An Experiment for Motivating Elderly People with Robot Guided Interaction

Ryohei Sasama, Tomoharu Yamaguchi, and Keiji Yamada

NEC Corporation, C&C Innovation Research Laboratories
8916-47 Takayama-Cho, Ikoma, Nara, Japan
{r-sasama@cp,yamaguchi@az,kg-yamada@cp}jp.nec.com

Abstract. It is important for elderly people to be involved in local community to reduce the risk of being isolated. The authors are building a framework for encouraging elderly people to participate in more activities by providing local news that may be interesting. Nowadays, there is a lot of information on the Internet; however, few elderly people can obtain the benefits of this information. The Internet is used less by elderly people. It has been reported that one reason for this is diminishing cognitive performance. It is not easy for elderly people to learn a new mental model for a new IT system. Thus, the authors propose a robot-guided interaction framework for elderly people. Once the user initiates an interaction, a communication robot initiates the following interaction sequences. The user can simply follow and respond to the guiding robot, and is not required to learn any operational sequence or mental model. An experiment on such guiding robots was performed with ten elderly subjects, and investigated as to how long elderly people can use the system. As a result of a 12-day experiment, all subjects kept using the system almost every day until the end of the experiment period. According to this result, we can conclude that the robot-guided interaction framework is effective for elderly people.

Keywords: regional activation, operation of information systems, robot guided interaction.

1 Introduction

Recently, the isolation of elderly people has been considered an important social issue. The number of elderly people who have less connection with their neighbors and don't have a connection to their local community is increasing [1]. The authors are building a framework for encouraging elderly people to participate in more activities by providing interesting local news [2]. Communication robots are delivered to each elderly person's home and placed at common places where people gather. By providing news of local activities through the robots, it is expected that participation of elderly people in the activities will increase. First, the robot at home provides news, and encourages participation in an activity, so that the elderly people have more opportunities to go out and meet others. Then, a robot at a common place proposes topics to enhance conversation among people who meet at that location. Finally, the robot at

C. Stephanidis (Ed.): Universal Access in HCI, Part II, HCII 2011, LNCS 6766, pp. 214–223, 2011.
© Springer-Verlag Berlin Heidelberg 2011

home also encourages the exchange of on-line messages with people who met at the common place in order to maintain longer and better relationships.

The framework is intended to support elderly people in meeting with others and becoming friends. Levinger reported that there are steps in the process by which people become friends [3]. An opportunity to meet comes first; people get to know each other and gradually become friendly. Since the process takes time, the community support framework also has to work for a long time. As a guideline for information systems for long term usage, Fogg proposed that the work load of using the system should be natural enough to be embedded in everyday life [4]. Once it becomes a part of the user's daily custom, it can be used for a long time without being boring. Thus, the authors designed the interaction scenarios of the robot to be short enough each time and to occur only a few times a day so that elderly people can use them long-term.

It is also important that the system be easy enough for elderly people to use. It is difficult to determine whether information systems such as the Internet are easy for elderly people to use. For instance, more than 90% of 13-49 year-old people use the Internet; however, the number of Internet users over 50 significantly decreases [5]. More than half of people 60 or older claim that operations of such a system are too difficult [6]. Etsuko et al. reported that the reason for this difficulty is decreasing cognitive performance according to age [7]. To help solve this problem, the authors propose a "Robot-Guided Interaction Framework" for elderly people to support them in obtaining information from the Internet. Once the user initiates an interaction, a communication robot initiates interaction sequences. The user can simply follow and respond to the guiding robot, and is not required to learn any operational sequence or mental model.

To investigate the efficiency of the "Robot-Guided Interaction Framework," an experiment with such guiding robots was performed with ten elderly subjects, and we investigated how long elderly people can use the system. As a result of a 12-day experiment, we found that all subjects continued using the system almost daily. According to this result, it is possible to conclude that the robot-guided interaction framework is effective for elderly people.

2 Framework for Enhancement of Communication among Elderly People

2.1 Three Stages for Enhancement of Communication

The authors are building a framework for encouraging elderly people to participate in more activities in three stages [2]. Levinger reported that there are steps in a process by which people become friends [3]. An opportunity to meet comes first, followed by people gaining knowledge about each other, after which they gradually become friendly. Thus, the authors suppose three major stages of activities for creating and maintaining good human relationships: (A) meet, (B) talk, and (C) repeat. Information systems can help elderly people at each stage (Fig. 1).

The authors suppose approaches in each stage as follows. At stage (A) meet, the information system at home provides news and encourages participation in an activity, so that elderly people have more opportunities to go out and meet others. At stage (B)

talk, the information system at a common meeting place proposes topics to enhance conversation among people who meet there. At stage (C) repeat, the information system at home also encourages exchange of on-line messages with people who met at the common place to maintain longer and better relationships.

2.2 Functions on of Each Stage

The three functions of the information system achieve the above-mentioned approaches. The information systems have (a) announcement, (b) mediation, and (c) message exchange on the stages of (A) meet, (B) talk, and (C) repeat, respectively.

(a) Announcement. This function provides local news and the amount of physical effort required to elderly people at home to increase opportunities to meet others. The authors considered that local news is efficient because it has been reported that one of the main reasons elderly people don't participate in local community is a lack of knowledge about events. The authors also considered that it is efficient to visualize the amount of physical exertion because visualization is an effective method for causing behavioral change [8].

(b) Mediation. This function assists a group of people in having a conversation at common places where people gather to build a relationship with others. Specifically, this function leads to introducing each other, provides topics of common interest, and speaks up when an angel passes by. It was reported that there are steps in the process by which people become friends [3]. The step of becoming friendly comes after the step of gaining knowledge about the other. The step of gaining knowledge has problems because some people feel uncomfortable talking to strangers. In such a case, a

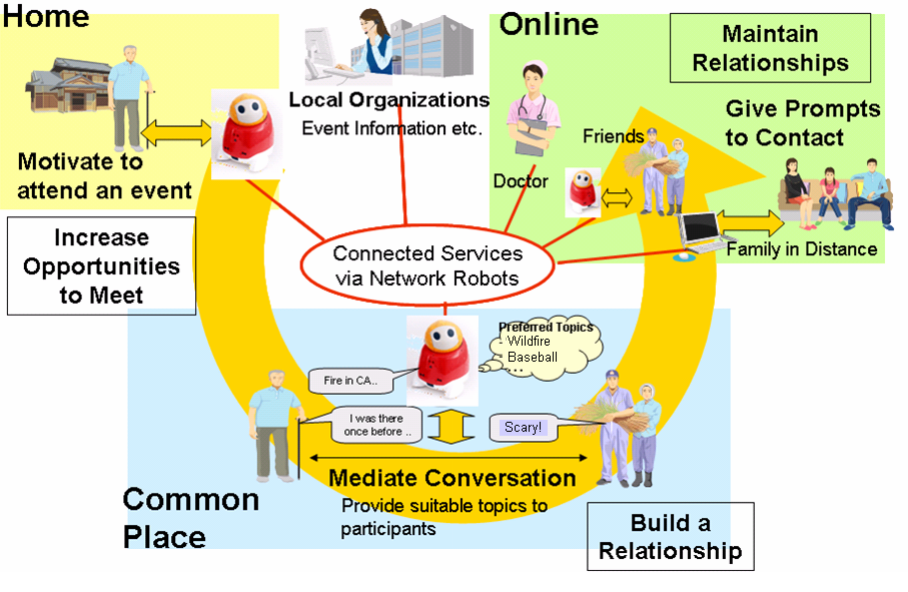

Fig. 1. Framework for enhancement of communication among elderly people

bit of assistance by another person who is well known or gregarious is very helpful for increasing comfort. The authors have confirmed the efficiency of mediation in a group conversation [9, 10].

(c) Message exchange. This function encourages exchange of on-line messages with people who met at the common place for maintaining longer and better relationships. Some elderly people are not good at using a keyboard to input text messages. Thus, this function encourages exchange of on-line messages in the form of voice mail.

3 Robot Guided Interaction

3.1 Design of Robot Guided Interaction

The authors propose a "Robot-Guided Interaction Framework", which supports elderly people to obtain information as mentioned in 2.2 with robot interface. Once the user initiates an interaction, an information system begins the following interaction sequences. The user can simply follow and respond to the guiding system, and is not required to learn any operational sequence or mental model.

The authors decided to use a robot as the interface for the information system, aiming at taking advantage of the intuitiveness which robot interface naturally has as Yukiko et al. have reported [11]. In fact, people facing the robot try communicating with same manner as to human without learning how to use.

3.2 Support for a Day of Elderly People with Robot Guided Interaction

The framework is intended to support elderly people in meeting others and becoming friends. It was reported that there are steps in the process by which people become friends [3]. An opportunity to meet comes first, after which people gain knowledge about each other, and gradually become friendly. Since the process takes time, the community support framework also has to work for a long time. As a guideline for information systems for long term use, Fogg proposed that the work load of the system should be simple enough to be embedded in everyday life [4]. Once it becomes part of the user's daily customs, it can exist without boring the user. Thus, the authors designed interaction scenarios for the robot to be short enough in each time, occurring only a few times a day, so that elderly people can use them for a long time. Specifically, the length of one interaction is around one minute, and the number of interactions per day is around five.

The authors designed the "Robot-Guided Interaction Framework" for one typical day for elderly people, from getting up to going to bed, because we aimed to incorporate this interaction in the everyday life of elderly people. Communication robots were delivered to each elderly person's home and placed at common places where people gather. The robots interact with elderly people as follows.

Morning

1. At home: the robot greets the elderly, and reports yesterday's record of her/his pedometer.

2. At home: the robot provides news of the day to encourage the elderly to go out for activities. The robot also asks questions to assess the physical conditions of the elderly.

Daytime

3. At home: the robot reminds the elderly of the arranged schedule for going out one hour advance so that they won't miss the activities.
4. On the road or at the place of activity: another robot is located there. It introduces another activity to provide an opportunity to visit another place for more exercise. It is connected with the robot at home, and the activity to be introduced is chosen based on the interaction history obtained from the robot at home.
5. At the common place: there is another robot for meditating between people. While visiting the common place, people have good opportunities to meet others. The robot helps them enjoy conversation.
6. At home (after coming back from outside): the robot greets the elderly coming back home. It reports the record of its pedometer, and asks a few questions about the impressions of the activities.

Evening and Night

7. At home: the robot checks online messages to the elderly from others, guides them in checking the messages, and asks the elderly whether to send a reply. The robot guides the sending of a message if the elderly wish to do so.
8. At home: the robot reminds the elderly of people met during the day and asks the elderly whether to send a message to them. The robot guides the sending of a message if the elderly wish to do so.
9. At home: the robot provides information about activities of the next day. It also asks questions to determine the physical conditions of the elderly.

4 Experiments

4.1 Environment, Subjects and the System

To investigate the efficiency of the "Robot-Guided Interaction Framework," an experiment on such guiding robots was performed. Ten subjects (seven males and three females) participated in the experiment. The experiment was performed with the cooperation of Uda City, Nara Prefecture, in Japan for 157 days from February 1 to March 31, and from June 24 to September 30. The function of message exchange was improved once during the interval from April 1 to June 23. The experiment consisted of two stages. In the first stage (March 1-12), physical robots called "PaPeRo" made by NEC were delivered to each subject's home. In the second stage (March 13 to September 30), the robots were replaced with a CG (Computer Graphics) version of PaPeRo. In each subject's home, a robot and a tablet-type terminal ("Web terminal") with touch screen were delivered. That equipment was connected by WLAN to the Internet. Figure 2 shows an actual setting in a subject's home.

In the "Robot-Guided Interaction Framework," PaPeRo speaks to a subject and the subject inputs his/her response to the web terminal. The subject touches the display of the web terminal with his/her finger to answer a question from PaPeRo. Subject also

touches a pedometer to the data-reader on the web terminal to start interaction as shown in figure 2. The pedometer has a proximity wireless communication function. Figures 3 and 4 show screen shot examples of the web terminal. Figure 3 show screen shot examples of the web terminal with PaPeRo. Figure 4 show screen shot examples of the web terminal with CG version of PaPeRo. A subject can start the function of announcement or message exchange by touching either button on upper-right portion of the display as shown in figure 3. Announcement topics or destinations of message can be chosen by touching a button on middle-right portion of the display. When PaPeRo asks a question, the subject can provide a response to the robot simply by touching the "O (yes/good)", "△(unsure/neutral)", "X(no/poor)" buttons on lower-left portion of the display as shown in figure 3.

Examples of daily interaction at home are shown below.

Morning

Subject: Touch his/her pedometer to the data-reader on the web terminal as shown in figure 2 to start a session.
PaPeRo: "Good morning, Mr. Yamada"
PaPeRo: "Today, tea party will be hold at the community place from 10 A.M."
PaPeRo: "Will you go this event?"
Subject: Touch "O (yes)" button to answers the question
PaPeRo: "Please enjoy this event"
PaPeRo: "How about your condition today?"
Subject: Did not answer within a certain expected time (e.g. five seconds)
PaPeRo: "If you are good, please touch "O(circle)" button. If you are normal , touch"△(triangle)" . If you feel bad , touch "X(cross)"".
Subject: Touch "O (good)" button to answers the question
PaPeRo: "You look like quite well."
PaPeRo: "See you later" to imply the end of the session.

Daytime (after coming back from going out)

Subject: Touch the pedometer to the data-reader on the web terminal.
PaPeRo: "Welcome home, Mr. Yamada."
PaPeRo: "You have a message from Mr. Suzuki. Do you hear this, now?"
Subject: Touch "O (yes)" button to answers the question
PaPeRo: Play back the voice massage, "(recorded voice) Hi, This is Suzuki. Today's party was wonderful. Let's go together agein."
PaPeRo: "Do you reply to this message?"
Subject: Touch "O (yes)" button to answers the question
PaPeRo: "Please leave your massage for thirty seconds after the beep ... (beep)."
Subject: "This is Yamada. The green tea was delicious. I'm looking forward to the next party."
PaPeRo: "Is it OK to send it?"
Subject: Touch "O (yes)" button to answers the question
PaPeRo: "I finish sending it."
PaPeRo: "See you later."

Night

Subject: touch the "Announcement" button on the web terminal.
PaPeRo: "Tomorrow, sale of vegetable will be hold at the supermarket from 4 P.M."

PaPeRo: “Will you go this event?”
Subject: Touch the “△ (unsure)” button,
PaPeRo: “Please tell me, if you change your mind.”
PaPeRo: “See you later.”

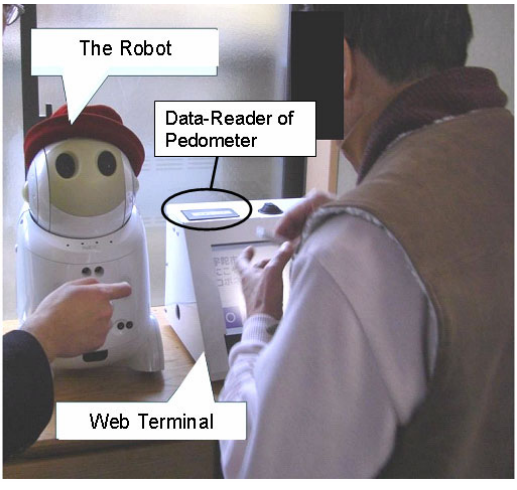

Fig. 2. Robot and terminal with subject

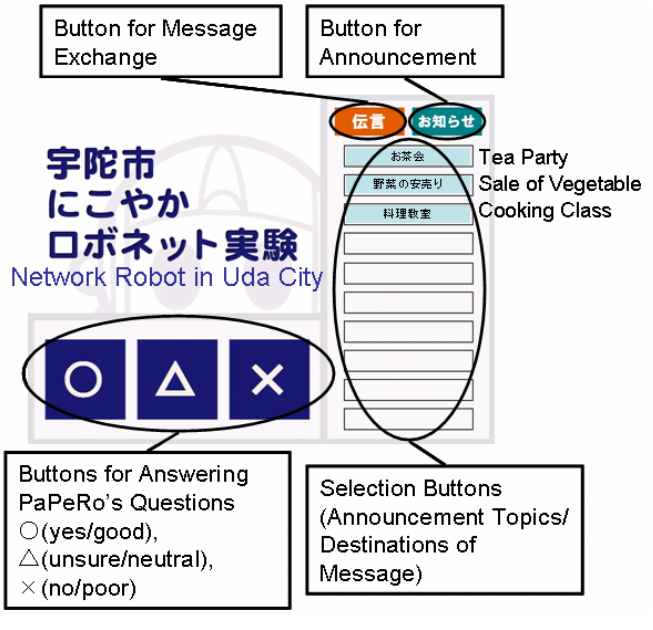

Fig. 3. Screen shots of the terminal with PaPeRo

Fig. 4. Screen shots of terminal with CG version of PaPeRo

4.2 Results Overview

As a result of the experiment in the first stage, all subjects kept using the system almost daily for 12 days. On the other hand, Four of ten subjects stopped using the system before the experiment period of 157 days. Table 1 shows the number of days from the beginning of the experiment to the day when the robot was last used.

If subject could not obtain new knowledge and mental models for our system in the experiment, the subject would stop using the system or ask how to use it. The authors interviewed the subjects who stopped using the system about reasons. No one claimed that the reason is difficulty of usage. Reasons why subjects stop using the system are described later.On the other hand, subjects who kept using the system didn't ask how to use our system. Thus, it may be concluded that subjects could obtain new knowledge and mental models for our system.

From the questionnaire results, behaviors and impressions of the subjects were revealed. Nine of ten subjects answered the questionnaire, which was collected immediately after the first stage of the experiment to investigate changes in the subjects' behavior. Figure 5 shows changes of subject behavior. Three subjects clearly stated that they increased opportunities for socializing with the system. Additionally, communications with family members increased. This is a good side effect of the system.

There were two reasons why subjects stopped using the system before the experiment period by the interview. One of the reasons is a difficulty in understanding speech of PaPeRo because of unfamiliarity with synthesized voice. The other reason is physical weakness of body. Three subjects mentioned the difficulty in understanding speech. Two subjects mentioned physical weakness.

Table 1. Number of days from experiment beginning to day when subject stopped using robot

	subject 1	subject 2	subject 3	subject 4	subject 5	subject 6	subject 7	subject 8	subject 9	subject 10
the number of days	157	155	155	154	154	153	127	111	74	16

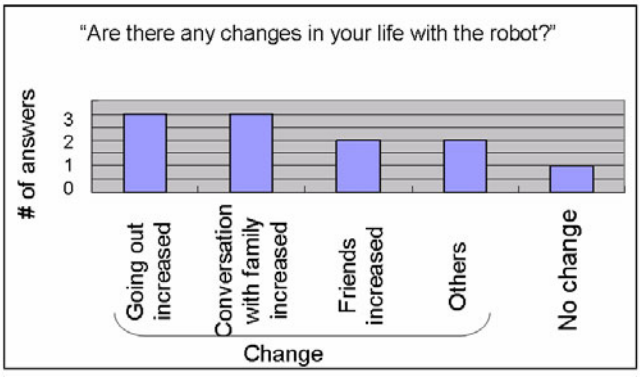

Fig. 5. Change of behavior

5 Summary

A "Robot-Guided Interaction Framework" was proposed, and the result of an experiment with a community support system for elderly people based on the framework was reported. It was observed that all ten elderly subjects used the system daily for the first 12 days. According to this result, we concluded that the framework overcomes the issue of obtaining new knowledge and mental models, and allows all subjects to use the system. On the other hand, four of ten subjects stopped using the system before the experimental period of 157 days. More refinement of the interaction framework is required for higher acceptability in the long term.

It can also be supposed that the design of the interaction framework was not the only reason for subjects to stop using the system. A multi-perspective investigation is necessary for creating long-term information systems.

Acknowledgments. This work was supported in part by the Japan Ministry of Internal Affairs and Communications. The authors would like to thank all the participants of the experiment, and the employees of Uda City and Nara Prefecture for their kind support.

References

1. The Cabinet Office, Government of Japan: White Paper on Aging Society 2007 Edition, Ch. 3. Tokyo Office of Government Public Relations (2007) (in Japanese)
2. Yamaguchi, T., Sasama, R., Yamada, K.: Design and Concept of Network Robots as Social Agents to Motivate Elderly People. In: Proceedings of the IEEE/RSJ IROS 2009 Workshop (2009)
3. Levinger, G., Snoek, D.J.: Attraction in relationship: A new look at interpersonal attraction. General Learning Press (1972)
4. Fogg, B.J.: Persuasive Technology, pp. 64–66. Elsevier, Amsterdam (2003)

5. Nielsen//NetRatings: Transition of Composition ratio of Web User in the Age Bracket (2006), http://csp.netratings.co.jp/nnr/PDF/Newsrelease11072006_J.pdf (in Japanese)
6. Ministry of Internal Affairs and Communications, Government of Japan: Report on Communications Usage Trend Survey 2010 Edition, Ch. 3. Tokyo Office of Government Public Relations (2010) (in Japanese)
7. Harada, E., Akatsu, Y.: Cognitive Science about Usability, Ch. 6. Kyoritsu Press (2003) (in Japanese)
8. Fogg, B.J.: Persuasive Technology, pp. 76–82. Elsevier, Amsterdam (2003)
9. Sano, M., Miyawaki, K., Sasama, R., Yamaguchi, T., Yamada, K.: A Robotic Introducer Agent based on Adaptive Embodied Entrainment Control. In: The 13th International Conference on Human-Computer Interaction (HCII), pp. 368–376 (July 2009)
10. Sano, M., Miyawaki, K., Sasama, R., Yamaguchi, T., Yamada, K.: Adaptive Embodied Entrainment Control and Interaction Design of the First Meeting Introducer Robot. In: 2009 IEEE International Conference on Systems, Man, and Cybernetics (SMC 2009), October 11-14, pp. 430–435 (2009)
11. Nakano, Y., Yamada, S.: Design between Human and Robot, pp. 88–113. Tokyo Denki University Press (2007)