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Social Modification using Implementation of Partial Agency toward Objects

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Abstract: This paper discusses what kind of partial agency is implementable for objects to bring more suitable agencies toward human agent interaction. Human beings have an ability to inform fellows about our intention, internal states and requirements using verbal talk, gestures, attitudes, timings and other representations. These representations can keep our belief that we are sufficient agents mutually. The robots and virtual agent also mimic these representations, reproduce as if they have an agency, and interact with them. However, their agencies are sometimes too excessive compared to its task. This mismatch leads high cognitive load toward users and brakes interaction consequently. This defect prevents to apply human agent interaction method toward application field. The authors consider that our agency is constructed by multiple features and dividable. If these features are selectable, we can choose more proper design for virtual agents, robots, machineries, daily home appliances according to their traits. The authors categorized these agencies in several group and discusses about what elements achieves these features. The paper also shows what method can extract these features from human being.

Keywords: Anthropomorphization, Human Agent Interaction, Human Robot Interaction, Human Interface

I. INTRODUCTION

Today's human computer interaction field is widely developed by several different background researchers. Various robotics technologies like actuators and sensors gives the researches on informatics field the access method toward real-world. On the other hand, rapid development of computer gives mechanics engineers more sophisticated control method. Ubiquitous, human-robot interaction, interfaces is occupied several researchers. Challenges are tried in several fields.

These studies which related in human computer interaction are conducted by two different policies. One policy is called extension of human's ability. Figure 1-A shows the brief image of this policy. Technologies are accepted as extended third arm and extended machines interfaces. For example, glass type augmented reality (AR) technology gives users more visible information. If someone gets the glass type AR technology, s/he simply gets upgraded eyes. Tele-operation is another kind of extension about our own bodies. If we can manipulate actuators in another location according to our will, these actuators behave as third arms or legs for us.

Another policy places social buffer between users and system and convert several input/output using this buffer (shown in Fig. 1-B). The buffer is called agent [1]. The agent uses several metaphors like internal states, emotions, requirements to inform users. This method is supported by several cognitive science results, the

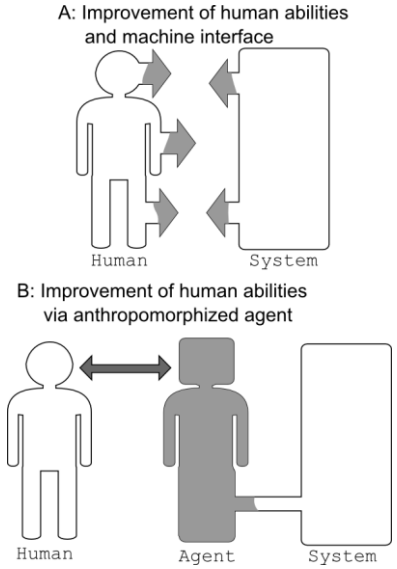

Fig.1. Difference between Extension and Agent Technologies in human computer interaction

background of artificial intelligence and enthusiasm toward lifelike agent. In this paper, we used human agent interaction as covering word of this ideology. We call human agent interaction as HAI. We also calls HRI (human robot interaction) as a HAI in the real world.

HAI method has advantages to inform several complex states toward users, especially for implying intentions and internal states by metaphors. For example, several states of video recorder, computers are possible to represent as its emotional states. If the object behaves with sad emotion, it suggests some wrong treatment is ongoing. On the other hand, if the object represents happy emotion, it multiply implies that the transaction is in order. The human-like social stance can bring restrictions toward determination of meanings. Ishida et al showed how conversation system improves quality by using several roles in the conversation.

Our study focuses to extend the application field of human-agent interaction toward more broad area using separation of agency. In this paper, we defines agency as any kind of representations that evocate user's intentional stance described in Dennett's work [2]. If we select and add agency separately according to required task of the system, system's ability will be expand. Figure 2 and 3 show how our approach extends human agent interaction. Figure 2 shows normal human agent interaction method. An agent is placed between the system and a user. It wraps system's input and output using social channels like attitude, emotion, gestures, and joint attentions. In our study, these channels are divided and applied partially according to the task the machineries required. Figure 3 shows the examples of partial agency method. If a machine runs under a location based task like a vacuum shown in Fig.3-A, it uses location related social channels. An attitude can emphasize which direction is informed. This works as a restriction of the representation. Joint attention has more sophisticated role in human-human interaction, but it also works to show a clue of positioned place [3]. On the other hand, emotions and gestures work more in the situation that a machine does not have an actual movement but have complex states like a printing machine shown in Fig.3-B. These social channels can inform several states to a user using metaphors.

This paper is organized as follows. Section 2 refers what kind of studies are conducted psychological field and HAI. Section 3 discusses what kind of problems disturbs the usage of agent toward application field.

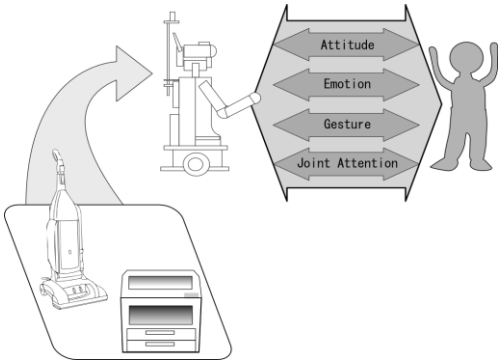

Fig.2. Previous Agent System

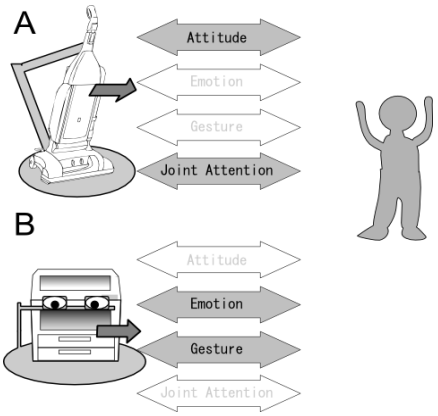

Fig.3. Implementation of Partial Agency

Section 4 shows the detail notion of partial agencies based on section 2 and 3. It also discusses how to extract partial agency from interactions by several implementations. Section 5 concludes our method.

II. STUDIES ABOUT USEFULNESS OF AGENT AND AGENCIES

Psychological studies and human agent studies have been revealed social features like emotions, gestures and attitudes that useful to improve machineries' interactions. We think that these features are important elements to construct agency. In this section, we examine how we have used elements of ourselves.

Emotions are one of the most important parts to evoke agency toward users. Human beings and other animals express emotions. One of the earliest studies about emotion is conducted by Darwin [4]. He compared several animals' expressions and discusses its influences. Paul Ekman categorized human faces with 6 types, happy, sad, angry, fear, disgust and surprise [5]. Robert Levenson organized another model for evaluation [6]. Even if the emotions do not be told just from abstracted appearances, these abstracted models are proposed and commonly used in virtual agent and communication robot. The utilization of emotions is

proposed several times. Rosalind Picard proposed effective computing that uses emotional cues as input and output of the system [7].

Gesture is another good example that is used to realize agencies. It is commonly used to support our conversations [8]. We use some gestures unconsciously, and other gestures intentionally. Mental space studies in psychological field describe how these gestures transfer information from one to another. When we hear spatial information like a feature location, we map the instructed position into our mental space. Psychologists analyzed this situation using blended mental space. The concept of blended mental space is proposed by Fauconnier [9]. Liddell suggests that mental space is also applicable to analyzing gestures [10]. The blended mental space helps to analyze the meaning of users' conversations using the virtual space of each user. For example, if you used the right hand to point a dial on wall and left hand for turning gesture, it is not instructing users to turn a dial in front of them. It instructs the user to blend these two gestures into the same mental space to turn one dial one way.

These human like features are selected from human activities. They have enough ability to make agency toward the object. Several human robot interaction and HAI studies uses these result for the improvement of interaction [1].

III. PROBLEMS BETWEEN HUMAN AGENT INTERACTION AND APPLICATION

Above section shows what kind of basic knowledge about human beings support HAI technologies. However, agent based interaction is sometimes not used in the real application instead of their usefulness. In this section, we discusses about several defects of an agent and HAI studies.

1. Compatibility problems

Agents' various modalities prevent to organize standard knowledge from comparing each study. Rene Descartes noted the importance "to divide each of the difficulties under examination" in his work [11]. This policy is basement of Science. However, HAI and HRI sometimes fails to order this requirement because the results of these studies are strongly related to the agent/robot themselves and difficult to discuss separately. For example, a result based on agent A may not be possible to be applied to another study using agent B, because of their different attributes.

2. Excessive anthropomorphization and agency

The researchers have a trend to hypothesize that anthropomorphism sometimes attracts people. However over-anthropomorphism sometimes distracts people from the interaction. This problem is based on three reasons.

First reason is mismatch of the agency. If the agent expresses the interaction that implies complex agency, the user estimates much more agency from the behavior. Adaptation gap study also noted this problem in the interaction [12].

Second problem is the mismatch of relationship between task and agents. Even if an agent acts is attractive and enough to express the appropriate agency, the mismatch of appearance still harm an interaction. For example, bug type robots are not appropriate for cooking task because it implies dirty image toward users. Robot designer Sonoyama illustrated several mismatch of the design of robots in his book [13].

Last problem is disgust toward anthropomorphization itself. Overwhelming feeling of social connection leads too much cognitive load toward users. Epley et al showed their study that people requires anthropomorphic attitude when they are disconnected by social connections [14]. This result indicates that if one is satisfied for social connection, additional anthropomorphic representation becomes unwanted exaggeration.

IV. HOW TO EXTRACT AGENCIES

In Section 3, we discussed what kind of shortcomings interfere the smooth applying of agency toward interface. To solve above problems, we simply propose the separated evaluation of agency using separated anthropomorphic devices. Each feature for an agency is constructed by each device. Extraction of the agency is achieved by subtraction of the interface from the previous agent equipped full of agencies.

Figure 4 shows what is achieved by our method. Figure 4-A describes the kind of features could be extracted by separation of agency. Each feature has been discussed in previous studies referred on Section 2. Previous HAI studies already researched what kind of agency is useful [1]. However, we can evaluate each feature simultaneously and separately if we divide each agency. As a result, we can evaluate more precise arrangements of agencies according to each user's tendency and attributes (like Fig. 4-B). Our previous study suggested that female users like anthropomorphic

representation more than male participants [15]. If a user does not want too much anthropomorphization, we can decrease features and can adjust most appropriate agency according to the user. Figure 5 shows some implementation according to our method. Figure 5-A shows partial embodiment. Eyes and arms are attached to a vacuum because a vacuum requires precise positioning toward users during cleaning. On the other hand, eyes and arms are removed from Fig. 5-B. Instead of rich appearances, 2 axis motors are implemented to represent to show an attitude because a microwave oven does not requires precise positioning.

V. CONCLUSION

We considered that our agency is constructed by multiple features and dividable. If these features are selectable, we can choose more proper design for virtual agents, robots, machineries, daily home appliances according to their traits. We categorized agencies referring previous studies and discussed about what elements are required. We also proposed what method can extract these features from human being using several devices.

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REFERENCES

[1] Yamada S, Kakusho K, Ono T, Ogawa K, Nakano Y, Komatsu T, Imai M, Osawa H, Komatsu K, Terada K, Kojima H, Nakagawa K, Kiyokawa S, Ueda K, Takeuchi Y (2008), Designing space between human and robot (in Japanese)
[2] Dennett DC (1987), The Intentional Stance, The MIT Press
[3] Tomasello M (1995), Joint attention and social cognition. In: C. Moore, & P. Dunham, editors. Joint attention: its origins and role in development, pp. 103–130
[4] Darwin C (1872), The Expression of the Emotions in Man and Animals, 1872
[5] Ekman P (1999), Handbook of Cognition and Emotion, John Wiley & Sons, Ltd.
[6] Levenson RW (1999), The intrapersonal functions of emotion. Cognition and Emotion, 13, 481-504.
[7] Picard R (1997), Affective Computing, MIT Press
[8] Morris D (1995), Bodytalk: The Meaning of Human Gestures, Crown
[9] Fauconnier G (1995), Mental Spaces, MIT Press
[10] Liddell S (1996), Spatial representations in discourse: comparing spoken and signed language, Lingua 98: pp. 145-167
[11] Descartes R (1637), Discourse on the Method, http://www.gutenberg.org/ebooks/59

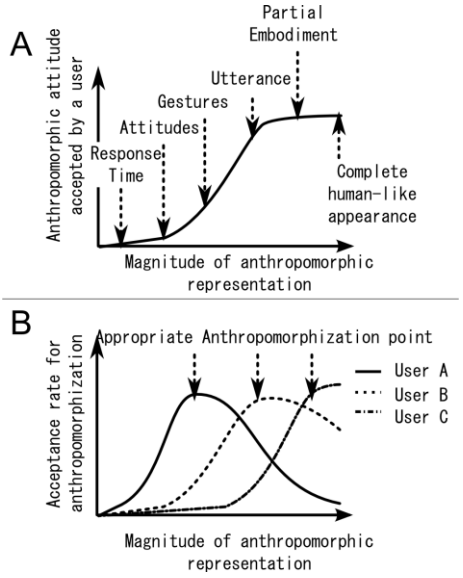

Fig.4. (A) Separated anthropomorphic elements. (B) Appropriate anthropomorphization according to each user.

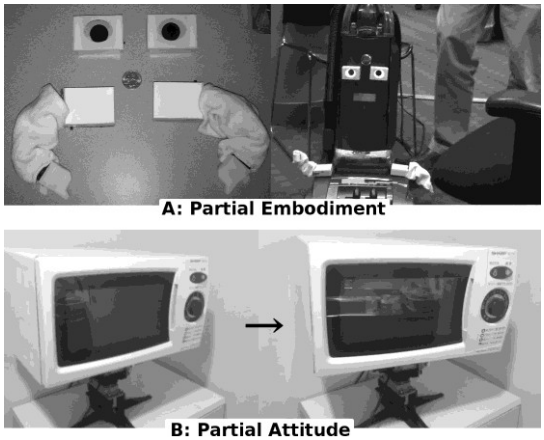

Fig. 5. Partial embodiment and partial attitude

[12] Komatsu T, Utsunomiya A, Suzuki K, Ueda K, Hiraki K, Oka N (2005), Experiments toward a mutual adaptive speech interface that adopts the cognitive features humans use for communication and induces and exploits users' adaptation, International Journal of Human-Computer Interaction, vol.18 (3), 243-268.
[13] Sonoyama T (2007), Introduction for Robot Design (in Japanese)
[14] Epley N, Waytz A, Cacioppo JT (2007), On Seeing Human: A Three-Factor Theory of Anthropomorphism, Psychological Review, 2007, Vol. 114, No. 4, 864-886
[15] Osawa H, Mukai J, Imai M (2007), Display Robot" - Interaction between Humans and Anthropomorphized Objects, 16th International Symposium on Robot and Human Interactive Communication, Vol.16, pp. 451-456, Jeju, Korea, 2007.8