Design of Health Advice System for Elderly People by Communication Robot

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Abstract: Recently in Japan, as the declining birth rate and the aging of the population progress, increased medical expenditures and nursing care burdens are presenting great social difficulty. To mitigate that difficulty it is necessary for many elderly people to live independently and healthily. Therefore, this study develops a health advice system to support health promotion for elderly people. We conducted verification experiments to assess the operability and impressions of tablet PCs and robots and to elicit impressions against health advice presented from different devices. Furthermore, we examined the usefulness of the health advice system for elderly people who used the robots.

1 INTRODUCTION

Recently, in Japan, declining birth rate and aging of the population are progressing. It is estimated that 1.2 people of 20–64 years will be compelled to support one elderly person aged 65 or older in 2050 (Cabinet Office, 2016). Increased medical expenses and nursing care burdens are cited as looming difficulties (Ministry of Health, 2016). To mitigate those and related problems will require not merely life span extension, it will be necessary for many elderly people to stay independent for as long as possible and to have daily health care. Therefore, this research is aimed at developing a health advice system that monitors the daily health condition of elderly people and which promotes light exercise.

In terms of operability, an earlier study (Suga et al. 2016) showed that elderly people had difficulty tapping a tablet PC. Recently, voice guidance for operations of general products is used (Narita et al. 2011). Therefore, we developed a system that can be operated by using a robot. Because a robot is presented the possibility that as an information presentation terminal suitable for use by elderly people, a robot is more effective than a tablet PC in previous study (Inoue et al. 2014) (Nihei et al. 2013). The novelty of this research is verifying the usefulness of a system that utilized a robot by comparing impressions for health advice presented from different devices by the same voice operation method. We conducted comparative experiments to verify the operability and impressions of tablet PCs and robots, and impressions of health advice presented by devices. We also assessed the health advice system used by elderly people who used the robots.

2 HEALTH ADVICE SYSTEM

2.1 Communication Robot

In recent years, robot development has advanced according to their use in various roles. Humanoid type robots are based mainly on motion mechanisms aimed at supporting people's lives. Pet type robots resembling dogs have been designed to heal people. Research assessing utilization of robots and dialog agents aimed at reducing burdens on health care workers and at preventing dementia is underway, especially at medical sites (Ibuki et al. 2005) (Ono et al. 2015).

2.2 Utilization of RoBoHoN

We adopted RoBoHoN (Sharp Corp.), a mobile robot phone, because of its high speech recognition rate. RoBoHoN, with gender set as male, is a small

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humanoid robot (20 cm height, 400 g weight) that is easy for elderly people to carry and easy for elderly people to use easily. Cameras, GPS, projectors, etc. are mounted as other functions (Fig. 1).

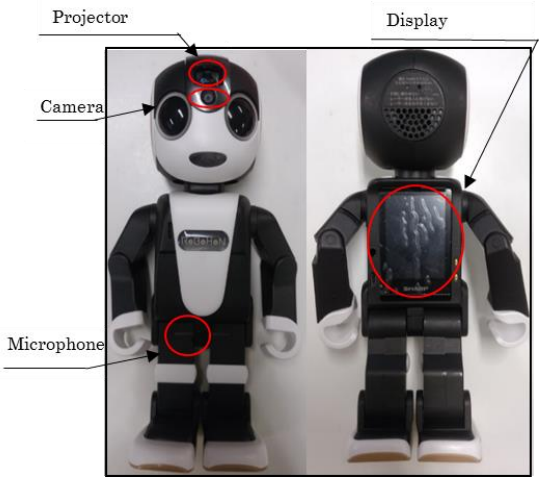

Figure 1: Appearance of RoBoHoN.

3 APPLICATION DEVELOPMENT

3.1 Application Overview

The overall flow of the developed application is presented in Fig. 2. The difference of the application between the tablet PC and the robot is whether or not tapping is necessary before inputting vital sighs data (blood pressure, pulse rate, body temperature) by voice. In the tablet PC, some operations are required to tap the buttons on the screen before the putting by voice, while the robot is designed to operate all by voice. Now, we show the procedure of the application. First, (1) the user inputs the measured vital sighs data by voice. For example, the voice guidance is "What was your body temperature today? Please enter by voice." Next, (2) the physical data for the past 30 days are displayed as a graph. (3) The physical condition is judged from the inputted data. Based on past data, health advice such as meal guidance and promotion of outdoor activities is provided to the user. For instance, when the blood pressure value is high compared to past data, more rest and lower salt intake are advised. When one's health is good, the robot proposes places to go and encourages daily exercise habits.

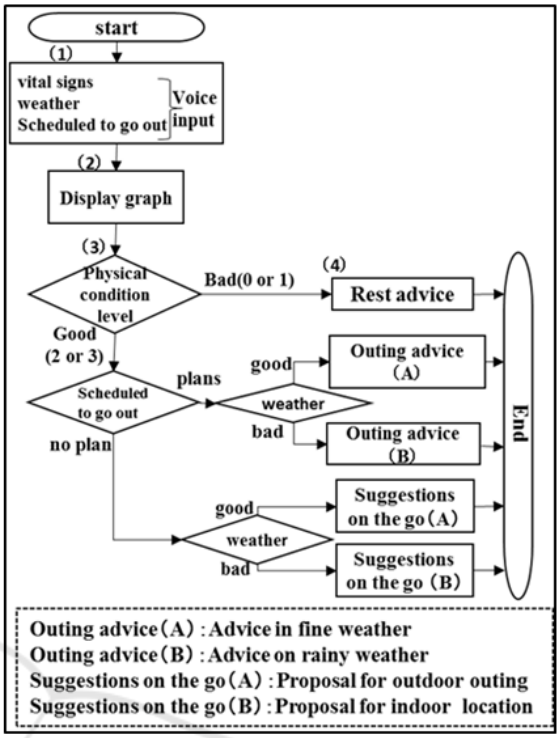

Figure 2: Overall flow of developed application.

3.2 Physical Condition Determination and Health Advice

The health state is ascertained by comparing the measured physical data of the day with the average value of the prior 30 days. The physical data of elderly people have the following features (The Japanese Society of Hypertension 2009) (Arita et al. 2016).

(1) Many people have high blood pressure
(2) The pulse rate fluctuates greatly, but lower values are better
(3) Elderly people have higher than normal body temperature, but have difficulty noticing it themselves

We set criteria based on these considerations (Table 1). We chose the physical condition level (Table 2) according to the number of items to be satisfied. Then we gave health advice.

If the physical condition level is good, then people are advised to do outdoor activities. At that time, advice is based on weather information. For example, when the weather is good, proper hydration is encouraged ("Outing advice (A)" in Fig. 2) and outdoor activities are proposed such as park visits ("Outside destination proposal (A)" in Fig. 2). By contrast, when the weather is rainy, temperature

regulation is advised ("Outing advice (B)" in Fig. 2) along with staying indoors and the like ("Outside destination proposal (B)" in Fig. 2). Moreover, in an earlier study [3], as information necessary for elderly people to venture outside, we described the presence or absence of toilets on the go and barrier-free information, among others. However, if a person's physical condition is bad, then advice is given in light of the physical condition such as refraining from outdoor activities (Table 3).

Table 1: Criteria for physical condition.

Type	Conditions	
	Good	Bad
blood pressure	Difference from the average value over the past 30 days is less than 10 mmHg	Difference from the average value over the past 30 days is 10 mmHg or more
pulse	Difference from the average value over the last 30 days is less than 10 beats per minute	Difference from the average value over the last 30 days is 10 and more beats per minute
body temperature	Difference from the average value over the past 30 days is less than 1°C	Difference from the average value over the past 30 days is 1°C or more

Table 2: Physical condition judgment I.

Conditions	Physical condition	
Blood pressure · pulse rate · body temperature is good 3	3	good
Blood pressure · pulse rate · body temperature are good 2	2	
Blood pressure · pulse rate · body temperature are good 1	1	bad
Blood pressure · pulse rate · body temperature are all bad	0	

Table 3: Physical condition judgment II.

Physical condition level	Advice
Good (2–3)	· Be careful not to catch a cold sweat. · Wear a mask because it is dry.
Bad (0–1)	· Refrain from going out for a long time. · Devote attention to salt intake. (e.g., when blood pressure is high)

3.3 Implementation of Robohon

In application development, we create a graph-based conversation scenario using software (yEd graph Editor; yWorks Co.). This graphical conversation scenario is implemented in RoBoHoN by conversion it into an hvml file using tools created in Python published by Sharp Corp. and running in Android Studio™.

Creating a conversation scenario for RoBoHoN differs from the original flow chart format. Because the graph notation method is special, a method to modify the sample scenario (Sharp Corp.) and add a necessary graph was developed. A conversation scenario development example is shown in Fig. 3.

As described earlier, RoBoHoN has male gender, which is reflected in conversation. Compared with tablet PCs and robots without gender, it gives a more human-friendly and familiar impression. In addition, RoBoHoN has many words and remarks that are pre-set, assuming responses in advance. By creating scenarios that use them, flexible and natural conversation can be conducted (Table 4).

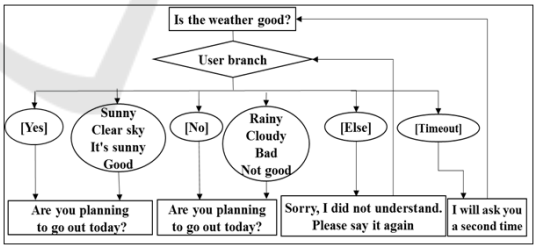

Figure 3: Conversation scenario development.

Table 4: Examples of words to which RoBoHoN reacts.

	Text example
Positive reply	Yes, good, ok, that's right, okay, Please do,
Negative reply	No, I can not, I do not want to, do not do, I do not need it, I will stop it, Different

4 PRACTICE

4.1 Evaluation Method

To assess the effectiveness in the developed system, we recorded the experiences of 10 men and women in their 50s to 80s who agreed to cooperate. We compared their questionnaire and interview responses to those obtained using tablet PCs equipped with a similarly developed application. The experiment conditions are portrayed in Fig. 4. The questionnaire was evaluated in four stages: 1. Good; 2. Somewhat good; 3. Somewhat bad; 4. Bad. Practices and timing are shown in Table 5. In this experiment, to present advice to promote outdoor activities when physical condition shows a change, the subject's response is set in advance: "when there is no physical schedule level 3 and no going out" and "there is no physical condition level 0 and no going out case" in the two scenarios were verified. This step eliminates differences among subjects according to the contents of presentation. Evaluation items for the system are presented in Table 6.

This research was conducted with the approval of the Research Ethics Committee of Osaka Prefecture University.

Figure 4: Experimental situation.

Table 5: Practice target and practical place · timing.

Target	10 adults in their 50s to 80s (6 men, 4 women)
Time	January 30, 2017 to February 1

Table 6: System evaluation item.

Voice operation	Was it easier to operate by voice?
Impressions	Did you want to use it in the future?
Health advice	Did you want to follow the suggested health advice?

4.2 Results

The average value of the questionnaire result is presented in Table 7. The speech manipulation was highly evaluated overall, but women evaluated it more highly than men did. Additionally, high evaluations were given for impressions of robots from participants of all ages.

Table 7: Questionnaire results.

Attribute		Overall	Men	Women
Number of people		10	6	4
Voice operation	Tablet PC	3.1	2.7	3.8
	Robot	3.5	3.3	3.8
Impressions	Tablet PC	3.4	3.2	3.8
	Robot	3.7	3.7	3.8
Health advice	Tablet PC	3.5	3.3	3.8
	Robot	3.4	3.0	4.0

Evaluation values are average (4.0 is the maximum)

5 DISCUSSION

Regarding operability by voice, the tablet PC was highly evaluated overall with 3.1 out of 4, robot 3.5. However, by sex, evaluation was 3.8 among women, but 2.7 among men. According to an interview survey, many men reported that they used electronic devices such as smartphones and tablet PCs on a daily basis. For those who are accustomed to tap operation, an inconvenience arose by which it can only be input after waiting for the voice guidance because it cannot be advanced at their own pace. However, one opinion holds that it is easier than the tap operation for a person who is not familiar with the tap operation. A system must be developed that allows a user to select the waiting time and guidance setting until input. Additionally, an opinion arose that the timing to address the robot is difficult because there are times when the robot reaction is slow and conversations cannot be done at a certain speed. Future improvements can be considered, such as shortening words to be recognized, thereby hastening the system operations.

As for impressions, the robot was given a very high rating of 3.7 overall. Reasons such as robot's "good appearance" and "good character" were described. RoBoHoN is small and can be picked up.

Because it speaks in first person voice, calling itself "boku," it might be perceived as a small boy, such as a child or a grandchild. The robot was therefore very accessible, with a friendly feel. Moreover, ambitious opinions were found related to the use of the developed system because "conversation is not working but fun." Responses of the tablet PC were monotonous responses such as "yes–no", whereas in the dialogue with the robot, responses were natural and conversational.

However, regarding the presented health advice, the tablet PC was evaluated as 3.5 vs. the robot evaluation of 3.4. Whereas a concrete example can be shown on the tablet PC, the robot can present only sound. For example, with meal advice, when presenting advice such as "Devote attention to salt intake," the tablet PC shows the amount of salt contained in food in the table.

However, evaluation of health advice from robots was high for women, probably because of the fact that the appearance is cute, so attachment is easy. It was easy to attract interest. To give effective health advice, we must consider visual as well as audio presentation using the display on the back and the projector function of RoBoHoN. Furthermore, regarding the health advice contents, in addition to proposals made outside, we would like to examine other points that were raised: "proposals for exercise for promoting health," "knowledge related to diseases," and "how to respond when symptoms of onset illness occur." Health advice must incorporate the age and sex of the user and the state of the individual.

This study used only conversation with RoBoHoN on the desk, but contact interaction with the robot might be effective for communication (Kanda et al. 2003) (Ogawa et al. 2011) (Nakagawa et al. 2012), so construction of a system to do them is also listed as a future task. In addition, this time, the subjects who consented to cooperate were few. Statistical analysis was difficult, only the evaluation by the average could be done. Therefore, it is a future subject to increase the number of subjects and conduct experiments.

The description presented above indicates that the health advice system using the robot is useful. It increases ones willingness to use it because of enjoyment of the conversation so that they talk with humans than speaking to a tablet PC, and the character nature compared. People are likely to listen to the health advice. Furthermore, since the evaluation was based on short interaction in this experiment, we would like to evaluate by long-term interaction similar to the actual situation in the future.

6 CONCLUSION

For this study, we developed a health advice system that uses a robot operated by voice. Elderly people can use it easily for promoting health management and light exercise (outdoors). Furthermore, this study compared the system with a tablet PC based system.

Speech manipulation was easy for those who were not accustomed to conventional tap manipulation. Evaluations were high, but it was reportedly difficult to use because it responded at its own pace. Therefore, it is necessary to design a system that can arbitrarily change according to user characteristics. Furthermore, flexible conversation capability that made use of the robot character is apparently fun because users can human communicate without monotonous input work and users tend to heed the suggested health advice. The system using a robot was demonstrated to be useful. We plan to improve the system using of the RoBoHoN's functions of camera and projector to promote behaviours modification.

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