Gendered Robots: The Impact of Visual Design on Robots' Gender Perception

Hsiao-Chen You, National Taichung University of Science and Technology, Taiwan
Wei-Tsz Hung, National Taichung University of Science and Technology, Taiwan

Abstract
With the rise of gendered innovations, the field of Human-Robot Interaction (HRI) has begun to pay more attention to gender issues of robots, especially the effects of gendered robots on Human-Robot Interaction. This study aims to investigate the influence of robots' visual design on people's gender perception in robots by using Kansai engineering methods. A within-subjects study experiment was conducted. Four types of design cues commonly seen in gendered robot design, hair length, body color, decorative color, and accessories, were chosen as independent variables. Based on Taguchi's orthogonal array, 9 experiment conditions were selected, and images of the 9 robot prototypes were prepared based on Ubtech's Lynx robot. The 6 masculine adjectives and 6 feminine adjectives in the 12-item Ben's Gender Role Inventory (BSRI-12), plus an adjective pair of subjective gender judgment, male-female, were used as the gender perceptual dimensions (the dependent variables). Through the online questionnaire, we asked the participants to look at the robot images one by one, then rated the gender perceptual dimensions with a 5-point Likert scale for each robot. From 280 valid questionnaires, the results showed that: (1) Visual design does affect people's perception of robot gender; (2) Stereotypes related to human gender are also suitable for judging the gender of robots (male/female), but It is not suitable for judging the gender roles of robots (masculine/feminine); (3) People's judgment on the gender of a robot and its gender role is slightly different, and the gender cues that trigger these two gender perceptions are also different. These findings could guide future designers to produce more sophisticated gendered robots.

Keywords: Human-Robot Interaction, Gender Cue, Gender Perception

iafor

The International Academic Forum
www.iafor.org

Introduction

In the evolution of human social interaction, "gender" has often been the basis for interpersonal interaction in socialization, which is used to define the characteristics of partners involved in the interaction. With the launching of anthropomorphic artificial intelligence (AI) related products such as Siri (intelligent assistant) and Pepper (service robot developed by SoftBank), people are becoming more curious about the virtual gender of AI (Knibbs, 2014; Newitz, 2009; Turk,2014). Schwartzman (1999) pointed out that "gender markers of robots can serve as 'anchor point' for users to further interact with the robots. With gender prompts, non-human robots can become more amiable and more human." Robertson (2010) believed that gender is a sign of identity, and "robot gendering" is actually giving robots a "socialized symbol", allowing users to understand the significance of robots in human life. In other words, users need to know the gender of the robot in order to create its identity for more meaningful interaction. The studies of Human-Robot Interaction (HRI) in the past have rarely touched the topic of robot gender. With the increasing popularity of AI services and the rise of the gendered innovation concept, researchers have started to include gender factors in HRI research, hoping to clarify the social interaction between robots and users and promote the innovation of robot services.

The purpose of this study is to investigate how people can determine the gender of robots through the design of their appearances. Kansei engineering was adopted to explore the impact of different design elements on "gendered robots", which can serve as a reference for designers in formulating the gender roles of robots in the future. The main questions discussed in this study include (1) can the design of a robot's appearance be used as a "gender cue" to trigger people's gender perception? (2) Will the difference in robot design for "gender cue" generate different effects on the user's gender perception?

Since there is a wide variety of robots, robots with different forms, functions, and media will affect users' experience and perception of HRI. Therefore, this study only focuses on simple humanoid robots, using Kansei engineering to explore the relationship between different design elements and their gender perceptions. In the following sections, some theories, research results, and methods related to this study will be briefly explained.

Related Studies

1.   Human-Robot Interaction

According to the definition of Latombe (2012), a robot is a multifunctional and mechanical device equipped with "actuators" and "sensors" under the control of a computer system. Robots can simulate the behavior or thinking of human beings. Such products or services will allow users to easily create the "Media Equation" (Nass & Yen, 2010). In other words, users will subconsciously regard robots as partners and adopt social rules of interpersonal communication to interact with the robots. Some robot researchers even discovered that users will apply the gender stereotype in human society to the interaction with robots, and suggested that designers should pay attention to the robot gender issue to avoid the misunderstanding between the user and the robot, or the formation of gender bias due to incorrect role setting (Wang, 2014; Wang & Young, 2014; Paetzel et al.,2016).

**2.	Gender Definition and Sex Role Inventory**

Human gender consists of two types: biological gender (Sex) and social gender (Gender). "Sex" is used to distinguish people's congenital differences from a biological point of view. For instance, human beings have clear differences in terms of their biological structures at birth, which are regarded as biological facts (Udry, 1994). "Gender", on the other hand, is a cultural and social attitude that is shaped under the process of social culture and supports "feminine" as well as "masculine" behaviors, products, technology, environment, and knowledge. In different societies and environments, individuals or groups of different sexes will have different expectations of genders in social roles due to their differences in cultures and lifestyles. Therefore, it can be said that gender is derived from the non-biological traits of social construction (Calhoun, Light, and Keller, 2001). Gender does not necessarily correspond to sex. As a matter of fact, gendered attitudes and behaviors are not regarded as fixed dualism, but as unsteady multiple continua (Fausto-Sterling, 2012).

In addition to the traditional gender role stereotype that men are masculine and women are feminine, Bem (1974) proposed the argument that "feminine" and "masculine" are relatively independent characteristics, rather than being at both ends of the same continuous gender dimension. Under the concept that these two personalities can be considered separately, gender roles can be divided into four categories: masculine, feminine, androgynous, and undifferentiated. The Bem Sex Role Inventory (BSRI) proposed by Bem is the most widely used gender role assessment tool available today since it contains as many as 60 BSRI items. Later on, some researchers proposed a short version of the BSRI, such as the BSRI-12 that contains 12 BSRI items (Carver et al., 2013).

**3.	The Impact of Gender on HRI**

A number of studies in the past have shown that even when the task and the interactive content are exactly the same, simply by assigning a specific gender to the robot through gender cues can affect the subject's feelings or behaviors about HRI. For example, Siegel, Breazea, & Norton (2009) explored the relationship between the gender of a robot and its persuasive power through a robot fundraising experiment and found that the gender of the robot does affect its persuasive power. Subjects of the experiment generally felt that the robot of the opposite sex is more credible, reliable, and attractive. In the actual fundraising experiments, male subjects indeed were more willing to make a donation to female robots. In contrast, the behaviors of female subjects were less affected by the gender of the robot. In the study conducted by Crowell et al. (2009), it was found that female voice AI makes people feel more reliable when only voice is used as an AI assistant for gender cues. However, in the case of physical robots, people felt that male robots are more reliable.

**4.	Gender Cues of Robots**

Studies have shown that several gender cues can make people generate the perception of gendered robots. For example, Wang (2014) found that using only different gender pronouns (such as "He" and "She") to describe robots can make the subjects demonstrate interactive differences in robots that are consistent with gender stereotypes in interpersonal interaction. Eyssel & Hegel (2012) found that hair length (Figure 1) will affect the subject's perception of the robot's gender. Moreover, it will also make the subjects apply gender stereotypes in human society to the personality and social role of the robot. Robots with short hair are considered more masculine, while robots with long hair are considered more feminine. Other

common robot gender cues include voice (Crowell et al., 2009), appearance color, body curvature (You & Lin, 2019), and accessories (Jung, Waddell & Sundar, 2016).
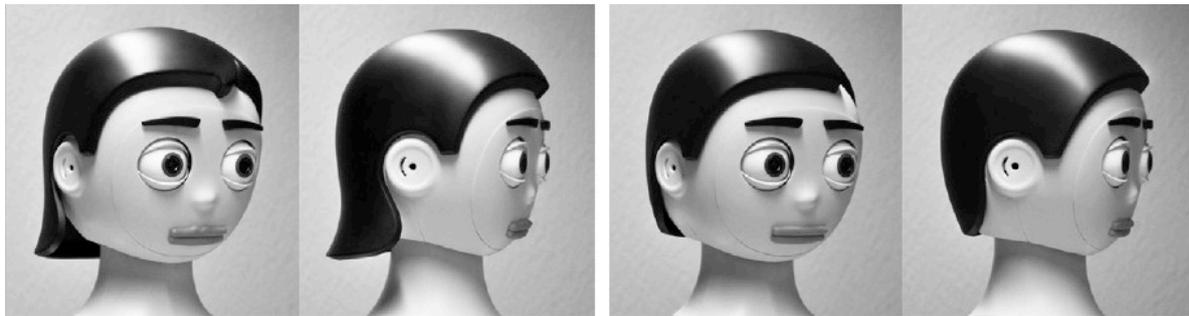

Figure 1: Eyssel & Hegel (2012) Used Hair Length as Gender Cues
(Left: Long Hair; Right: Short Hair).

5. Kansei Engineering

Kansei engineering is a consumer-oriented technique created for the development of new products, which can specifically transform the perceptions and images of consumers into design elements of new products (Chou & Chen, 2003). This technique was proposed by Kenichi Yamamoto, President of the MAZDA Group, in the 1980s. He believed that companies must design products with the objective of meeting the perceptual needs of users. With many successful cases, the technique has attracted the attention of the international design community, leading to the substantial application of the technique as well as its theory to product development (Nagamachi & Lokman, 2016). This technique often uses scales and statistical analysis of semantic expressions (Kansei words) representing different human feelings to explore the relationship between design elements and specific perceptualities. In the study, the main components (design elements) of the product are called "Items". The possible types or styles of each item are called "Categories". The main research processes include (1) collecting product samples and Kansei words, (2) selecting representative product samples and representative Kansei words, (3) deconstructing and sorting product samples to determine items and categories, and (4) establishing the correlation between design elements and Kansei words (Chou & Chen, 2003).
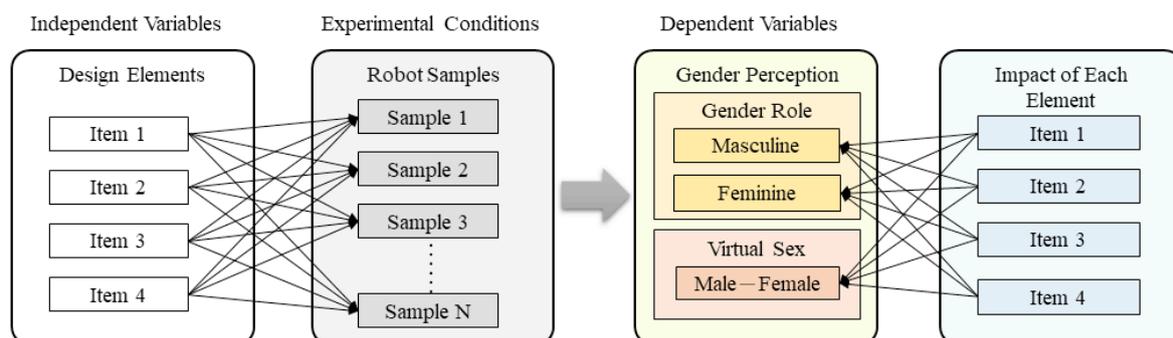

Figure 2: Conceptual Framework of the Study

Method

The overall conceptual framework of this study is shown in Figure 2. The gendered design elements (items and categories) of the robots determined through the "Kansei engineering" technique were the independent variables of the experiment. The dependent variables were

the subjective gender perceptions of the subject for the robot samples (experimental conditions) with different combinations of independent variables. They were divided into two major types of Kansei images, namely "gender" (gender role) and "sex" (biological gender). To collect a wide range of cases and obtain a significant amount of data, participants were recruited through online as well as on-campus recruitment. The participants were allowed to access the online form with their own digital devices, view the images of the robot samples, and complete in the Kansei scale. Finally, by the use of statistical analysis, the impact of each design element on different gender perceptions was determined. The detailed research method is described as follows.

1.   Collect Product Samples to Build a Corpus of Robot Appearance

First of all, considerable images of humanoid robots were collected online. Robots that are linked to well-known characters in movies/games were eliminated and duplicated or toy/cartoon-based robot images were removed. The collected images were used as the corpus of robot appearance in this study (Figure 3).
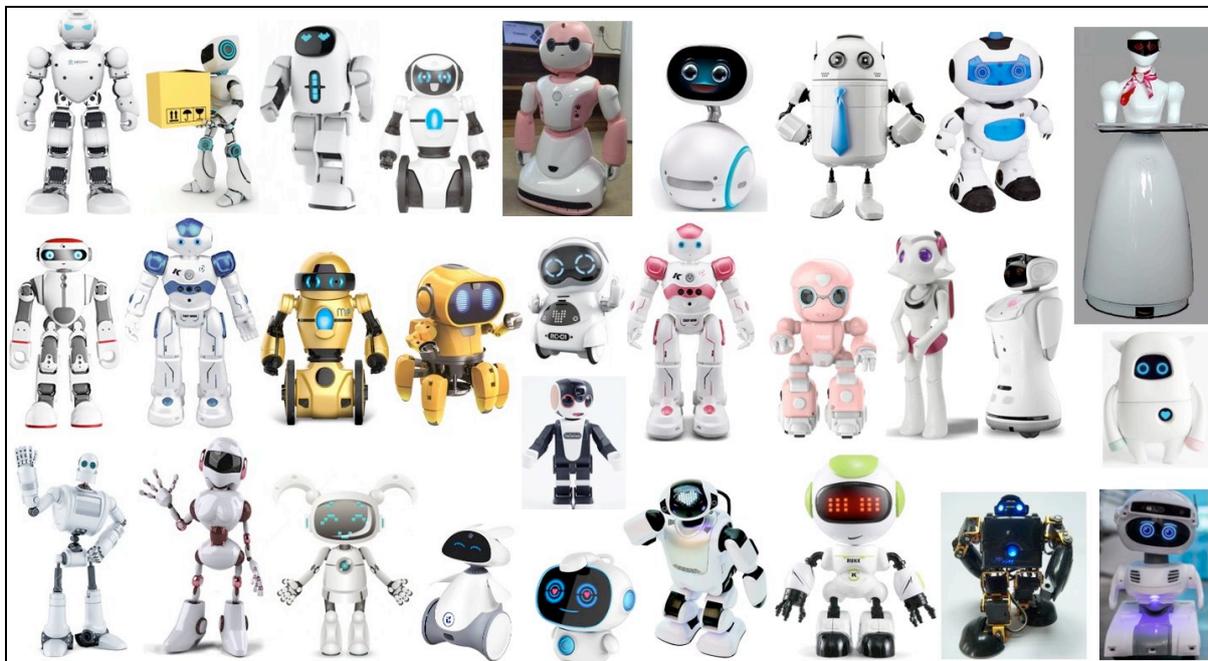

Figure 3: The Corpus of Robot Appearance in this Study

2.   Deconstruction of Robot Gendered Design Elements

The images of the robots in the abovementioned database were color printed on small cards. Students from the design department were recruited on the campus to carry out the experiment. They were asked to perform the classification of robots with different appearances based on gender or gender role by using the card sorting method. According to the returned data, the robot design elements that are more related to gender perception are summarized. Among them, four major elements were selected: decorative color, body color, accessories, hair length. Each design item consists of 3 categories. The design items and categories selected in this study are listed in Table 1.

Item / Categories	Decorative color	Body color	Accessories	Hair length
1	Blue	White	Tie	Long hair
2	Pink	Light gray	Bowknot	Short hair
3	none	Dark gray	none	none

Table 1: Robot Design Items and Categories Selected in this Study

3. Robot Sample Preparation

According to the description of the robot design items and categories in Table 1, the possible combinations of robot samples may reach as high as 81 (3 X 3 X 3 X 3). Considering a large number of samples in the full factorial experiment, the Taguchi Method is used for the experimental design. According to the L_9 (3^4) Taguchi Orthogonal Array, the number of samples was reduced to 9 representative samples. This study used the more neutral-looking humanoid robot, Lynx, developed by Ubtech as a prototype, and then used Photoshop to add the 9 combinations of design categories described in the L_9 (3^4) Taguchi Orthogonal Array onto the appearance of the original Lynx robot, completing the 9 representative images of robot samples (Figure 4).

Figure 4: Lynx (Left) and the Robot Samples in this Study (Right)

4. Selection of Representative Kansei Words and Measurement Method

In order to cover the implication of "sex (biological gender)" and "gender (social gender)" in gendering, this experiment used 6 feminine words and 6 masculine words from the BSRI-12 representing "gender (social gender)" and a pair of "female-male" adjectives representing "sex (biological gender)" to give a total of 14 Kansei words, as shown in Table 2.

Type	Sex		Gender (gender role)	
Level	Female	Male	Feminine	Masculine
Kansei Words	Female	Male	Warm	Has leadership abilities
			Gentle	Strong personality
			Affectionate	Acts as leader
			Sympathetic	Dominant
			Sensitive to other's needs	Makes decisions easily
			Tender	Defends own beliefs
Measurement Method	5-level semantic differential scale		5-point Likert scale	

Table 2: Kansei Words and Measurement Method Used in this Study

5. Scale Design

To recruit a large number of participants for the experiment, the robot samples were illustrated by 2D simulation images and displayed through the use of Google form, and the subject's subjective perceptions of the Kansei words were returned. There are 12 Kansei words related to "gender roles". The subjects are asked to use the 5-point Likert scale for evaluation: (1) strongly disagree, (2) disagree, (3) neither agree nor disagree, (4) agree, and (5) strongly agree. The most appropriate answers for the adjectives of these 12 gender roles were selected. The higher the score, the more the subjects are in agreement with the Kansei words. Regarding the Kansei word related to "sex" (biological gender), a five-level semantic differential scale was used. From 1 to 5, the subjects were asked to determine the gender of the robot sample, 1 being the most "male" and 5 being the most "female", 3 is neutral or no opinion. The subjects were asked to answer the 13 gender-related Kansei questions for each robot sample.

6. Statistical Data Analysis Methods

After collecting the Kansei evaluation data, the "Quantification Theory Type I" of Categorical Multiple Regression Analysis method was adopted to analyze the relationship between each design element and different perceptions. The impact of each item on a specific perceptual image was then analyzed by using the correlation between each item and category as well as the weighted value "partial correlation coefficient". The larger the value, the greater the impact of the item on the product perceptual image. In addition, the "Category Score" can be used to determine the impact of the categories under each item on the image, and the image prediction formula can be further deduced.

Results

The survey was conducted in June 2020. 280 participants were recruited online or on campus, including 148 males and 132 females. They are between 15 and 68 years old, with an average age of 26.7. Those aged under 20 accounted for 18.2%, those aged 20-29 accounted for 61.4%, those aged 30-39 accounted for 5.7%, and those aged over 40 accounted for 14.6%.

1. Analysis of Correlation Coefficient of Gender Role Kansei Words

First, through Pearson correlation coefficient analysis, the correlations of the 6 Kansei words relating to the gender role of "feminine" or "masculine" in the gender Kansei scale after translating into Chinese were examined. The results are shown in Tables 3 and 4. Regardless of feminine or masculine perceptions, the Pearson correlation coefficients of the two types of words are between 0.70-0.99, suggesting that the 6 Kansei words representing "feminine" and "masculine" in the BSRI-12 selected in the experiment are highly and positively correlated.

Masculine Kansei Words (Masculine expressions)	Word 1	Word 2	Word 3	Word 4	Word 5	Word 6
Word 1	1.000					
Word 2	0.870	1.000				
Word 3	0.879	0.988	1.000			
Word 4	0.859	0.761	0.701	1.000		
Word 5	0.867	0.851	0.825	0.872	1.000	
Word 6	0.856	0.940	0.950	0.711	0.868	1.000

Table 3: Pearson Correlation Coefficient for the Masculine Kansei Words in the BSRI-12

Feminine Kansei Words (Feminine expressions)	Word 1	Word 2	Word 3	Word 4	Word 5	Word 6
Word 1	1.000					
Word 2	0.971	1.000				
Word 3	0.891	0.932	1.000			
Word 4	0.904	0.964	0.906	1.000		
Word 5	0.889	0.918	0.852	0.969	1.000	
Word 6	0.831	0.893	0.822	0.927	0.906	1.000

Table 4: Pearson Correlation Coefficient for the Feminine Kansei Words in the BSRI-12

2. Quantification Theory Type I Analysis

Furthermore, Quantification Theory Type I of Multiple Regression Analysis method was adopted to examine the relationship between various categories/items and different Kansei words. This study aims to understand the impact of the robot's appearance on the two independent gender role traits of "feminine" and "masculine". Therefore, the ratings provided by the subjects for the 6 feminine Kansei words and the 6 masculine Kansei words are averaged to obtain the Quantification Theory Type I Analysis results of various items and categories in robot design elements for "gender role-masculine", "gender role-feminine" and anthropomorphic "biological gender-male/female" as shown in Table 5:
1. The Kansei (perceptual) image of masculinity: From the full range of category score, it is noted that the degree of impact of the design item on "gender role-masculine" is in the following order: "accessories"> "decorative color"> "hair length"> "body color". Among the three categories of the item "accessories" with the most impact, "tie" gives people a more masculine perception, while "bow tie" is less masculine.
2. The Kansei (perceptual) image of femininity: From the full range of category score, it is noted that the degree of impact of the design item on "gender role-feminine" is in the following order: "decorative color"> "accessories"> "body color"> "hair length". According to the category score, "pink" and "bow tie" give people a more feminine perception, while "tie" and "dark gray body" are less feminine.

3. The Kansei (perceptual) image of male or female: The degree of impact of the design item on the judgment of the robot's "virtual gender" is in the following order: "decorative color"> "accessories"> "hair length"> "body color". According to the category score, "pink", "long hair" and "bow tie" are more female-like, while "tie" and "blue" are more male-like.

Item	Category	Masculine (Gender Role)		Feminine (Gender Role)		Male /Female-like (Sex)	
		Category Score	Range	Category Score	Range	Category Score	Range
Decorative Color	Blue	0.19	0.38	-0.17	0.43**	-0.69	1.53**
	Pink	-0.19		0.26		0.84	
	none	0.00		-0.10		-0.14	
Body Color	White	-0.05	0.09*	0.10	0.29	0.08	0.21*
	Light gray	0.01		0.09		0.05	
	Dark gray	0.04		-0.19		-0.13	
Accessories	Tie	0.25	0.49**	-0.20	0.40	-0.72	1.47
	Bowknot	-0.24		0.20		0.75	
	none	-0.01		0.00		-0.03	
Hair Length	Long hair	-0.13	0.22	0.01	0.02*	-0.23	1.31
	Short hair	0.09		0.00		0.77	
	none	0.04		-0.01		-0.54	
Constant term		3.15		3.21		3.19	

Table5: Quantification Theory Type I Analysis Results of Various Kansei (Perceptual) Images

3. The Prediction Formula of Robot Gendered Design

By using the scores and constants of each robot design item and category in the "masculine", "feminine" and "male and female" perception in Table 5, a prediction formula for the gender of robots perceived by people can be determined. That is by summing up the "category score" of a certain perceptual image of the selected category under the four design items, and then adding it to the perceptual image, the predicted values of the three perceptions for all possible robot design combinations in this study can be deduced.

4. Prediction and Visualization of Extreme Values of Robot Gender Perception

According to the abovementioned formula and the scores of the Quantification Theory Type I categories, the highest value and the lowest value of the gender perception effect for the three perceptual images were determined and are shown in Table 6. Based on the highest and lowest prediction values of each perceptual image in Table 6, the extreme robot appearances of the three gender perceptions, namely "gender role-masculine", "gender role-feminine" and "biological gender (male/female)" were reconstructed as shown in Table 7. Through the visual comparison of the most extreme "gender roles", it is found that the robots with the "least masculinity" and the "most femininity" have the same design combination. However, the robots with the "least femininity" and the "most masculinity" do not have the same design combination (the robots have different hair length), suggesting that "masculinity" and "femininity" in the design of the robot's appearances are indeed not completely at opposite ends of the same dimension.

Kansei Image	Item	Decor. color	Body color	Accessories	Hair length	Masculine Prediction	Feminine Prediction	Sex Prediction
Masculine	Most	Blue	Dark gray	Tie	Long	**3.72**	2.42	2.65
Masculine	Least	Pink	White	Bow knot	None	**2.54**	3.78	4.63
Feminine	Most	Pink	White	Bow knot	None	2.54	**3.78**	4.63
Feminine	Least	Blue	Dark gray	Tie	Short	3.67	**2.64**	1.11
Male /Female	Most Female	Pink	White	Bow knot	Long	2.76	3.77	**5.63**
Male /Female	Most Male	Blue	Dark gray	Tie	Short	3.67	2.64	**1.11**

Table 6: Predicting the Extreme Value of Each Perceptual Image Based on the Quantification Theory Type I Results

Kansei Image	Masculine (Gender Role)		Feminine (Gender Role)		Male /Female-like (Sex)	
	Most Masculine	Least Masculine	Most Feminine	Least Feminine	Most Female	Most Male
Predictive value	3.72	2.54	3.78	2.64	5.63	1.11
Robot design						

Table7: Visualization of the Appearance of the Robots with Various Extreme Value Combinations for Each Perceptual Image

In addition, in the two most extreme images of the virtual "biological gender" of robots, the design of the "most male-like" robot is the same as that of the robot with the "least femininity" in the "gender role". However, the design of the "most female-like" robot is not the same as that of the robot with the "least masculinity" and "most femininity" in the gender role. It is noted that there is a slight difference between the "gender role" and the "virtual gender" of the robot.

5. Robot's Gender Role Classification and Virtual Gender Visualization

To emphasize the minute difference between the "gender role" and the "virtual gender" of the robots, the aforementioned formula was used to calculate the predicted values of the masculine, feminine, and male/female perceptions for all possible robot design combinations (81 combinations). According to the gender role classification method of the Bem (1974)

theory, the robot combinations with the top three predicted values in the four categories of "masculine", "feminine", "androgynous" and "undifferentiated" are presented visually by using the two dimensions of masculine and feminine as the coordinate axis (Figure 5). Similarly, the robot combinations with the top three predicted values of male and female are illustrated in a graphical representation by using male and female as a classification method at both ends of the gender dimension (Figure 6). From Figure 5 and Figure 6, the difference between the three different perceptual images of the robot's "gender role" and "virtual gender" can be observed.
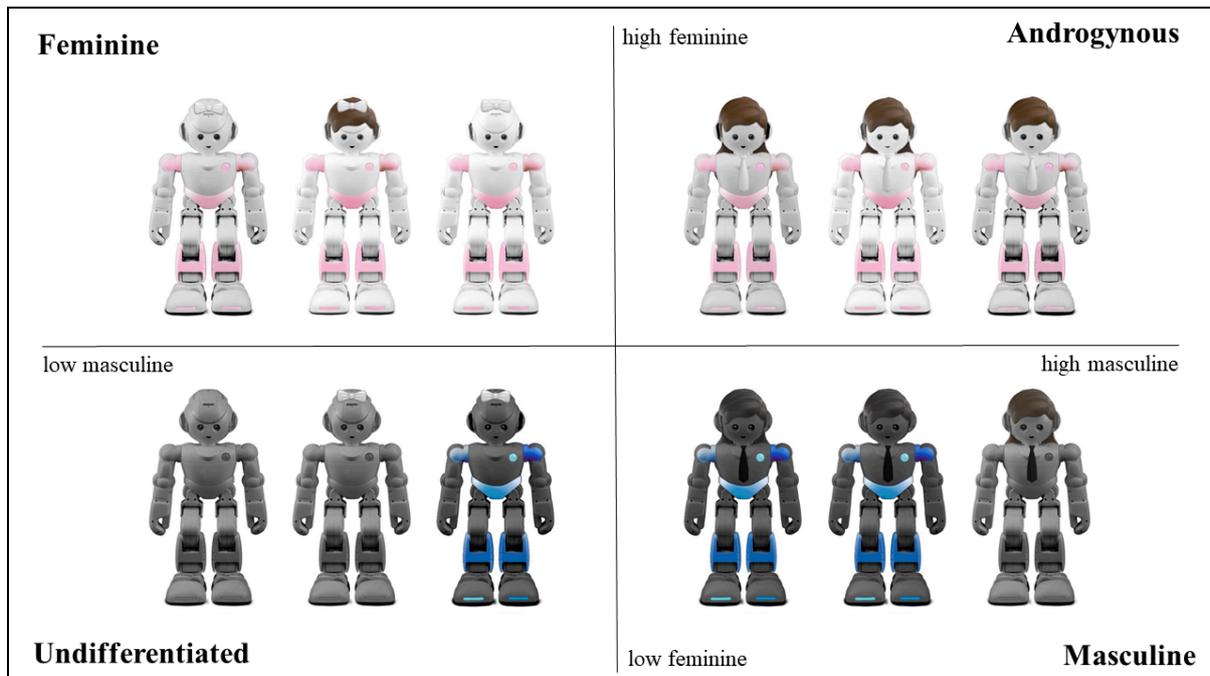

Figure 5: The Robots with Top Three Predicted Values in the Four Categories According to the Bem (1974) Gender Role Classification.
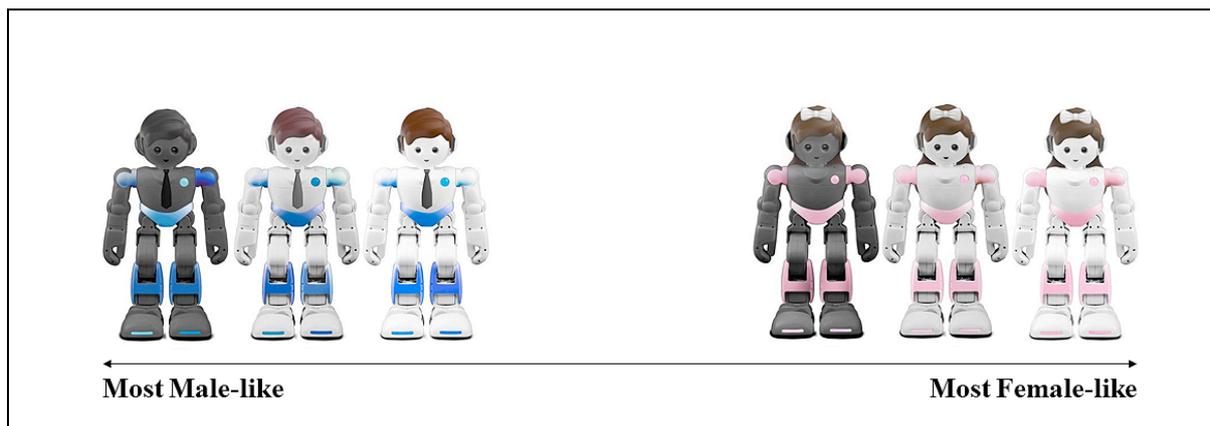

Figure 6: The Top Three Most Male-Like and Female-Like Robots According to the Virtual Gender Prediction.

Conclusion

With the advancement and popularization of artificial intelligence, robots are gradually entering into people's daily life. While robots are providing power and information processing for people, their anthropomorphic characteristics also make HRI users generate

the perception of pseudo-interpersonal interaction. To meet the demand for gender marking of robot roles in social interactions between people and robots for better AI experience, this study conducted Kansei engineering experiments on the gendering method of humanoid robots with low fidelity. We found that: (1) People do extend the gender stereotypes in human society to the virtual gender cognition of robots. The appearance design of robots does affect people's gender perceptions; (2) Robots do not have innate gender. Their pseudo-gender is provided through "gender cues". Therefore, it is particularly important to explore the differences that affect people's perception of the gender role (masculine/feminine) as well as the virtual gender (male/female) of robots, and the gender cues that may affect gender roles as well as virtual genders. The conclusions of this study are summarized as follows：

1.　　The "decorative color", "body color", "accessories" and "hair length" of the robot's appearance can indeed be used as gender cues to affect people's gender perception.

2.　　The impact of design elements on the perception of robots' "gender roles" and "biological gender" is slightly different, suggesting that people's perceptions of the robot's gender also differ between "gender roles" and "biological (virtual) gender".

3.　　The impact of "hair length" on robots' "gender roles" and "virtual genders" is inconsistent. The gender stereotype of humans in hair length is not quite applicable for the shaping of robots' "gender roles".

4.　　"Body color" has a greater impact on the perception of "feminine", but less on the perception of "masculine" or the perception of "male/female".

Since ancient times, people have developed abundant and diverse social behaviors as well as interaction rules by interacting with other members of society, forming the basic patterns of human civilization and social life today. With the popularization of robots, this study, through the analysis of preliminary experimental results, hopes to provide HRI researchers and robot developers with some design references for shaping the virtual gender of robots. In the future, if gender markers for promoting AI experience are required in robot design, one can divide the tasks and attributes of the robot, and choose the gender cues that suit the robot's "gender role" or "virtual gender" images to produce more sophisticated gendered robots.

Acknowledgements

References

Bem, S. L. (1974) The Measurement of Psychological Androgyny. *Journal of Consulting and Clinical Psychology*, 42, 2, 155-162.

Calhoun, C., Light, D., and Keller, S. (2001). *Understanding Sociology*. New York: Glencoe-McGraw-Hill.

Carver, L. F., Vafaei, A., Guerra, R., Freire, A., & Phillips, S. P. (2013). Gender differences: Examination of the 12-item Bem Sex Role Inventory (BSRI-12) in an older Brazilian population. *PloS one*, 8(10)

Chou, C. J., & Chen, K. (2003). Creating product forms with preferred Kansei Via formal features. *Journal of Design*, 8(2), 77-88.

Crowell, C. R., Villanoy, M., Scheutzz, M., & Schermerhornz, P. (2009, October). Gendered voice and robot entities: perceptions and reactions of male and female subjects. In *2009 IEEE/RSJ International Conference on Intelligent Robots and Systems* (pp. 3735-3741). IEEE.

Eyssel, F., & Hegel, F. (2012). (S) he's Got the Look: Gender Stereotyping of Robots1. *Journal of Applied Social Psychology*, 42(9), 2213-2230.

Fausto-Sterling, A. (2012). *Sex/Gender: Biology in a Social World*. New York: Routledge.

Jung, E. H., Waddell, T. F., & Sundar, S. S. (2016, May). Feminizing Robots: User Responses to Gender Cues on Robot Body and Screen. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 3107-3113). ACM.

Knibbs, K. (2014) What Gender Is Your Robot? *Gizmodo*, November 5, 2019. http://gizmodo.com/would-you-rather-own-a-boy-robot-or-a-girl-robot-1654656508.

Latombe, J. C. (2012). Robot motion planning (Vol. 124). *Springer Science & Business Media*, 1-2.

Nagamachi, M., & Lokman, A. M. (2016). Innovations of Kansei engineering. *CRC Press*, 1-10.

Nass, C., & Yen, C. (2010). *The Man Who Lied to His Laptop: What Machines Teach Us about Human Relationships*. New York, NY: Current.

Newitz, A. (2009). What Gender Is Your Roomba? http://io9.gizmodo.com/5268217/what-gender-is-your-roomba.

Paetzel, M., Peters, C., Nystrom, I., & Castellano, G. (2016, November). Congruency matters-How ambiguous gender cues increase a robot's uncanniness. In *International Conference on Social Robotics* (pp. 402-412). Springer International Publishing.

Robertson, J. (2010) Gendering Humanoid Robots: Robo-Sexism in Japan. *Body and Society.* 16.2 (2010): 1-36.

Schwartzman, R. (1999) Engenderneered Machines in Science Fiction Film, *Studies in Popular Culture*, Vol. 22, No. 1 (OCTOBER 1999), pp. 75-87.

Siegel, M., Breazea, C. & Norton, M. (2009). Persuasive robotics: the influence of robot gender on human behavior. *Intelligent Robots and Systems*, 2563-2568.

Turk, V. (2014) We're Sexist Toward Robots, *Motherboard*, November 3, 2014. https://www.vice.com/en_us/article/539j5x/were-sexist-toward-robots.

Udry, J. R. (1994). The nature of gender. *Demograp*hy, 31(4), 561-573.

Wang, Y. (2014). *Gendering Human-Robot Interaction: exploring how a person's gender impacts attitudes toward and interaction with robots*. http://mspace.lib.umanitoba.ca/bitstream/handle/1993/24446/wang_yan.pdf

Wang, Y. and Young, J. E. (2014) Beyond "Pink" and "Blue": Gendered Attitudes towards Robots in Society. *Proceedings of Gender and IT Appropriation (GenderIT'14),* pp 49 -59

You, H. C., & Lin, K. W. (2019, April). Gendered Tour-guide Robots and Their Influence on User Attitude and Behavior. In *Proceedings of the 5th International ACM In-Cooperation HCI and UX Conference* (pp. 32-35).

Contact email: hcyous@gmail.com