Comparison of Human–Robot Interaction of Robot for Children's Hospital Life Adaptation

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***Abstract*— Experiencing hospitalization and illness is an important event that affects the child 's development process. However, pediatric hospitals do not fully consider the child patients' adaptation as they mainly focus on the treatment and prevention of disease. Therefore, Robot 'Mun' was proposed to help children's treatment process in order to provide a pleasant hospitalization experience in the children's hospital. In order to develop a robot for children certain supplementation sequence trial should be made in advance. Subsequently, Human–Robot Interaction (HRI) trial was held to actualize the Mun robot development process. Referred as HRI Human–robot interaction stands for the study of interactions between humans and robots. Human–robot interaction is a multidisciplinary field with contributions from artificial intelligence, human–computer interaction, robotics, natural language understanding, design, and social sciences.**

This study was conducted for the purpose of additional development and evaluation of the robot based on comparison of its Human–Robot Interaction (HRI). Eventually, the HRI results will be used to develop Mun robot before applying it to the clinical setting. Through this study a set of Godspeed Questionnaire Series was used to analyze and compare the robot perception regarding Nao robot and Mun robot.

***Index Terms*—HCI, HRI, hospitalization, human-robot interaction, Nao robot**

I. Introduction

Child patients sometimes feel anxious and scared when they are in a hospital environment [1]. Caring robots for child patients have been researched and developed in preceding studies, to relieve such a sense of fear and anxiety. The Huggable robot that was developed by the MIT Media Lab is well-known as a medical companion robot. It is a robot made in the form of a teddy bear. It was introduced for the purpose of mitigating the pain and stress that hospitalized children experience [2].

According to a previous research, child patients can feel friendly toward the teddy bear robot by communicating and playing with it. It can contribute to alleviate stress caused by the hospital environment. The mediRobbi is also an interactive robot that helps child patients feel more comfortable during their visit to the hospital. It introduces the process of the medical treatment and accompanies child patients [3]. Moreover, there have been studies about child patients' demand for the humanoid robot Nao. Nao is capable of conversation and psychical curing, and it has recently been released in the market [4].

In line with such trends, Mun robot has been produced in Korea to help the process of children's treatment and help them have a more comfortable experience at the hospital. It was developed with the motif of Korea's traditional Moon jar (Korean traditional ceramic jar produced in the 17th and 18th centuries in the shape of the full moon). The robot focuses on giving child patients the visual, tactile, and auditory sense of warmth. One of the remarkable characteristic feature of Mun robot is that from its appearance it doesn't look like a robot. Its round curved shape and tangible texture is more like a soft ball which helps the child relaxe without causing tension.

For detiled infornation, Nao robot which was used for comparison with Mun robot was first produced in 2008. It has two legs and two arms and can move with various joints. The height of Nao robot, is about 0.57 cm and the weight is 4.5 Kg. Eventhough it has three fingers, Nao robot's has a child-friendly appearance and the shape of the robot itself is similar as a child. It is not only cost effective but also easy to program the software with its own Graphic User Interphase(GUI) Choregraphe. Moreover, it supports various languages so it can approch people from various multi national countries. Because of these advantages, Nao has been used in many human–robot interaction (HRI) and Child-Robot Interactions (CRI) studies such as intervention for autistic spectrum disorder (ASD) patients using. Moreover, it is also used to amuse children with cancer [5][6][7][8]. Therefore, for the comparison Nao robot was used in this research.

For detail comparsion Human–Robot Interaction (HRI) method was used. By using Human–robot interaction method we can analyze robots from various dementions. We can analyze and compare the contributions from artificial intelligence, human–computer interaction, robotics, natural language understanding, design, and social sciences. General HRI research include methods for perceiving humans, methods for motion planning, cognitive models and theory of mind, methods for human-robot coordination. Human–robot interaction is the area of robotic science which focus studying people's behavior and attitudes towards robots. Relationship between different factors can be seen such as physical,

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technological and interactive features of the robots. HRI method can reflect whether the robot can be acceptable to people, and meet the social and emotional needs. By considering the individual users need, the robot can be developed on the base of respecting human values[9].

This study was conducted for the purpose of additional development and evaluation of the robot based on comparison of its before its clinical application.

Figure 1. Mun and Nao robot demoplay

II. Methods

As the Mun robot and Nao robot demo-play was held in the final presentation of robot development project, the evaluation was carried out on June 5, 2018 at the Faculty Lounge of the Seoul National University Library. Seoul national university faculties and other researchers participated in the evaluation. As shown in Fig. 1, both Mun and Nao robots were observed and evaluated on the table.

The Mun robot responded to the touch sensor which is a unique function during the process(see Fig. 2). By activation, the robot delivered the sounds of traditional instruments recorded in advance and changed color of robot's body. On the other hand, Nao robot, which has been set to the Korean mode, showed pre-prepared dialogs and gestures for event guidance and Nao introduction in order. Nao robot programmed with Choregraphe 2.1.4(see Fig. 3)

Participants proceeded to evaluate the two robots after all demonstrations. A total of 13 questionnaires were distributed, and 2 unreliable responses were excluded. The remaining 11 were used for analysis.

Figure 2. Mun robot's reaction by touch

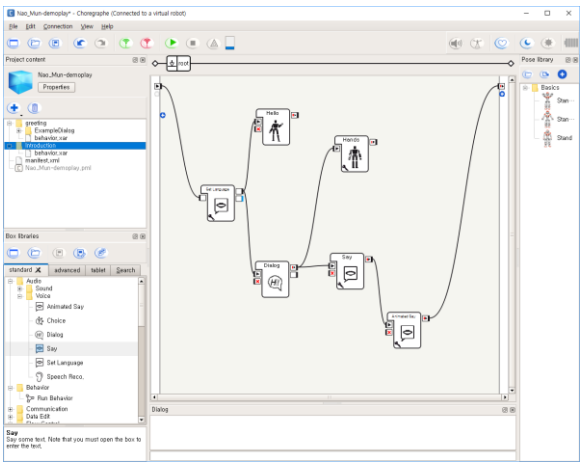

Figure 3. Nao demoplay programming by Choregraphe 2.1.4

A. Measurement

The Godspeed Questionnaire Series was used for questionnaire. This is one of the most widely used questionnaires in the field of HRI, and it has been cited more than 600 times as of October 2018 [10]. The tool, developed in Germany, has been translated into diverse languages. It was translated into Korean by a professional translator and was revised based on the advice of a relevant expert. For convenience sampling, 11 related people were selected to participate in the survey.

B. Analysis

The results were processed using IBM SPSS 22.0. Demographic characteristics collected from the questionnaire were analyzed using constants, percentages, means, and standard deviations. A Wilcoxon rank sum test was used to compare robot perception regarding the Nao robot and Mun robot.

III. Results

A. Demographic Characteristics

Eleven participants were surveyed; 72.7% were male and the mean age was 42 ± 10.3 years. Most of

participants have master or Ph.D. degrees, and the major was diverse (Table I).

TABLE I. DEMOGRAPHIC CAHRACTERISTICS (N=11)

Characteristics	N	%
Sex		
Male	8	72.7
Female	3	27.3
Age		
≤40	5	45.5
>40	6	54.5
Education		
≤bachelor	1	9.1
Master	3	27.3
Doctor	7	63.6
Major		
Nursing informatics	4	36.4
Art	5	45.5
Robotics	1	9.1
Business administration	1	9.1

B. *Differences in Robot Perception Between Nao Robot and Mun Robot*

A comparison of the perception of robots by the subjects who observed the performance of two kinds of robots showed differences in animacy, likeability, and perceived safety. The differences in the animacy categories were "stagnant/lively" (Z = -2.111, p = .035) and "mechanical/organic" (Z = -2.132, p = .033). Users felt Nao was more active than Mun, but Nao was more like a machine. The items that showed differences in likeability categories were "dislike/like" (Z = -2.640, p = .008), "unfriendly/friendly" (Z = -2.460, p = .014), and “awful/nice” (Z = -2.460, p = .014). Participants reported that Mun was more appealing, intimate, and good than Nao. In perceived safety categories, all three items showed differences, and Mun was more relaxed (Z=-2.332, p=.020) and silent. However, participants felt that Nao was calmer than Mun (Z=-2.511, p=.012). There were no significant differences in anthropomorphism and perceived intelligence categories (Table II).

TABLE II. PERCEPTUAL DIFFERENCES BETWEEN NAO ROBOT AND MUN ROBOT (N=11)

Categories	Nao	Mun	Z
	Mean ± SD		
Anthropomorphism			
Fake/Natural	3.55±0.69	4.09±0.83	-1.730
Machinelike/Humanlike	3.18±1.17	3.27±1.01	-0.183
Unconscious/Conscious	3.64±0.81	3.45±1.04	-0.412
Artificial/Lifelike	2.82±1.17	3.36±0.92	-1.200
Moving Rigidly/Moving Elegantly	3.45±0.93	3.45±1.21	0.000
Animacy			
Dead/Alive	3.64±0.67	3.64±1.03	0.000
Stagnant/Lively	3.73±0.65	3.09±0.94	-2.111*
Mechanical/Organic	2.73±1.01	3.91±1.14	-2.132*
Artificial/Lifelike	2.82±1.08	3.45±1.04	-1.208
Inert/Interactive	3.73±0.90	4.09±1.14	-0.973
Apathetic/Responsive	3.91±0.94	4.09±1.22	-0.491
Likeability			
Dislike/Like	3.45±0.69	4.36±0.92	-2.640**
Unfriendly/Friendly	3.55±0.82	4.36±0.92	-2.460*
Unkind/Kind	3.82±1.17	4.00±1.00	-0.513
Unpleasant/Pleasant	3.64±0.92	3.91±1.04	-0.879
Awful/Nice	3.36±1.21	4.45±1.21	-2.460*
Perceived Intelligence			
Incompetent/Competent	3.91±0.83	3.55±1.04	-1.190
Ignorant/Knowledgeable	3.91±0.83	3.36±1.12	-1.897
Irresponsible/Responsible	3.82±.75	3.45±1.04	-1.633
Unintelligent/Intelligent	3.82±0.87	3.55±1.04	-1.000
Foolish/Sensible	3.64±0.81	3.45±1.13	-0.577
Perceived Safety			
Anxious/Relaxed	3.18±0.87	4.09±1.30	-2.332*
Agitated/Calm	2.91±0.70	1.73±0.90	-2.511*
Quiescent/Surprised	3.18±0.87	1.64±0.67	-2.588*

*p<.05; **p<.01

IV. DISCUSSION

It is thought that the animacy of the Nao robot is greater and its perceived safety is lower than those of

Mun, reflecting the difference between the Nao robot, which has joint movements, and Mun, which does not have joints, in terms of the characteristics of their robotic structures. Interestingly, likeability is significantly higher for Mun than for Nao. According to the previous study of robot motion and behavior, certain movements of the robot such as movements accompanying speed or direction may increase the users anxiety. The robot users may feel frightened, annoyed or disturbed [11][12]. Considering these results, the robots appearance and movement was designed. Mun's like ability was higher than Nao for 34 aspects under five items. This implies that an emotional approach in HRI makes people have a more favorable impression about the robot, while the robot's active movement is important.

The result of this study has limitations in that it was conducted with demonstration play of the robots, so it cannot be widely generalized; in addition, the study was conducted on adult participants, not the actual users of the robots. Lastly, acceptance and perception of robots may differ depending on the characteristics of user. Further research should assess perception according to the age, gender, and experiences with robot. However, it is meaningful as a foundation for further research in the field.

V. Conclusion

As a result of comparing two robots, interestingly, robot preference was high through emotional approach using only sound and visual effects without physical movement. In addition, robots with less joint motion were highly evaluated for stability.

These results can be used to develop robots for vulnerable subjects in the future.

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