A Study on Robot Motions Inducing Awareness for Elderly Care

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***Abstract*—In recent years, there are many applications based on IT for watching the elderly due to the increase of elderly population. Watching and medical care for the elderly is one of the promising application fields in IoT. Among them, detecting and preventing the risk of indoor heat stroke is an important topic. It is a crucial issue on how effectively notice the danger of heat stroke to the elderly. In this paper, we describe our trial for alerting the risk of heat stroke to the elderly people using a communication robot. We design and verify what kinds of robot motions are effective to solve the risk warning problem.**

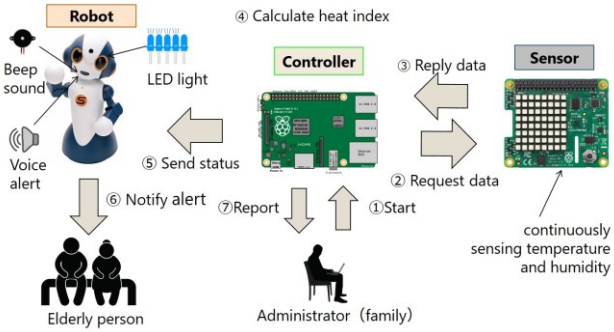
I. INTRODUCTION

Nowadays, the number of heat stroke patients over 65 years old has been increasing and about half of all the patients are occupied by that age. Additionally, half of elderly patients are affected indoors. Because aging makes the insensitivity of temperature and the consciousness level for heat stroke of the elderly lower significantly [1]. Therefore, developing a system for monitoring and detecting any risky conditions of indoor heat stroke and effectively warning the elderly can improve the situation. There is an attempt for exploring the mental support of the elderly using a robot by Sabelli et al. [2]. They installed a conversational robot at a nursing home for 3.5 months and observed the process of which the elderly has gradually accepted the robot in daily life and lived together based on ethnographic methods. They concluded that some activities such as daily greetings and talking to relatives using the robot make them feel closer to the robot and the robot becomes a mentally reliable partner.

In this paper, we propose a method for constantly monitoring indoor environment of the elderly by deploying our custom-made device and alerting them when detecting the dangerous state of indoor heat stroke using a communication robot. It is expected that the risk of indoor heat stroke can effectively be conveyed to the elderly using the robot. We design and implement some robot motions to robustly notice any incidents to the elderly by performing unique behaviors that are different from normal actions being generated during daily conversations with the elderly. We verify how such robot motions can effectively convey the critical information to users through preliminary experiments.

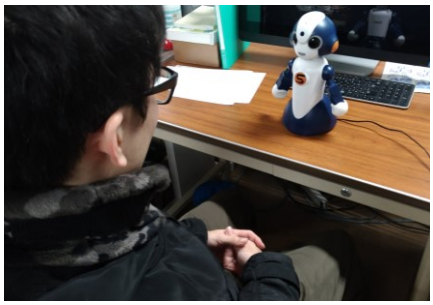
II. SYSTEM IMPLEMENTATION

Figure 1(a) shows the proposed system organization. A Raspberry Pi board is used as a main control device of the whole system. We use a sensor module called Sense HAT installed on the Raspberry Pi board for monitoring indoor environment and a robot as an agent for warning the risk to the elderly. The sensing device monitors the temperature and humidity of indoor environment and the control device analyzes the data. After that, the robot informs the elderly about the temperature and humidity, the risk level detected based on the heat index, and advice. Figure 1(b) shows a captured image of the experiment for the study using the bare metal system [3]. In this experiment, we found the elderly needed to pay careful attention to the system in order to get the environmental information such as confirming the LED flashing and hearing voice guidance. Additionally, we got some opinions from the elderly such as "psychological burden is imposed by the physical appearance of the system such as wiring", "I feel psychological resistance to many unknown



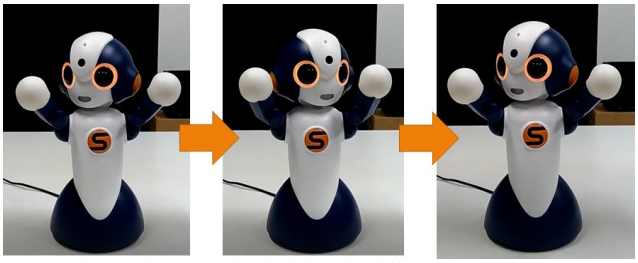
(a) System organization

(b) Experiment image using a bare metal system

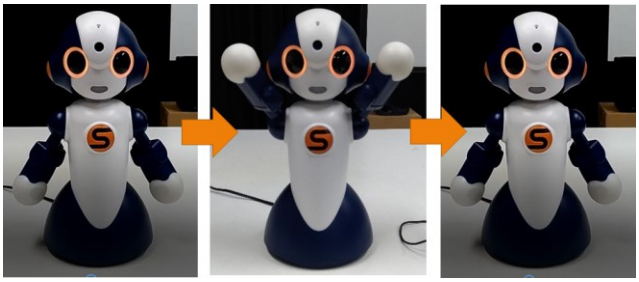


(c) Experiment image using a robot system

Figure 1. System organization and appearance.



(a) Motion A: finely moving both hands while swinging the neck twice



(b) Motion B: raising both hands twice

(c) Motion C: rotating the body while raising both hands twice

Figure 2. Robot motions used in the experiment.

devices in front of me". Based on these opinions, we devised the system by adopting a small humanoid robot as an agent for effectively warning the risk to the elderly while avoiding the psychological burden and making the elderly comfortable. Figure 1(c) shows a captured image taken in the experiment using the robot as elaborated in the next section. Whereas the robot normally makes the elderly comfortable by performing cute motions, it needs to effectively alerting the risk when detected. The motions for waking the elderly about the risk should be different from the normal ones. We, therefore, focus attention on designing and evaluating useful robot motions for the risk warning.

III. EXPERIMENTS

In the proposed system, we conducted experiments to verify the effective robot motions for making users noticed. We employed ten university students as subjects who are in their early 20s. We implemented three types of robot motions in this experiment as shown in Figure 2. In the motion A as illustrated in Figure 2(a), the robot finely moves both hands while swinging the neck twice. This behavior is similar to a human motion when he puts his hands on his head. This motion may make the subjects to feel closer to the robot. Figure 2(b) illustrates the motion B controlling the robot to raise both hands twice. It is an action for getting their attention by an unexpected strange hand motion. Finally, the motion C is the most exaggerated motion for rotating the robot body in parallel with raising both hands twice as shown in Figure 2(c). We implemented these motions to make the subjects pay more attention than other normal behaviors. In the experiment, we set a robot in front of the subjects and asked them to observe each motion as shown in Figure 1(c). Subsequently, we queried some questions such as "What is the most noticeable motion among the three motions?", "What is the most surprising one among the three motions?", and "What kind of impression did you have in each motion?" We also asked them to describe the reasons for why they gave the answer. Table 1 shows the results of the evaluation experiments. The most noticeable and surprised one was the motion C among the three motions. The subjects who indicated the motion C was noticeable as well as surprised one stated "it reminded me due to its big movements and strange behaviors". On the other hand, the motions A and B got the same number of supporters as an impressive behavior. Some subjects stated that "it seemed to be a human-like behavior". As a result, we found the big and exaggerated robot motions are effective for awaking users and conveying some important states like risky conditions through robot behaviors. We also realized that unusual robot motions should be an important factor for notifying the users of some different conditions from normal ones. Furthermore, we learned that the users can feel a sense of affinity to the motions of a humanoid robot. We would, therefore, like to improve the robot motions by designing effective motions for awaking the elderly based on the above-mentioned factors.

Table 1. Result of evaluation experiment.

	a	b	c	d	e	f	g	h	i	j
Most aware	C	C	C	C	C	C	C	C	C	C
Most surprised	C	C	C	C	C	C	C	C	C	C
Good impression	A	B	C	A	C	B	B	B	A	A

a-j: subject IDs

IV. CONCLUSIONS

In this paper, we proposed a system for alerting the risk of indoor heat stroke to the elderly using a communication robot. We designed and implemented three different robot motions for the risk notification. We conducted an experiments for verifying the influential factors of robot motions on awaking users, and got some useful results for further investigations. In the future, we would like to improve the system based on the findings acquired in the experiment.

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