Categorizing Robot Appearance Attributes by Way of an Experimental Research Design

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ABSTRACT

This research mainly discusses the categorization of human's appearance attribute characteristics of robots and the image concept represented by appearance attribute characteristics in the connotation and extension of the category. The experimental design is divided into two stages. In the first stage, 6 design experts are invited to perform mixed-using the KJ method, along with the expert evaluation. and the categories are divided according to the appearance attributes of the robots for 106 different robot graphics cards. In the second stage, the focus group method is carried out according to each category, and then grounded theory coding is used to find out the image represented by the connotation and extension of the constituent category. The first level is the "five body" and "five unknown". The lower sub-levels of "Five body"is "humanoid", "Anthropomorphism", "animal shape " and "non-human as well as non-animal". The lower levels of "Anthropomorphism" and "non-human as well as non-animal" are "expression" and "flexibility" in order. The key feature point that affect "expression" is "the degree of changing in the eyes" and the key feature point that affect "flexibility" is "head to body ratio". However, the "flexibility" influenced by the "proportion of head and body" has opposite meanings under the categories of "non-human, non-animal" as well as "anthropomorphism".

1. INTRODUCTION

As the interactions between robots and human beings are increasing, robots are being recognized as social creatures. The interactions between human beings and robots are under the influence of the robot's appearance, facial expressions, gestures, voices and so on(Bartneck and Forlizzi, 2004; Kirby, Forlizzi and Simmons, 2010; Woods, 2006). However, the appearance of a robot is the first impression it gives to the user. And the appearance as well as the shape of a product can be composed by one or several shape features, and those different shape features will let people to have different feelings over different images, and eventually arouse remote or related attachments. Norman (2004/ Wang, Weng, Zheng and Zhang, 2014) points out that when he mentioned about the three levels of design and emotions, that the instinctive level of stage is the moment when the product appearance exerts the greatest influence, and it is also the time when the first impression is made. At that stage, people's reaction is an immediate perception.

Ever since Mori (1970) proposed the uncanny valley theory, a large number of researches that focused on the appearance characteristics of robots have been developed on the basis of anthropomorphism and the uncanny valley theory. Fong, Nourbakhsh and Dautenhahn (2003) proposed to classify the appearances of robots into four types: anthropomorphism , animalization, cartoon and function. Pütten and Krämer (2014), applied the cluster analysis to identify those common design characteristics shared by robots with the same adjective images, however, the identified sequences of each image characteristics or the connection between the designed feature and the connotation remain unknown. Current studies that are

focusing on the appearance of robots mainly explore the influence of the level of anthropomorphism has on people's feeling. Anthropomorphism is important, still, it may be simply one of the many identifying features. Entities which belong to the same category share same important characteristics. Therefore, through the understanding of human beings' categorization process of robots, the research further explores the important appearances, shape, attribution characteristics as well as their priorities with the certain categories.

2. METHOD

The cognition and **categorization** experiments of robots' appearances and shape as well as attribution characteristics are mainly conducted through the form of Focus Group workshops. The cognition of robots' appearances and poses as well as attribution characteristics are described and discussed mixed-using the KJ method, which was initiated by Kawakita Jiro, along with the expert evaluation. The experimental design is divided into two phases: the first phase is to collect a large number of picture samples of robots; the second phase is to held a focus group interview. On the basis of the "similarity between appearance and image", the appearance attributions of robots were grouped, and then each group was named according to their group, in the mean time, the most representative robot sample of each group was selected

2.1 Sample Preparation

The collection of picture samples of robots adopted online searching as methods. Three design experts were invited to collect a large number of robot pictures. Pictures collection time is two weeks. The repeated robot images were screened out, and a total of 106 original robot pictures were collected. Upon the completion of collecting the robot pictures, the robot pictures were processed by gray scale and printed out, the production size is of 8×8 cm image card, and each robot picture is coded in card.

2.2 Experimental Procedure

In order to further explore the cognition and the categorization method of robot appearances, shape attributions and characteristics, Invite six design-related experts to participate in the workshop of focus group interview. Participants shall classify the similarities of robot's appearance, shape attributions and characteristics according to the "Similarities between Appearance and Images. Each classified group shall then be named and select the most representative sample of robots from each group.

According to the profile data of audio and video recorded in the workshop, First carry out textual processing and organize it into verbatim drafts. Secondly, with the application of grounded theory in coding, conducting a coding analysis on the contents of the verbatim script. First, performing the open coding and the coding level are as follows: "punctuate the verbatim sentences" and "speaker", and "remarks" are needed to write down. Through comparative analysis, the surrounding text will be analyzed, compared and examined, and a paragraph of text will be named after an abstract concept so that it could define the "categorization category of human to robot appearances, shape attributions and characteristics", and then continue to analyze the nature and orientation of each category. Secondly, proceeding the Axial coding. Last but not least, the study summarizes and analyzes the cognitive concepts and categorization concepts of human beings on the appearances and shape attributes of robots, and establishes the categorization theory of human beings on the appearance and shape attributions of robots.

Table 1. Summary of the results from the experiment.

Conceptua Code	Code	Contents of Verbatim Script	Appendix
b.1	002-E	His Feature characteristic is with feet	Specify the boundary of the problem after defining the feature of the appearance attribution

3. RESULTS AND DISCUSSION

In the process of group division, study participants will not completely focus on one single group, but to constantly compare with the existing and clearly defined groups according to the attribution cards of robots that they selected. Only when the robot map of attribution is in line with the categorization feature points card, can the round map of categorization be placed to the recognized group position. Among them, participants in the study will also examine the clustering of robot cards while categorizing the robot cards, so the the consensus of the clustering partitioning strategy can be determined.

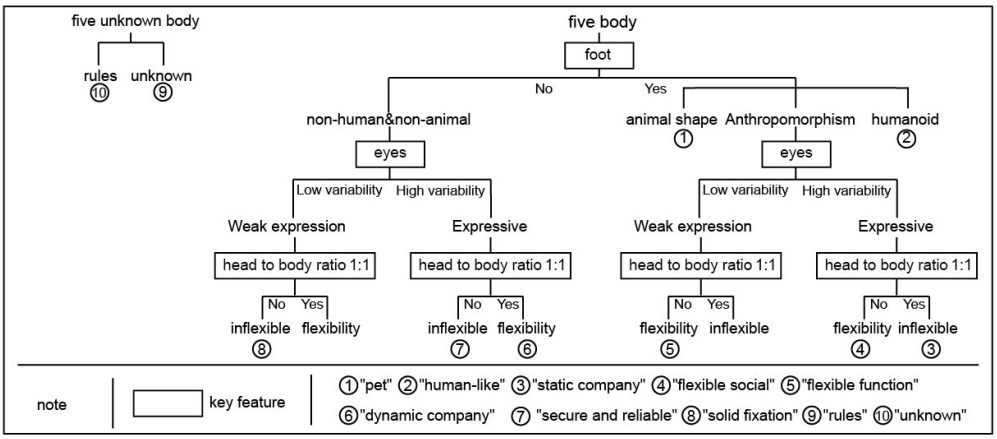

Figure 1：The Tree Diagram of the categorization Category Pattern for the Robot Appearance，Shape attributions and Characteristics

According to coding result that generated from the induction and analysis that the research participants performed on the robotics cognitive concept and characteristic of appearance attribution, and from the grouping method that research participants used, the first level is the "five body" and "five unknown". "Five body" has lower sub-levels of categorization, while the "five unknown body" is not limited to the zero lower levels of categorization. The second level of the "five body" is "humanoid", "Anthropomorphism", "animal shape " and "non-human as well as non-animal", among which "humanoid" and "animal shape" are not divided into lower sub-levels; The next level of "anthropomorphism" is "expression", while its key feature point is "the degree of changing in the eyes"; The key characteristic of "flexibility" of the next level is "head to body ratio"; The lower levels of "non-human and non-animal" are also "expression" and "flexibility", and the key feature are also "degree of changes in eyes" and "proportion of head and body". However, the "flexibility" influenced by the "proportion of head and body" has opposite meanings under the categories of "non-human, non-animal" as well as "anthropomorphism". The categorical pattern tree of the

coding analysis results is shown in Figure 1. On the basis of the results of the various aspects, the research participants proposed the names of images feelings of each field. So it can be divided in 10 groups, such as "secure and reliable", "solid fixation", "dynamic company", "static company", "flexible function ", "flexible social", " human-like ", "pet" and "rules" and "unknown".

4. CONCLUSIONS

In accordance with the "The Tree Diagram of the categorization Category Pattern for the Robot Appearance, Shape attributions and Characteristics " one can see that people's perception of the appearance attribution of robot is derived from the "differences between self", which is in line with Progoras (cited from what Plato/He, 2016) who believe that "Man is the measure of all things". The perception of people toward all kinds of people, things and objects of cognition, are all from the perspective of self standard, and then compared with its own state for further analysis. Understanding the way to divide the above mentioned category could help to understand consumers' expected images of robot appearances during the designing of robots in different fields.

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