Case Study of HRI for Elderly People : Effects of awareness of water intake in words and gestures of humanoid robot

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***Abstract*—In this paper, we examine the effects of utterances and gestures of a small humanoid robot on the awareness of water intake of elderly people. If the small humanoid robot can regularly notice the water intake that the elderly people tend to forget in their daily lives, it can suppress their dehydration symptoms and reduce the work of caregivers in nursing care sites. We investigated the response to the recommendation of elderly people in cases the small humanoid robot recommends water intake to the elderly with utterances, gestures, or combinations of these. This paper reports the preliminary experimental results and discusses the future work.**

I. Introduction

In recent years, many advanced countries are entering an aging society with a declining birthrate, and the shortage of caregivers has become a problem. Especially in nursing homes, it is difficult to allocate a caregiver to each elderly who suffers from dementia for a long time. Caregivers spend a lot of time to clean up rooms, prepare and clean up meals and help each elderly with bathing, excretion, eating meals. It is difficult to do finely daily conversation, recommendations for exercising, walking and water intake with each elderly with dementia, unfortunately.

On the other hand, research to introduce communication robots into daily life has been done in recent years. There are studies of mobile robots that guide people at art museums [1] or shopping malls [2], and robots that assist children and students in studying by themselves [3]. In the field of nursing care, research on care robots, for example, Paro [4] and Babyloid [5], [6], for mental health improvement of elderly people have been conducted. However, these robots are rather passive, not actively recommending conversation, exercise, and water intake from the robot.

Therefore, in this study, as an example of support of the daily life of elderly with dementia without the help of a caregiver, we construct a system to promote water intake by older people with dementia by a small humanoid robot. If the small humanoid robot can regularly notice the water intake that the elderly with dementia forget in the everyday life, it is possible to suppress the dehydration symptoms of the cognitive elderly and reduce the work of caregivers in the nursing care field. We are investigating the response of the elderly to the recommendation of water intake using utterance and/or gestures of the small humanoid robot, and verify the effect of the robot's words and/or gestures. This paper reports the preliminary experimental results and discusses the future work.

II. Method

We set up the experiment with an elderly person and a small humanoid robot that can give utterance to him/her and manipulate a cup with its hand to show a gesture of drinking a water. We recode the behaviors of the elderly person during the experiment and verify the effects of the utterance and/or the gesture of the humanoid robot to notify the water drinking to the elderly people. The details of the experiments are described below.

A. Participants

8 elderly people (2 males and 6 females) living in a special nursing house volunteered for our experiment. We obtained consent from the person in charge of the special nursing house and the volunteers after we have explained the procedures of the experiment and its objectives.

B. Experimental Design

Figure 1 shows one scene of the experiment of the human-robot interaction with a small humanoid robot and an elderly person. A volunteer elderly person sat facing the humanoid robot, then, he/she made some simple conversations and

Fig. 1. Experimental setup for human-robot interaction with a humanoid robot facing elderly

games. A cup of water was served during the conversation. The humanoid robot gives utterance and/or showed a gesture of drinking of a cup of water during the conversations, then, we observed how the elderly person responded to the awareness of drinking the water.

C. Materials

Two humanoid robots, Softbank robotics NAOs, were used in the experiments. The actual control of the humanoid robot was based on the Wizard of Oz method, that is, the robot was controlled by human operators outside of the experiment room. One robot, performing robot, was for performing the conversation, block play, and gestures of drinking. The other robot, interface robot, was for the user interface to control the performing robot. The interface robot was located outside of the experiment room so that the elderly people did not see the human operation. The servo control of the interface robot was off and the human operator moved the hands and the head of the robot by hands. The performing robot mimicked the pose of the interface robot in real-time so that the human operator controlled the performing robot to show the gestures and playing with the block to the facing elderly person. The camera images of the performing robot were transmitted to the monitor outside of the experiment room and the human operator watched them in real-time and controlled the performing robot.

Another human operator controlled the utterance of the performing robot. The operation interface laptop computer was located outside of the experiment room. One microphone was set in front of the performing robot and recorded the voice of the elderly person. The recorded voice was transmitted to the human operator outside of the experiment room in real-time so that he could listen to the elderly person and made natural communications. Some simple utterances were designed beforehand and the human operator just selected one of them on the laptop computer. The examples of the utterances are listed in Table 1.

The humanoid robot is set to a baby chair on a small table. The baby chair has another small table in front of the humanoid robot. 3 blocks of marble were on the table so that the humanoid robot can do a block play. A cup was also prepared for the humanoid robot to show a gesture of drinking water. A cup of barley tea was prepared for the elderly person.

D. Coding and Analysis

The humanoid robot took one of there behaviors, each of which includes an utterance and a gesture, an utterance only, and a gesture only. The robot took the above behaviors one by one with an interval of a few minutes. We counted the responses of the elderly person after each behavior during the experiment. The response of the elderly person includes drinking water, saying something about drinking water, and denying the drinking water. The number of responses is statistically processed to see if there is a significant difference in the number of responses depending on the behavior of the humanoid robot that is supposed to remind the elderly person to drink the tea.

E. Procedure

We have conducted the experiment that the small humanoid robot makes simple conversations and games with the elderly person and remind him/her to drink a cup of barley tea by a gesture and/or utterance. The procedure is below: An elderly person was brought into the experiment room and sit on a chair in front of the humanoid robot. The humanoid robot kept its eyes on the face of the elderly person during the experiment except during the block play. The robot started a simple conversation, for example, self-introduction. Some daily-life conversations are prepared beforehand and a human operator selected one of them according to the conversation situation. After some simple conversations, the robot started block play. The robot tried to keep the conversation on the block play during it showed the play, for example, ”Do you like the block play?”, ”Could you help me to stack the yellow block on the red one?”, ”Could you pick the blue block for me?”, ”Could you clap your hands for me if I successfully pile up the building blocks?” The block play was continued for about 5 minutes. After the block play, a caregiver set up a cup of barley tea for the elderly person. Another cup was prepared for the humanoid robot and let it grasp the cup. The robot continues the simple daily conversations with the elderly person. One of the behaviors below was executed by the robot during the conversation.

- The robot says something to remind drinking water and shows a gesture of drinking water.

TABLE I
EXAMPLES OF THE HUMANOID ROBOT UTTERANCES DURING THE CONVERSATION

Introduction	Block play	Drinking	Question	Answer
Hello!	Could you play block with me?	Today is hot. I am thirsty	I am twelve. How old are you?	Yes.
I am NAO.	Could you clap your hands for me?	Could you drink water with me?	What date is it?	Wow, great!
What is your name?	Could you help me?	The tea is delicious.	When is your birthday?	That's right.
Nice to see you.	Do you like block play?	Do you like tea?	It is a beautiful flower. What is it?	You know very well.
See you again.	I like block play.	I like the tea.	It is nice weather today, isn't it?	I am sorry to ask.
Could you talk with me?	It is difficult.	I am happy with you.	How old are you?	You are great!

TABLE II
NUMBER OF RESPONSES TO THE HUMANOID ROBOT BEHAVIOR THAT REMINDS THE ELDERLY PERSON TO DRINK DURING THE CONVERSATION

Subject ID	Utterance and gesture	Utterance only	Gesture only
A	2	1	1
B	2	3	3
C	1	0	1
D	5	1	2
E	2	0	0
F	1	2	0
G	2	4	1

- The robot only says something to remind drinking water.
- The robot only shows a gesture of drinking water.

The robot took the above behaviors one by one with an interval of a few minutes. We counted the responses of the elderly person after each behavior during the experiment. The response of the elderly person includes drinking water, saying something about drinking water, and denying the drinking water.

III. RESULTS

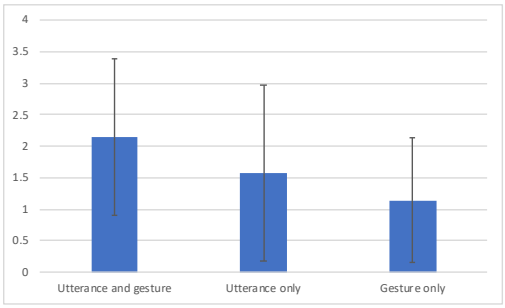

Fig. 2. Mean and standard deviation of the number of responses to the humanoid robot behavior that reminds the elderly person to drink

Table II shows the number of responses to the humanoid robot behavior that reminds the elderly person to drink during the conversation. We remind here that the response of the elderly person includes not only drinking water but also saying something about drinking water and denying the drinking water. Figure 2 shows the mean and standard deviation of the number of responses to each humanoid robot behavior, an utterance and gesture, an utterance only, and a gesture only. The interval for the water intake notification was just a few minutes so that the actual responses could be seen less than 5 times. That is why the maximum value of vertical axis in Fig. 2 is 4. There is no statistically significant difference between them because that the number of subjects is too small. However, we can see that the elderly people tend to respond to the humanoid robot reminder with an utterance and gesture more time than the other. The reminder only with a gesture does not lead elderly people to drink the tea according to the experiment.

IV. DISCUSSION

We have conducted a preliminary experiment to investigate the response of the elderly to the recommendation of water intake using utterance and/or gestures of the small humanoid robot. The preliminary experimental result suggests that the small humanoid robot can remind the elderly people to drink tea. The response of the elderly people to the reminder with an utterance and a gesture seems to be higher than the other reminders only with an utterance or a gesture. However, we need to have more experiment to see the statistically significant difference between them.

The preliminary experiment suggests us some points. One point is that the context of the conversation between the elderly people and the humanoid robot should be carefully chosen. Too many questions from the humanoid robot annoy the elderly people and make them tired. Some elderly people got angry or tried to leave there. It is important to realize a confortable conversation between the humanoid robot and the elderly people.

The timing of the utterance of the humanoid robot is also important. It should avoid the utterance while the elderly people speak. They become in frustration if their talk is interrupted and they feel difficulty in continuing the conversation. In the preliminary experiment, the human operator carefully listened to the utterance of the elderly people and started the utterance of the humanoid robot. It is preferable to control of the timing of the utterance automatically.

In the preliminary experiment, the elderly people enjoyed the block play of the humanoid robot. They watched the block play, helped the robot to grasp the block, picked up the dropped block and returned it on the table. Actually, the humanoid robot could not play very well and often failed to stack the block. The unskilfulness of the robot playing the block has a beneficent influence on the feeling of the elderly people.

V. Conclusion

We have investigated investigate the response of the elderly to the recommendation of water intake using utterance and/or gestures of the small humanoid robot with a preliminary experiment. The experiment suggests that the suggestion of the humanoid robot with the utterance and the gesture works effectively, however, we need sufficient data under the long-term experiment with more number of volunteers to show the effectiveness clearly.

It is one of the future work to generate an automatic conversation system that chooses some topics for the conversation and control the timing of the utterance of the humanoid robot. It is also interesting to develop the autonomous block play system with the humanoid robot to reduce the effort of the human operator. It is important to include the unskilfulness of the robot to attract the elderly people and lead them to help the block play of the humanoid robot spontaneously.

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