The Elderly and Robots: A Factor to be Investigated for Human-Robot Symbiosis

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I. Age as a Factor in HRI

IT is estimated that there are several differences between elder and younger people on cognitive and behavioral characteristics toward anthropomorphized artifacts such as robots and animation characters on screens. Robots are expected as one of assistive technologies in home for the elderly, in particular, in industrialized countries including Japan, due to the decrease in rates of childbirth and the increase in the elderly population [1]. On considering the designs of these robots in domestic fields, it is necessary to clarify differences between elder and younger people on cognitive and behavioral characteristics toward robots.

However, there are only a few studies on direct comparison between elder and younger people focusing on robots. In an international study in several countries (Japan, United Kingdom, Sweden, Italy, and Korea), Shibata, Wada, and Tanie [2] developed and reported on participants' subjective evaluations of a seal-type robot called "Palo". Their results suggested that younger people had more favorable impressions of the robot than older people. Dautenhahn, et al., [3] reported results of a human-robot interaction experiment conducted in the United Kingdom which suggested that in the future, younger people compared to older people would like to have a home robot companion. Scopelliti, et al., [1] conducted a social research study in Rome and reported that younger people had more familiarity with robots than older adults.

The above existing studies measured participants' impressions and attitudes toward robots after interaction with some specific types of robots or instruction about scenes of using robots. However, they lack a comparison on concrete behaviors and cognitions in interaction with robots between elder and younger subjects. For this comparison, the research group of the author conducted two psychological experiments in Japan by using a small-sized humanoid robot, from October to December, 2008 [4, 5].

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II. Experiments for Comparison between the Elderly and University Students

A. Impressions of and Behaviors toward a Robot

Kidd and Breazeal [6] found that the difference on robot appearance (really existing robots or virtual CG animation robots) affects human cognition toward robots. When considering the introduction of robots from the perspective of cost and benefit, we should take into account the problem on which we should select virtual robots that can be implemented on the existing computers, or real robots that need other physical structures. The experiment aimed at investigating differences on impressions of and behaviors toward two types of artificial agents, a small-sized humanoid robot and a CG animation robot similar to this humanoid robot, between elder and younger people [4].

The experiment was conducted with 2 x 2 between-subject design of real v.s. CG robots and elder v.s younger persons. A total of thirty seven persons participated to the experiment. The number of the elder subjects was twenty (male: 10, female: 10, age: min 59, max 79, mean 68.7). They were inhabitants at a local city in the western area of Japan. The number of the younger subjects was seventeen (male: 7, female: 10, age: min 19, max 22, mean 20.6). They were university students in the western area of Japan.

The task to be requested for subjects in the experiment was manipulation of physical objects on a desk, similar with Kidd and Breazeal [7]. In the experiment, it was instructed by the robots with voice. The scenes of the experiment were recorded with a digital video camera to extract the subjects' concrete behaviors toward the robots. Moreover, a questionnaire consisting of twenty eight pairs of adjectives was used for measuring the subjects' impressions of the robots after the experiment sessions.

Behavioral indices extracted from the video data revealed that more elderly subjects performed utterance or greeting behaviors toward the real robot than the student subjects, although most of both subjects followed the instructions from the robots. Moreover, impression scores extracted from the questionnaire results found that the elderly subjects felt more positive impressions of the robots than the student subjects, the student subjects felt less attachment to the virtual robot than the real robot, and the student subjects felt less attachment to the virtual robot in comparison with the elderly subjects.

B. Identification of Affective Behaviors Expressed by a Robot

Expressive behaviors based on body motions are one of channels for communication between humans, and has a possibility of contribution to human-robot interaction, in particular, affective information from sociable robots to humans. However, it is also assumed that effects of affective body motions expressed by robots depend on age. In fact, Wong, et al., [7] suggested in their experiment on facial expression identification that older participants were at a distinct disadvantage on identifying fearful, angry, and sad faces by fixating their eye movement on the lower halves of faces. The experiment aimed at investigating differences on emotion identification of affective behaviors expressed by a small-sized humanoid robot, between elder and younger people [5].

A total of thirty two persons participated to the experiment. The number of the elder subjects was fifteen (male: 9, female: 6, age: min 64, max 79, mean 69.1). They were inhabitants at a local city in the western area of Japan. The number of the younger subjects was seventeen (male: 8, female: 9, age: min 18, max 23, mean 20.8). They were university students in the western area of Japan.

The experiment focused on three basic emotions, anger, sadness, and pleasure to simplify the experimental design. Based on the existing studies on affective body motions and a literature on modern dances, motions corresponding to these emotions were defined and implemented on a small-sized humanoid robot. Each subject watched these three motions in randomized order, and then responded a questionnaire measuring degrees to which she/he felt the expressed motion looked like the specified emotions, degrees to which she/he paid their attentions to some of body or motion parts, and degrees to which she/he felt the speed of the expressed motion was fast or slow, and the magnitude of the expressed motion was large or small.

The accuracies of emotion identification, rates of attention to body and motion parts, impression of motion speed and magnitude, and correlations between them revealed that almost all the student subjects identified the three types of affective body motion as the emotions intended by the motions, and many of them identified the anger and sadness motions of the robot as hate, in comparison that many of the elder subjects did not identify these motions as either the intended ones or the proximate one. Moreover, in comparison with the student subjects, more of the elder subjects paid their attentions to the upper body in the anger motion of the robot, the legs and feet in the sadness motion, which were not important on the affective expression implemented in the experiment. Furthermore, it was found that identification for the anger motion of the robot was more correct as the upper body was less paid attention to, and identification for the anger motion of the robot was more correct as the magnitude impression was stronger, and identification of the sadness motion was more correct as the speed impression was weaker.

III. Discussion

The results of the first experiment suggest that elder people may more positively accept robots as social entities and be less sensitive for the differences between robots with real bodies and virtual robots on computer screens than younger people. Important is that the above trend in the Japanese subjects of the experiment is opposite to those in Europe suggested by Scopelliti, et al., [1] and Dautenhahn, et al., [3]. This fact implies cultural differences on age effect into the acceptability of domestic robots.

On the other hand, the results of the second experiment suggest that effects of emotional expression by robots may depend on age, relating with individual cognitive characteristics. It implies that robotics designers using body motions as a mode of affective human-robot interaction should be sensitive for human factors for emotion identification and their dependence on users' demographics such as age.

The above experiments have some problems such as the small sample size, limited interaction between humans and robots, and limited factors of robots. In order to realize human-robot symbiosis, we should take into account age effects in HRI and extend experiment designs, while considering their interaction effects with cultures, context under which robots perform, and robot factors such as appearance and size.

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