application and a Conversational Agent for Addressing Memory Problems

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Abstract. Computer based recreational activities can be solution for aging. We are addressing memory related problems using a computer. We propose "Old Photos on Map" application (Vanhat Kuvat). The aim of Vanhat Kuvat is to activate one's memory by using old photos and an assistant agent to wake up the past memories and experiences of childhood surroundings and architecture as well as personal hidden stories. We describe design issues related to user interfaces and interactions.

1 Introduction

According to the Demography Report 2010 [1], population in Europe is aging dramatically. As the result of this there will be almost one person of working age for every dependent person aged under 19 or over 65 years. The situation in Finland is even more challenging. Finland will have the oldest population in Europe, measured in terms of the old-age dependency ratio [1]. Japan is in the similar situation. According to the statistics released by the government [2], the population of elderly people accounts 25 % of entire population.

In the project called Gamified Solutions in Healthcare, Finnish and Japanese research organizations are searching together new solutions for aging. Because of challenges described above we are forced to find new options for the elderly's self-care and ease the healthcare professional's work load. We have found that the use of recreational activities is useful activation method for elderly people in many ways.

One of problems caused by aging, memory related problems can affect daily life of people crucially. Researchers have suggested interventions using reminiscence activities. On the other hand, providing patients opportunities of reminiscence along with communications needs human resources; therefore, some of researchers are pursuing computer assisted interventions [11]. Life-like entities such as virtual characters (agents) can enrich communication between a user and a computer. They can incorporate with nonverbal strategies like facial expressions and gestures.

In this paper, we introduce "Old Photos on Map" application (Vanhat Kuvat) which incorporates a conversational agent, and describe a survey in terms of agent design and usability as a fundamental base of Vanhat Kuvat. The aim of Vanhat Kuvat is to activate

one's memory by using old photos for to wake up the past memories and experiences of childhood surroundings and architecture as well as personal hidden stories. This kind of memory impulses function as a link between present and future and promote the plasticity of the brain and are seen a bridge for better health and well-being. The frame of this concept is a combination of Semir Zeki's theory of neuroaesthetic [4] and John Dewey's theory of art as experience [3] and research in practice [5, 8].

2   Related Work

Several researchers [3, 4, 6, 9] have come to the conclusion that cognitive mental activity is high important for brain health. The effectiveness of using old photos to enhance brain health has examined in the research and development project Art and culture – Keys for better Brain Health [8].

In autobiographical activities like watching and sharing experiences of old photos, exploring punctum photographs allows an emotional connection to be formed with the most significant people, places and events in our lives. Subjective sense of time refers to the ability to shift to thinking about something that has happened in the past. Memory layers and visual perception are in active motion in this phase, when narratives, photographs and maps are integrated into each other. The autobiographical memory and discussions about the old photos require complicated cooperation be-tween our cognitive and emotional processes which activate different parts of the brain [7, 10].

Social interaction has also seen a significant factor in promoting brain health. A sense of belonging to the community, a sense of participation, sharing stories and experiences and, as a result of sharing, the deepening of one's own understanding and experience are regarded as important. Brain health is a lifelong, proactive process in which the brain is molded by the stimuli in the environment. The brain feels well when the environment promotes activation and involves social interaction. From the point of view of promoting brain health, it is important that the brain is occupied with new and complex tasks throughout our lives: this way, the unused reserve of our brain may also promote brain health and delay the emergence of memory disorders [8, 9].

The effectiveness of an agent for dementia patients has been examined by researchers. For example, Yasuda et al. have used a computer agent resembles a five-year-old grandchild to intervene dementia patients [11]. They have developed a conversational agent that can give 120 reminiscent questions. Using this agent, they conducted an experiment asking a patient to have a one-to-one conversation. From the result of their experiment, they have reported that most of patients had positive. One of patients said that conversations with the agent reduce hesitation or anxiety compared to real human. In addition to this experiment, they have also investigated the effectiveness of an agent with a group of patients [12].

3   System Design

This application consists of a client-side user interface (UI), server-side components and a database. Each component is described in this section.

3.1   Overview

The UI component includes a map and related buttons. The main functions are photo icons (B: showing picture), informative time period (C: filtering photos based on this criterion), search icon (A), and agent icon (D).

These UI components include an agent (E). An agent has flows of behaviors defined in JavaScript codes and stored on the server. A part of codes and data are provided by server-side components (Fig. 1).
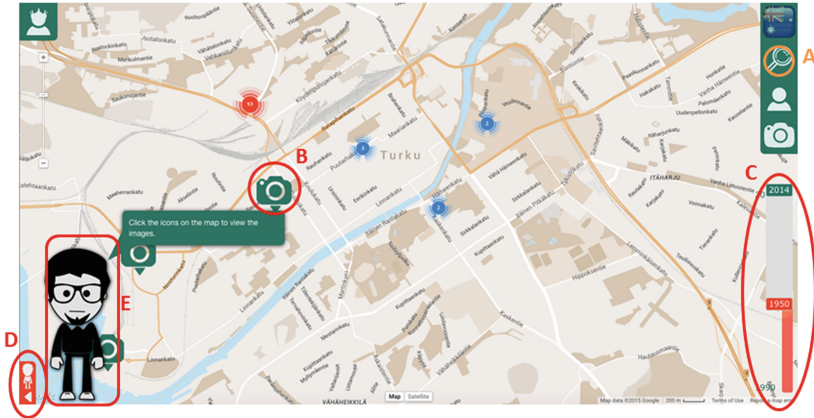

Fig. 1. System overview

3.2   Agents

In the design phase, we specified perceived personality and visual characteristics of an agent. Besides, visibility and agent interaction lead to accessibility. We formulated hypothesis that relationship between cultural differences and appearance affect the preferences of a user. Existing work suggests the effect of appearance on impression of an agent perceived by a user. Zambaka et al. have compared among agents in three different categories: humans, virtual humans and virtual nonhuman characters [13]. As a result, the persuasiveness of agents was not affected significantly by the categories. However, people tend to attracted by an agent with different gender.

An agent runs on the application has variable facial expressions and behaviors. The agent can utter words according to each location. The agent attempts to encourage patients to discuss past memories related to pictures linked to the location.

4   Survey

We have conducted a questionnaire to compare among multiple agents and interface designs with different color variations. Participants are asked to choose the most preferable ones and then we determined elements suitable for Vanhat Kuvat.

Participants are 24 Finnish people (16 males and 9 females) with ages ranging from 56–93. The age and gender were based on their self-reporting. The questionnaire was made with Webropol.[1]

Questions related to text size (Fig. 2(a)) and color scheme (Fig. 2(b)) were included to examine accessibility of user interfaces. Participants chose one of options in each question, and the combination of text size and color scheme that includes the most popular ones was adopted (Fig. 3).
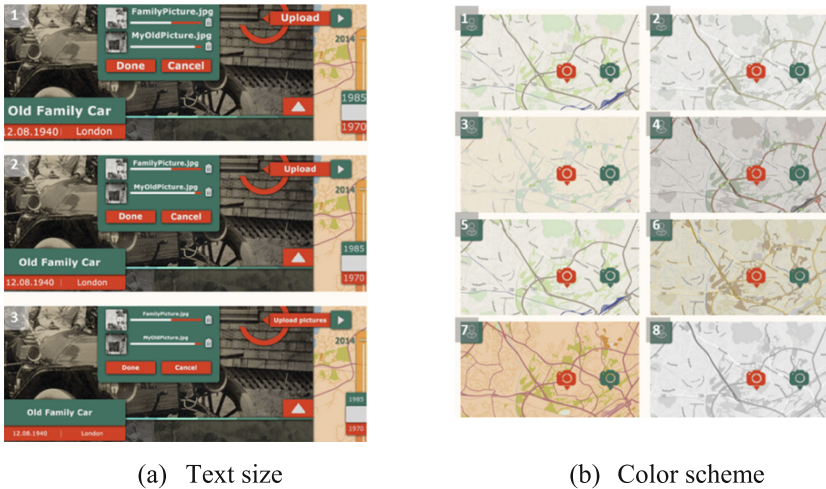

(a) Text size   (b) Color scheme

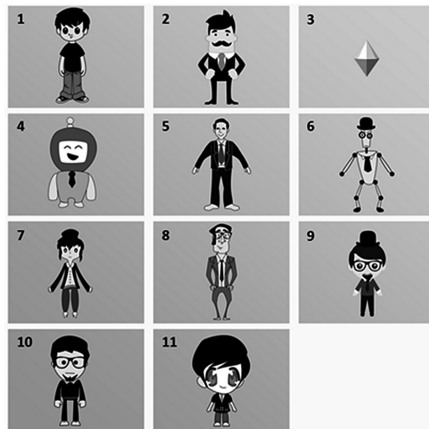**Fig. 2.** Comparison of each interface element

Fig. 3. Comparison of agents

The agent questionnaire consists of multiple-choices style questions according to impression, and written style ones. We focused on three aspects in multiple-choices style questions: how much an agent is child-like, trustful and kind. The written style questions ask participant their favorite characteristics and concrete examples (i.e. existing persons or characters).

While Yasuda et al. have used a child agent in their study [11] simulating a grandchild, we are considering examining whether cultural difference in impression of child-likeness affects familiarity of an agent or not. Shedroff and Noessel describe the relationship between expectations and actions from an aspect of behaviors of characters [14]. That is, when actual services provided by an agent do not match expectation from a user, the user can be annoyed. Based on these aspects, multiple adjective were chosen: kind, trustful, child, adult, negligent, mischievous, interesting, and boring. These questions are prepared for examining cultural difference in an aspect of acceptance and expectation for an agent by people.

5   Results and Discussion

As consistence with accessibility aspect, larger text was found to be preferable. The most popular text size combination was no. 1 in Fig. 2(a) obtaining support from 19 participants. In a color scheme aspect, no. 7 (10 participants) and no. 1 (7 participants) were popular.

As for an agent, no. 5 obtained the highest points (the number of participants who have chosen the agent) in "kind" (11 points) and "adult" (21), and the second highest in "trustful" (7) and "interesting" (6). Contrary, it was considered as least "child" (2) and "negligent" (1), and second least "boring" (2) character. Therefore, the no. 5 agent can be a preferable character with positive impression.

No. 1 and 11 were respectively the first and second most "child" (21 and 18) characters. Although they are both human-like character, the ratio between head and body is different. While points of "kind" (11 and 4) and "trustful" (5 and 1) are not necessarily higher, the "negligent" (1 and 2), "mischievous" (0 and 2) and "boring" (1 and 3) points located in a range from first to third least numbers. This result suggests that a "child" character can also be candidates for an agent because of the accordance with related work regarding an agent [7, 11].

No. 3, 4, and 6 were not human characters. Especially, the no. 3 did not have a face. Points of "interesting" and "boring" for the no. 3 character were 4 and 6 respectively while the other point was 0. This result suggests that no. 3 obtains few expectations from participants while the possibility of expressions is limited.

6   Future Direction

We have described design issues of Vanhat Kuvat application along with the results of survey. Multiple categories of agents were compared regarding how much an agent is child-like, trustful and kind. Based on survey results, we are planning to experiment with these agents in a usability study.

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