A Pilot Study Investigating Self-Disclosure by Elderly Participants in Agent-Mediated Communication

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***Abstract*— Generation gap can make communication difficult, even within a family. Each family member has a preferred style of communication. To address this, we proposed a shared-agent system for encouraging remote communication between family members. This paper reports the results of a pilot study, in which a prototype robot interface was evaluated, and the acceptance of asynchronous communication by elderly participants was investigated. The effects on family communication were approached from the viewpoint of self-disclosure in old age. Feedback suggested new research hypotheses, for example that the establishment of relationships between the shared-agent and the family members may encourage deeper communication within the family.**

I. Introduction

Nuclear families and one-person households are replacing extended families in countries, and dual-income households are also becoming common. As families become dispersed, a generation gap arises from differences in lifestyle and familiarity with communication tools. Against this background, a shared-agent system has been proposed [1] that supports communication across three generations, connecting each family member with the other. In this system, family members in different locations share an agent. Each member accesses the agent through an interface designed specifically for members of that generation (Fig. 1).

However, the proposed shared-agent system is still at the conceptual and early prototyping stage. In this pilot study, we will focus on developing a shared-agent system for grandparents. The goal of the study is to collect feedback that can be used to support the further development of this specific interface. We also investigate the role of the shared-agent system in family communication. Psychological and sociological research suggests that self-disclosure cues are important for senior citizens. A further goal of the pilot study, therefore, is to obtain insights into communication between parents and grandparents, with a special emphasis on self-disclosure by the elderly.

II. Related Works

TABLE I presents a classification of remote communication systems, classified by richness of nonverbal cues and synchronicity. Telephone and video chatting fall into in the first quadrant. Telepresence robots are also within this region, as they simulate a communication partner in the real world. Numerous studies have been conducted of telepresence robots. Tanaka et al. suggested that a telepresence robot can help children communicate with teachers who speak a foreign language [2]. Okamura et.al. proposed a two-way telepresence robot for supporting remote teaching by senior people to children [3]. ChiCaRo is a telepresence robot that allows adults to conduct child care when away from home [4][5]. These studies have demonstrated successful uses of robotic interfaces to facilitate communication across great distances. However, these synchronous communication interfaces may be less useful for intergenerational communication, because a lifestyle difference imposes time constraints on both generations.

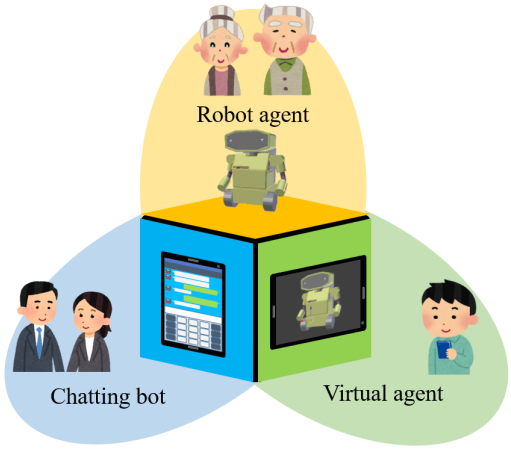

Fig. 1. The Shared-Agent System [1]

E-mails and letters are seen as a good medium for such communication, as they are asynchronous. However, exchanging only linguistic information makes it easier for users to misunderstand their partners, which is inappropriate in the context of inter-family communication. In particular, many elderly people live separately from the other family members, and it is hard to eliminate this misunderstanding by meeting directly.

In contrast, video and voice messaging services, while being asynchronous, provide rich nonverbal cues. BOCCO is a robot interface developed by a Japanese company to support parent-child communication [6]. Parents can not only monitor the states of their young children, but can also communicate asynchronously by exchanging voice messages via smartphones. However, we hypothesized that this type of communication is unsatisfactory because of the discontinuity between messages and responses. A form of asynchronous

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TABLE I

CLASSIFICATION OF REMOTE COMMUNICATION INTERFACES

	Asynchronous	*Synchronous*
Rich nonverbal cues [1]	Video messages Voice messages	Telepresence robots Video chatting Telephone
Poor nonverbal cues	Letters E-mails	Text chatting

1: Voices based systems transmit more nonverbal cues than just text-based systems, including tone and type of voice and pauses when speaking.

communication that provides rich nonverbal cues and allows interaction is required. For grandparents in particular, we assumed that a communication interface between the user and a non-human agent would improve communication. This must take into account the difference in skill levels when handling the agent interfaces.

III. THE SHARED-AGENT SYSTEM

A. Requirements and interface design

To address differences in daily routines, asynchronous communication and interaction using a local agent can be effective. In a shared-agent system, a specific interface should be designed for each generation, taking account of social background and different communication requirements.

Social isolation and digital divide are two of the most serious problems faced by the elderly. Many elderlies are uncomfortable using a portable device to communicate with family members. We hypothesized that the appearance of an embodied agent in front of the elderly user could help mitigate this. The agent interface must be capable of voice recognition and natural languages processing. The agent must also be able to act both as a communication tool and as a conversation partner, requiring different robot modes.

The generation that is supporting a family forms the core of the labor force, and has less time to devote to the family. However, they are concerned both about their children and their parents. Communication requirements for parents are efficiency and the ease of use. The shared-agent proposed for parents was therefore of the chat bot type.

Modern parents are busy, and their children may spend more of their time playing video games than communicating with their parents or playing outdoor, because of security concerns. It is therefore important to help the children manage themselves. An agent may appear as an avatar within the game screen, the children are playing with. The agent acts as a companion and also notifies the children when a message is received.

B. A prototype agent interface for grandparents

A prototype of the robot interface for grandparents was built using a laptop computer connected to an Arduino Uno microcontroller board. The laptop provided speech, server access, and high-level robot control, while the Arduino controlled the hardware that provided physical expression. The robot was given two degrees of freedom (DOF) at the neck and one at the shoulder. To control the behavior of the robot, Arduino programs that made use of both the servo controller and serial communication packages were developed, while the speech recognition and speech synthesis components on the laptop were implemented in Python. An API [7] provided the robot with autonomous use of natural languages.

Comments made by the user triggered state transitions of the robot mode, from (a) stand-by to (b) normal mode, or (c) listening mode (TABLE Ⅱ). In stand-by mode, the robot acted as if it was sleeping, lying face down with eyes switched off. The command ”OK! Roboch!” woke the robot and its state changed to normal mode, allowing processing of speech to text and text to speech. When the robot was in listening mode, elderly users could record their voice through a microphone that it carried in its left hand. In this mode, the eyes changed from blue to green and the microphone was turned toward the user. At the command “I’m all right now.” the robot reverted to stand-by mode.

A key feature of a shared-agent system is asynchronous communication with other family members. In this study, we focused on the communication between a grandparent and parent. The chat bot interface was designed for the parental generation. The chat bot was developed using the LINE bot API [8], allowing the user to switch between text and voice communication. A message sent by the parent was posted to a web server, where it was stored until demanded by the robot. Once the message had been received, the robot notified the grandparent by activating its LED eyes and then read out the contents. It also promoted the user to reply to the message. The response from the grandparent was translated by the robot from speech to text and posted to the LINE server, from whence. The text message was forward immediately to the chat bot.

IV. MEASURING SELF-DISCLOSURE

A. Self-disclosure by senior citizens

The genetic psychologist Erikson et.al. defined the psychological conflict that arises at around 65 year in the grandparents’ generation as, *integrity vs. despair* [10][11]. This makes self-disclosure very important. Here, *integrity* refer to the sharing of recollections and building a sense of being valued by contemporaries or by the younger generations. This acts as a therapeutic intervention [12]. Embarrassment about the frailties encountered in aging may disclosure to another, as a trigger for social support. However, elderly people are reluctant to disclose their feeling of *despair*, even to their family members or their intimate friends. It is therefore difficult to elicit this kind of disclosure, and to know when social support is needed.

B. Human-Robot Interaction studies and self-disclosure

Human-Robot Interaction (HRI) studies investigated self-disclosure to robots. Turkle suggested that the wellbeing of the elderly could be improved by building relationships with robots. Case studies suggested, for example, that elderly care patients were willing to tell personal stories to and discuss personal issues with Paro [13][14]. Martelaro et.

TABLE II

STATES AND ROBOT BEHAVIORS

States	Robot's behaviors
 (a) Stand-by mode	• Eyes are off and sounds from the environment are recorded. • On receipt of a message from the web server, notify the user by green eyes flashing. • Translate speech to text every seven seconds. • If "robot" is in the text, the robot wakes up and shifts to the normal mode.
 (b) Normal mode	• Head rises with eyes blue. • Speech in a female-like synthesized voice [9]. • WAV file streaming receives as a voice message. • Message reads out, "He/She said that (original message). Do you want to reply?" • Speech to text by analyzing the audio files recorded while in listening mode. • If "I'm all right now." is in the text, moves to the stand-by mode with saying "Call me again." • If the robot hears the user's voice, switch to the listening mode.
 (c) Listening mode	• Eyes become green and the elderly user's voice is recorded using a microphone held in the left hand. • When recording complete, return to the normal mode.

al. investigated self-disclosure by students, from the viewpoints of trust and companionship [15]. They found that students had more trust and feelings of companionship with a vulnerable robot, and reported the students disclosed more with an expressive robot. They also reported that, while vulnerability and expressivity may both improve the human-robot relationships, their effects were different. These studies suggest that self-disclosure is related not only to user's impression of the robot itself, but also to the subjective evaluation of the relaionship with the robot.

V. METHOD

A. Pilot study

We had three research goals. The first was, to evaluate the agent interface for the elderly, in terms both of design and interaction with the user. The second was to investigate the acceptability of asynchronous communication to elderly users. The third was to investigate the way in which agent-mediated communication influences communication between parents and grandparents. Four active senior citizens (one male in his 90s and three females in their 60s and 70s) participated in the pilot study. Each participant experienced two conditions: a phone condition and a shared-agent system condition. Their reactions were recorded through personal interviews and group discussions.

B. Test scenarios

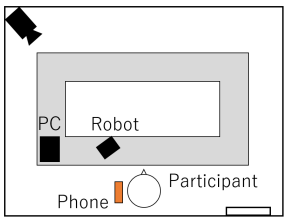
In both conditions, participants were asked to simulate communication with a daughter who is living independently. A female college student played the role of the daughter. The participants and the student were provided with scenarios for the role playing. In these scenarios, the student played the role of the daughter who wanted to maintain communication with her parents, while living independently. The focus of the role play was discussion of any health or financial problems as these are two areas in which senior citizens often require social support. The scenarios were provided to the elderly participants and encouraged them to share anecdotes about recent events, and to talk about places that they would like to visit. The scenario contained twelve examples, which participants could use freely.

C. Phone condition

A smartphone with LINE installed was used in this condition. LINE is an application that supports both free calling and text chatting [16]. Figure 2 shows the configuration of the room used in this condition. Each participant entered the room and sat at a desk. The experimenter briefed the participants on the scenarios and experimental procedures. The student playing the role of daughter located two rooms away. When both were ready, the experimenter called the student and passed the phone to the participant. They communicated for approximately 5-6 minutes, while the experimenter was remained with the "daughter". After the daughter terminated the call, the experimenter returned to the experimental room and retrieved the smartphone, completing this condition.

D. Robot condition

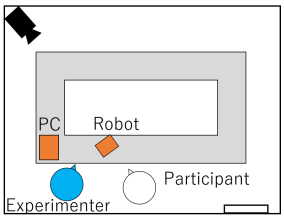
The experiment was then moved to the robot condition. The scenario was the same as that used in the telephone condition. The room configuration is shown in Figure 3. In this condition, the experimenter explained the usage



(a) Room configuration

(b) Talking with a "daughter"

Fig. 2. Phone condition



(a) Room configuration

(b) Instruction about the use of the robot

Fig. 3. Robot condition

and functions of the robot, and demonstrated sending and receiving messages. An illustrated manual describing the basic usage of the robot was also used. The experiment ran for approximately ten minutes, including the instruction time. Under instruction, the participants communicated via the robot with two or three sets of sent messages and received messages. In this condition, the daughter sent messages as text.

E. Personal interviews

To explore self-disclosure in old age, we adopted an existing questionnaire used in Japan [17] (TABLE Ⅲ (a)). This was divided into eight categories, with two questions in each. Participants were asked to consider whether they had found it easier to discuss these points when using the phone or the robot as the interface. If, for a particular item, the participant reported feeling at ease when using the robot, the reasons for this were probed using a list of 12 descriptors (TABLE Ⅲ (b)). Nine of these items were selected from an evaluation of the humanoid robot Robovie [18], but the list also included "Trust" and "Companionship", as well as "Other".

Next, we gathered opinions and comments from participants. Each participant was asked about the topics that they had found easy to discuss in a telephone conversation, and those they had found difficult. We also probed for things they had found pleasurable when interacting with our prototype robot, and sought suggestion for improvements.

F. Group discussions

To elicit further comments, group discussions were held. These were attended by the participants, the female student, and the experimenters. The goal was to clarify points for improvement, through an exchange of opinions on the experiments and the prototype.

TABLE III

SELF-DISCLOSURE QUESTIONNAIRE

(a) Categories[2] and questions		
Q1	(3)	Suffering from awkwardness in relationships
Q2	(7)	Pleasure from amusing events
Q3	(1)	Anxiety about a chronic disease
Q4	(6)	Desire to transmit his/her wisdom
Q5	(4)	Anxiety about life in the future
Q6	(8)	Desire to begin something new
Q7	(2)	Demand a settled money
Q8	(5)	Desire to communicate his/her history
Q9	(1)	Worry about negative physical condition
Q10	(8)	Desire to visit somewhere place
Q11	(3)	Loneliness from having few acquaintances
Q12	(7)	Joy of new discovery
Q13	(2)	Anxiety about money for the future
Q14	(6)	Tradition of beliefs
Q15	(4)	Desire for things make to be motivated
Q16	(5)	Reflection on memories

(b) Impression items[3]		
Trust	Companionable	Funny
Cute	Warm	Approachable
Human-like	Friendly	Intelligent
Curious	Interesting	Others ( )

2: Eight disclosure categories concerned (1) Deterioration of mental or physical health, (2) Financial concerns, (3) Depression conerning social connections, (4) Deterioration of motivation, (5) Recollection of memories, (6) Transmitting one's values, (7) Sharing joy, (8) Communicating desires. Categories (1)-(4) are about *despair*, (5)-(8) are about *integrity*.

3: For each topic that the participants reported finding easier to disclose to the robot, they were also asked to their impressions of the robot, using the list of 12 descriptors. Participants were allowed to select multipl items.

VI. Feedback and Discussions

A. The appearance of the robot interface

There was general agreement that the appearance of the robot was satisfactory. Participants suggested that the robot was easy for elderly people to accept because of its small body size and appearance as a three-dimensional object. One suggestion was that the robot could be an animal-like appearance, and the soft exterior of a living organism. In future work, we will investigate the effect of exterior design and material on haptic interaction with the robot.

We hypothesized that the disclosure by participants would represent a transfer from the remote family member to the local robot. Research on telepresence robots suggests that when the appearance of the robot is significantly different from that of the speaker, the robot distorts the personality perceived by interlocutors [19]. Our research suggests that when interaction is asynchronous, the presence of the robot is strengthened while the presence of the other person is weakened, due to the intervening local interaction with the robot.

B. The interaction

As there was no evidence of participants having difficulty in understanding the speech of the robot, we concluded that voice interaction makes communication easy for elderly people. In terms of the interaction with the robot, opinions such as "I was happy because the robot listened quietly." and "Its behavior was attractive" were obtained. Participants

also found the robot commands "OK! Roboch!" and "I'm all right now." amusing. Comments included feeling sorry for the robot when using the command "I'm all right now." and that its slow response resembled that of a baby. These anthropomorphic reactions make it conceivable that the robot was recognized as another person, rather than a machine. This feedback suggested that the elderly participants found interaction with the robot acceptable.

However, it was also found that improvements were needed to the voice interaction. Comments about the difficulty of hearing the robot's voice suggest that improvement is needed to the voice streaming method and quality of the speaker components. Other opinions included "I want the conversation tempo to be a little faster." or "It was difficult for me to understand when I should speak.". Participants also noted that "I got nervous when the robot pointed its microphone at me." and confusion when confronted with the microphone was observed. In the prototype, as the robot had limited capability to record the participants' voices, the robot controlled the timing of utterances. This may have indeed feelings of pressure or tension in the user. As a future task, a form of voice interaction should be developed that allows the users to lead the conversation. This is especially important in applications for elderly people.

C. Asynchronous communication

Asynchronous communication is a major feature of the shared-agent system. This appeared to be accepted by the elderly participants, with comments including "It is convenient to send a messages at my chosen time.".

One participant said that it was difficult to disclose his/her health problems on the phone, but he/she also said that it was preferable to talk about such problems on the phone than using robot because he/she could get immediately responses from the family members. Asynchronous communication can not always be the best approach in which conversation topics include serious health problem and immediate help is needed.

D. Self-disclosure and impression of the robot

We observed a tendency to prefer using the robot rather than the telephone when participants were disclosing to their children. This was especially true for the *integrity* questions, when most participants chose the robot. This suggested that communication through the robot had the effect of eliciting self-disclosure to families. This had been noted in Computer-Mediated Communication (CMC). CMC studies have reported selective self-presentation becomes possible, as few nonverbal cues are transmitted to the other party, and communication is asynchronous [20]. It is also known that personal information is disclosed significantly more readily than in face-to-face interactions [21]. Our results suggested that self-disclosure by the elderly may be related to a view of the robot as simply a communication interface. In particular, we observed that when participants were disclosing experiences of *despair*, "trust" and "companionship" tended to be chosen. In contrast, when disclosing contents related to *integrity*, "interesting" or "amusing" were more likely to be chosen. "Trust" and "companionship" reflect the relationships between the human and the robot. It is conceivable that, even when the relationship established with the robot is that of a communication interface, the elderly are more motivated to disclose information that they would be reluctant to reveal in a face-to-face interaction.

A further interesting comment was that "telling the robot about my troubles makes it easier to deepen interaction with my family later". This suggests that direct and deep conversation with family members can be encouraged by indirect disclosure through the shared-agent system. This suggests a new research question: the effect on the dynamics of intra-family communication of a relationship established with a shared-agent.

VII. Conclusions

In this paper, we reported a pilot study on the robot interface of a shared-agent system used by elderly people. The first goal was to obtain user feedback on the prototype. The results suggested that the design of the robot and interaction with it were accepted to senior citizens, but still need improvements. In particular, it was suggested that the interaction took account of leader/follower roles. We next investigated self-disclosure by elderly people and the effect of the agent on communication within families. As this was a pilot study, no statistically testable results were obtained. However, it is suggested that the establishment of relationships between the agent and the family members might help elicit self-disclosure by the elderly members, and encourage communication within the family.

In future works, the shared-agent system should be adapted for use in real family lives, and its effect on family communication across generation gaps should be investigated.

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