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Preparatory data analysis for customer servicing interface of Buddhism statue ordering system

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Abstract: The authors have proposed a human mind model consisting of Stimulus, Knowledge, Emotion and Response Processing Agents and simulated human-robot communication based on it. This paper describes artificial *Kansei*, namely, *Kansei* for a robot as tight collaboration of Knowledge and Emotion Processing Agents of our mind model, and verbalization of affective information so called *Kansei* expression by Response Processing Agent, focusing on basic analysis of *Kansei* words for the customer servicing interface of a Buddhism statue ordering system under development.

Keywords: artificial *Kansei*, customer servicing interface, image retrieval

1 INTRODUCTION

In not so far a future, there will come true a symbiotic world of people and robots where they interact as naturally as people do without robots. For such a symbiosis, robots will be required to understand, as exactly as possible, what people do. Recently, there have been developed various types of real or virtual robots as artificial partners. However, they are to play their roles according to programmed reactions to stimuli and have not yet come to perform human higher-order mental functions such as *Kansei*. The multi-agent model of human mind was proposed by Minsky, M. [1]. This mind model, however, was too theoretical and complicated to computerize. The authors have proposed a human mind model consisting of Stimulus, Knowledge, Emotion and Response Processing Agents, much simpler and practical than the Minsky's model, and defined *Kansei*, more exactly, artificial *Kansei* as tight collaboration of Knowledge and Emotion Processing Agents [2].

Recently, they have been considering its application to the customer servicing interface of a Buddhism statue ordering system. This system is intended to help the customers specify their favorite Buddhism statues intuitively by *Kansei* expression.

The remaining sections of this paper are as follows. Firstly, the Buddhism statue ordering system is overviewed in Section 2 and a brief sketch of the multi-agent mind model and artificial *Kansei* is given in Section 3. Section 4 analyses several kinds of preparatory data of the system from the viewpoint of *Kansei* (or affective) engineering. Lastly, Section 5 discusses and concludes this paper.

2 SYSTEM OVERVIEW

Figure 1 shows the configuration of the Buddhism statue ordering system intended here. The customers are expected to input keywords and *Kansei* words and specify their intended statues well enough. At the present stage, such specifications are limited to statue categories (e.g., *Dainichi-nyorai*, *Fudomyoo*), materials (e.g., ebony, sandalwood), and facial expressions (e.g., fearful, peaceful).

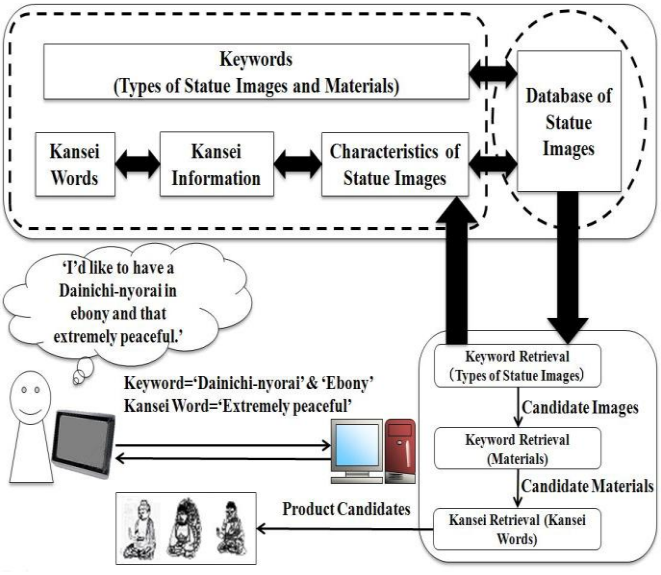


Fig.1. Buddhism statue ordering system

3 MIND MODEL AND ARTIFICIAL KANSEI

Figure 2 shows the multi-agent mind model proposed by the authors [2]. This is a functional model of human central nervous system consisting of the brain and the spine. The basic performances of its agents are as follows.

(1) **Stimulus Processing Agent** (**St**) receives stimuli from the world (**W**) and encodes them into mental images (i.e. encoded sensations) such as *"I sensed something cold."* (if verbalized in English.)
(2) **Knowledge Processing Agent** (**Kn**) evaluates mental images received from the other agents based on its memory (e.g. knowledge), producing other mental images such as *"It is false that the sun goes around the earth."*
(3) **Emotion Processing Agent** (**Em**) evaluates mental images received from the other agents based on its memory (e.g. instincts), producing other mental images such as *"I dislike the food."*
(4) **Response Processing Agent** (**Re**) converts mental images (i.e. encoded physical actions such as *"I'll run fast."*) received from the other agents into real physical actions against **W**.

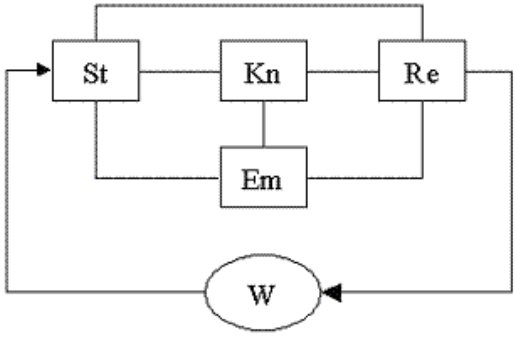
A *performance* ***P*** for a *stimulus X* with a *result Y* at each agent can be formalized as a function by the expression (1).

$$Y=\boldsymbol{P}(X) \quad (1)$$

where

P: a combination of ***atomic performances*** described later
X: a spatio-temporal distribution of stimuli from **W** to **St** or a mental image for another agent
Y: a series of signals to drive an actuator for **Re** or a mental image for another agent

A performance ***P*** is assumed as a function formed either consciously or unconsciously. In a conscious case, a set of atomic performances are to be chosen and combined according to *X* by a meta-function, so called, '***Performance Selector*** (PS)' assumed as '***Conscience***'. On the contrary, in an unconscious case, such a performance as associated most strongly with *X* is to be applied automatically.



St: Stimulus Processing Agent.
Kn: Knowledge Processing Agent.
Em: Emotion Processing Agent.
Re: Response Processing Agent.
W: World surrounding human mind, including his/her body.

Fig.2. Multi-agent model of human mind

It is well known that emotion in a human can be affected by his/her world, namely, ***W*** in Fig.2. For example, a person's evaluation of live image of an object (i.e. image output from **St**) expressed by such words as 'favorite', 'beautiful', 'tasty', etc. can vary depending on his/her emotional bias such as 'hunger', 'depression', etc.

Kansei is one of mental functions with emotion involved but has a more complicated phase than pure emotion originated from instincts or imprinting. For example, sweet jam may be nice on toast but not on pizza for certain people knowledgeable about these foods. For another example, people can be affected on their evaluation of an art by its creator's name, for example, 'Picasso'. These are good examples of *Kansei* processing as emotional performance affected by knowledge in humans.

Therefore, *Kansei* can be defined as human emotion toward an object affected by its information, so called, 'concept', including his/her intellectual pursuits, traditions, cultures, religions, etc. concerning it. In this sense, *Kansei* is assumed to be reasonable among the people sharing such concepts unlike pure emotion. These hypothetic considerations are formalized as (2) and (3).

$$I_P(x)= \boldsymbol{P}_E(S(x)) \quad (2)$$

$$I_K(x) =\boldsymbol{P}_E(S(x)\wedge O(x)) = \boldsymbol{P}_E(S'(x)) \quad (3)$$

where

$\boldsymbol{P}_E(X)$: Performance of **Em** for mental image 'X',
$I_P(x)$: Mental image as pure emotion for object 'x',
$I_K(x)$: Mental image as *Kansei* value for object 'x',
S(x): Live image of object 'x' from **St**,
O(x): Concept of object 'x' from **Kn**,
S'(x): Unified image of live image and concept.

4 AFFECTIVE ANALYSIS OF STATUES

Many psychologists have claimed that certain emotions are more basic than others [3]. We have assumed that human emotion consists of 5 primitives representing the degrees of 1) Anger, 2) Disgust, 3) Anxiety, 4) Happiness, and 5) Superiority. For example, the degree of Anger is intuitively measured by using such a word set as {terror, fear, scare, annoyance, upset, irritation, displeasure, anger, furry}, whose each element is possibly arranged on a coordinate axis and fuzzified with a certain characteristic function. Therefore, we have assumed *Kansei* as a certain function to evaluate totally the loci in the attribute spaces of these primitives [4]. Figure 3 shows our tentative arrangement of the word meanings on the scales of the primitive emotions (i.e., -9 through +9), where each wedge points the representative value of the corresponding word without characterization such as fuzzification.

Based on the 5 primitive emotional parameters, we have analyzed 18 Buddhism statues of 11 categories as shown in Fig.4 in order to plot them in the attribute space of *Kansei*

[4]. At the present stage of our study, semantic characterization of the involved words has not been completed yet and therefore we have used a rough scale with three ordered ranges such as 'Anti-emotion degree range (A)', 'Neutral degree range (N)' and 'High degree range (H)', whose intervals on each axis are [-9, -3], (-3, 3), and [3, 9], respectively. Table 1 and Fig.5 show an example of such analysis using this scale, where the values represent the averaged subjective scores of the authors (3 persons) and, as a matter of course, the averaged image (AI) was put at the origin (0,0,0,0,0) of the *Kansei* space [2, 4] (See Fig.6 in APPENDIX).

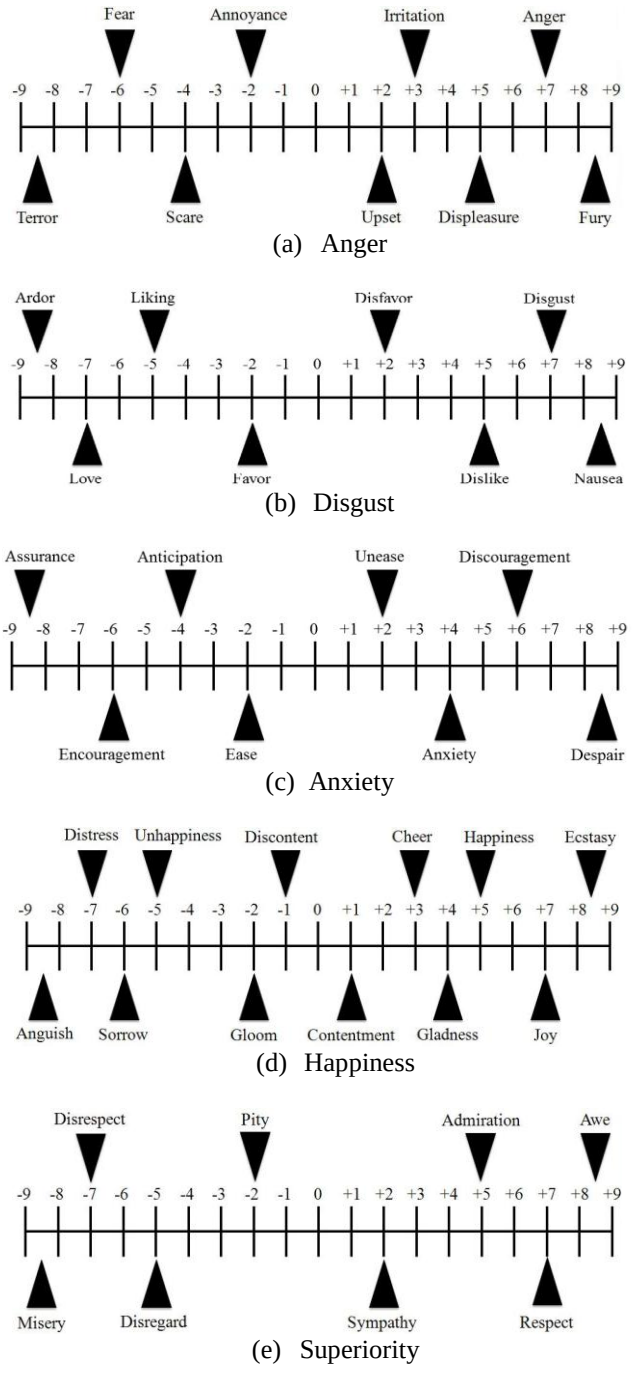


Fig.3. Scales of the primitive emotions

Fig.4. Samples of Buddhism statue images

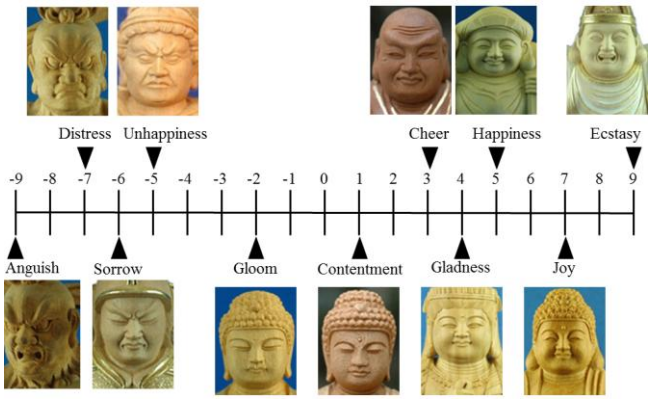


Fig.5. Tentative arrangement of images on Happiness-axis

Table 1 Affective analysis of Buddhism statues

Sample	anger	disgust	anxiety	happiness	superiority
AI	0	0	0	0	0
DN	N	N	N	N	N
FM	H	H	H	A	N
DT	N	N	N	H	N
AS	H	N	H	A	N
DS	N	N	N	N	H
SK	N	N	N	H	H
MT	H	N	H	A	H
NO	H	H	H	A	H

5 DISCUSSION AND CONCLUSION

The affective analysis of Buddhism statue images and the semantic analysis of *Kansei* words were described. Quite distinguished from others [e.g., 5], the images and the words are associated with each other indirectly via their semantic expressions, namely, vectors in the 5-dimensional space of *Kansei* and therefore their semantic analyses were conducted independently each other.

These results are to be associated with more sophisticated *Kansei* words for Buddhism statues such as peaceful, divine, gentle, reverential, noble, valiant, etc. and finally to be applied to the customer servicing interface of a Buddhism statue ordering system. The meanings of such words are to be represented as certain complicated vectors in the *Kansei* space as well as the images while each of primitive words such as happy, angry, etc. is represented simply in terms of the unit vector for each corresponding primitive emotion. The customers of the system are expected to use these words together with primitive ones for describing their own favorite statues at ordering and the system is bound to propose the users several candidates of high correlation values.

The averaged image was generated through the processes shown in Fig.6 in APPENDIX. Firstly, the image data were arranged for the noses to come to the center of the frame. Secondly, the faces were resized for their contours to touch the rectangular border of the frame and finally, they were averaged at each pixel. The computed cross-correlation values show, for example, that the average image is near to *Dainichi-nyorai* and far from *Fudomyoo*. This fact corresponds well with our intuition shown in Table 1. By the way, the variance image is not considered for any use at present.

As defined by Equation (3), *Kansei* can be affected by the knowledge of the person involved as well as his/her pure emotion. For example, the legend of Acala (*Fudomyo*) says that he is to be a powerful deity who protects 'All the Living (*Shujo*)' by burning away all impediments and defilements, thus aiding them towards enlightenment [6]. The knowledge of this fact can affect persons in their emotions so as to weaken the degrees of 'Disgust' and 'Anxiety' in comparison with their pure emotions evoked by its appearance. However, our qualitative and quantitative study of this point is still shallow and therefore its further elaboration will be also included in our future work.

Our mind model is much simpler than Minsky's but its realization based on the attribute spaces can work for representing and computing mental phenomena fairly well [2, 4]. The attribute space of *Kansei* is to play an important role in a certain robotic individuality of general use. For realizing a plausible *Kansei*, it is most essential to find out functional features of **Em** and to deduce from them such laws that rule $\boldsymbol{P_E}$. The most important problems to be solved are how to realize the attribute space of *Kansei* and how to build its corresponding atomic performance. In order to solve these problems, focusing on Buddhism statues, we will consider the application of soft computing theories such as neural network, genetic algorithm, fuzzy logic, etc. in near future.

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APPENDIX

The 18 image data were averaged through the processes shown in Fig.6 below. Additionally, the variance and the cross-correlation values among them were computed.

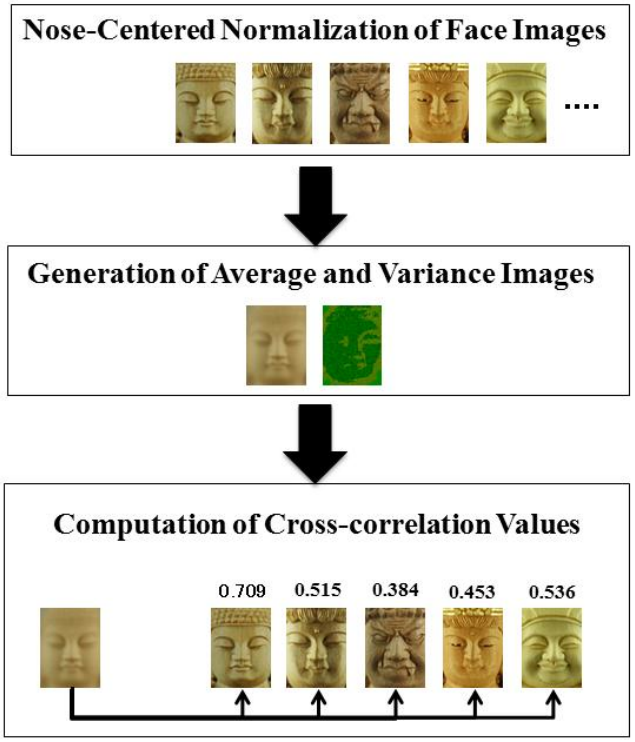

Fig.6. Process flow for image averaging