Differentiation Model of Individuality Using Ontological Network for Communication Robot System

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Abstract-

We propose ontology for an agent communication with human and other agents according to environmental information. Recently, various types of robots and information tool are developed and used. But now, the system is not able to build interaction between human and to differentiate communications by individuality. The agent processes information is led by a single robot, and isn't able to utilize relationship with human or other agents. We consider the informational aspects of intimacy recognition technology, and information transport and sharing. Therefore, we focus attention on ontology technology. Human can communicate with others, by considering the situation and the body language.

In this paper, we show the composition of ontology from the interaction between human and agent, and experiment of the communication with robot using ontology.

I. Introduction

Recently, the system cannot build the interrelation between human, and the correspondence to the individual. While, human can communicate even if there is no word, and correspond to the individual. Then, in this research, we focus human's ontology. Robots construct ontology in communications with human.

We propose the method of achieving human and robot communications by using ontology. And, the differentiation model of individuality by ontology is constructed in this research.

II. System Outline

A. Composition of agent

The base of the system of this research is Rasmussen model (Fig.1). Each agent's model is based on intellectual layer model. Rasmussen divided the behavior of human into the category of three. We applied this to the agent model. We divided the behavior of agent into the category of three as swarm intelligence, higher layer, and lower layer. Ontology is used in the swarm intelligence. This becomes common basic for human and agents on the network (Ontological Network).

In this research, intelligent space – iSpace (Fig.2) was used to recognize the position of the human's hand position. iSpace can recognize a user's skin color and the position information of human and the robot.

In addition, in the experiment, we constructed the ontology that was able to correspond to each person.

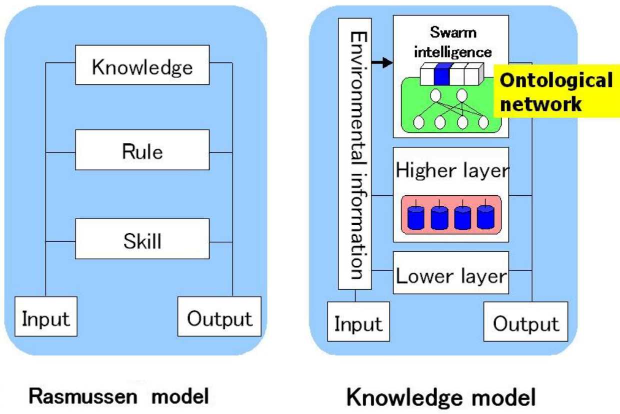

Figure 1. Rasmussen model and agent model

Figure 2. iSpace software

B. Action recognition of human

In the symbiosis of human and robot, the robot should understand specific instruction as well as non-specific instructions given by a human. In This research, Fuzzy Associative Memory (FAM) is used, so the robot can understand instructions that are conveyed directly by the human as well as those that come from the human's environment. FAM is composed of a front layer of fuzzy rule (If layer) and a back layer (Then layer). The rule layer by which one node represents one rule is set. The fuzzy rule is expressible by using the composition of the BAM (Bi-directional Associative Memory) between the If layer and the Then layer (Fig.3).

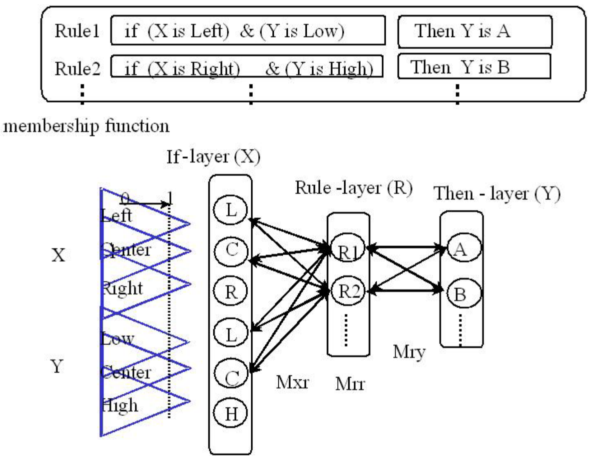

Fig. 3 Fuzzy Associative Memory

III. ONTOLOGY

A. About Ontology

The term "ontology" means a "systematic theory of existence" in the study of philosophy. Philosophically aiming to arrange everything in the systematic world, it is called Ontology.

We show the ontological concept and the proposal model in Fig.4. Human can communicate by gesture and so on, who has different culture and language (Fig.5). Because human has common basis, such as mirror neuron, which 'own' action neuron did observing other human motion like a mirror activate. There is ontology on that extension line. The research into ontology has been performed to study the problem of "Share of knowledge" and "Construction of the knowledge base" in the field of the knowledge proceeding. The knowledge proceeding system constructs the knowledge base of the targeted world by using ontology. By studying the targeted concept, a contribution to knowledge sharing can be expected for its result the ontology proposed here is of the knowledge-construction type and is used to communicate for the human and the system. This ontology is called a bottom up ontology. Ontology is composed of Conceptual Fuzzy Sets (CFS) that has the dispersive express of concept (Fig.6).

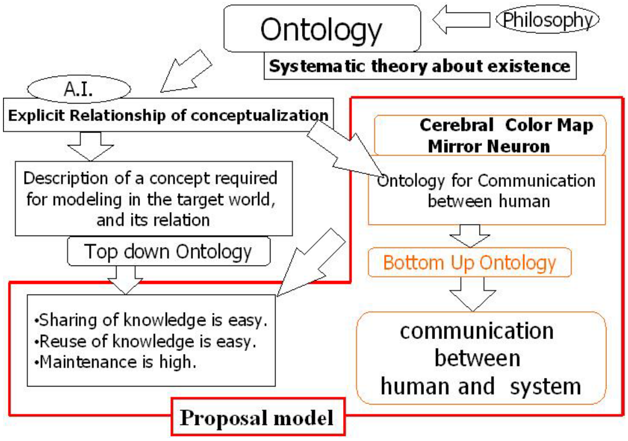

Fig. 4 Ontology and proposed model

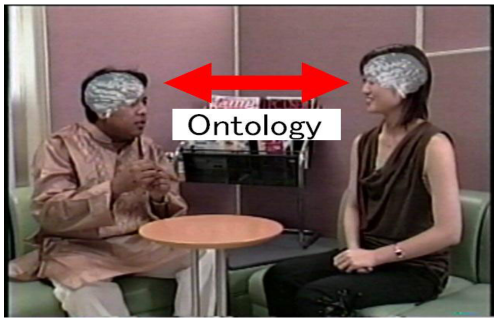

Fig.5 Ontology for human's communication

B. Conceptual Fuzzy Sets

The label of a fuzzy set represents the name of a concept and the fuzzy set represents the meaning of the concept. According to the theory of meaning representation from use proposed by Wittgenstein, the various meanings for a label (word) may be represented by other labels (words) and thus grades of activations, which show the degree of compatibility between different labels, can be assigned. The distributed knowledge called Conceptual Fuzzy Sets (CFS) is shown in Fig.6. Since the distribution changes depending on the activated labels indicating the conditions, the activation resulting from the CFS displays a context-dependent meaning. Thus, a CFS can represent not only logical knowledge, but also knowledge whose representation is logically impossible.

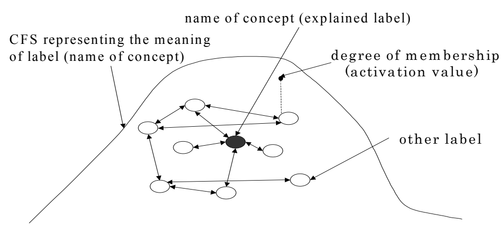

Fig.6 Image of Conceptual Fuzzy Sets in Associative memory

Fig.7 shows the CFS representing the meaning of "pet fish" evolved by the activation of "pet" and "fish". The CFS simply recollects the abstracted upper concept-explaining instance by using the property of associative memories without the use of any procedure. The nearest upper concept arises from the activations of instance. This abstraction behaves robustly against errors. The left side of Fig. 7(left) shows the recollection of "pet" from the activation of "guppy" and "cat" with a small activation of "tuna" as an error. Similarly, the right side of Fig. 7(right) shows the recollection of "fish" from the activation of "guppy" and "tuna".

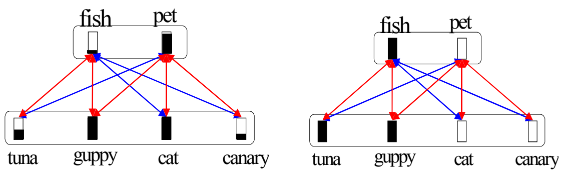

Fig.7 Recollection of "fish" from "tuna" and "guppy"

C. Construction of ontology

The ontology of constructing an interface for human-robot interaction is shown in Fig.10.

STEP1

Base of agent's ontology is composed by BAM, CFS, Observation of human, and Experiment (Fig.8 and Fig.10 – Step1). This ontology is easiest prototype and intelligent agent is composed of sharing information and synthesis. Many operations can be stored in one "instance". In this research, an instance is one robot operation.

STEP2

Apply the ontology of input from human and from corresponding agent, compose the ontology of output from human (Fig.9 and Fig.10 – Step2).

STEP3

Next, constructs a new ontology by using a new instance. If other agents have ontology with the same patterns, a new ontology is constructed by synthesizing ontology with the same pattern (Fig.10 – Step3).

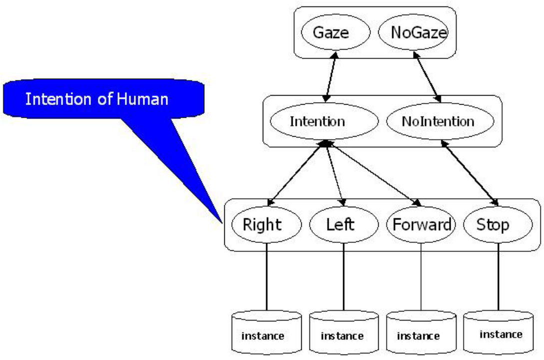

Fig.8 Ontology – Step1

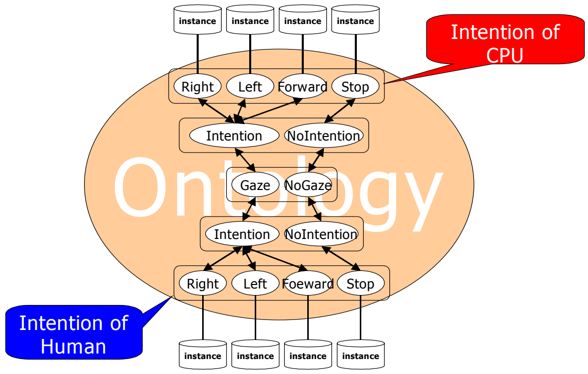

Fig.9 Ontology – Step2

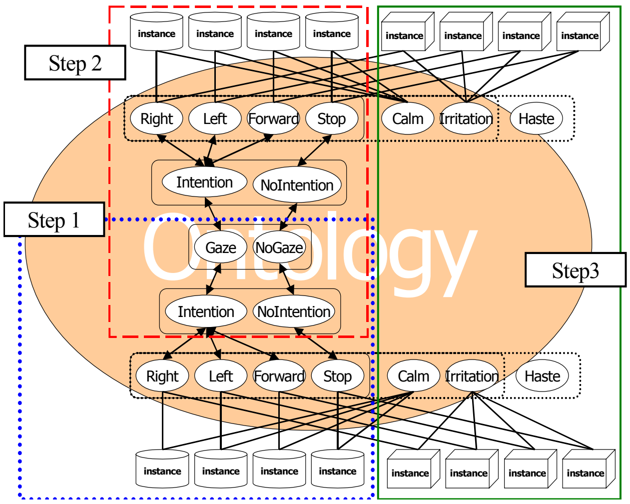

Fig.10 Ontology – Step3

IV. Experiment And Result

Ontology systematizes the concept of the object. Therefore, a common structure is expected to be formed between the human and robots. In a word, technological ontology enables some robots to cooperate naturally with human.

In this paper, we show experiment robot communication with different human using ontology. We make an experiment using the robot. The robot takes part as a table, which automatically move, we call it iTable.

Command to move forward is made by raising hand.

Fig.11 shows the ontology used by this research. The robot has the instance corresponding to the instruction of human and the situation. In this experiment, there are two kinds of individuality of human's situations.

1. Human sitting raises the hand (situation "Moderately") (Fig.12).
2. Human sitting slowly raises the hand (situation "Calmly") (Fig.13).

All these actions are instructions "Forward". The robot additionally moves "Forward" variously to the situation.

When the robot system becomes general, various human will use the system. This system is desirable to differentiate and correspond human at such time.

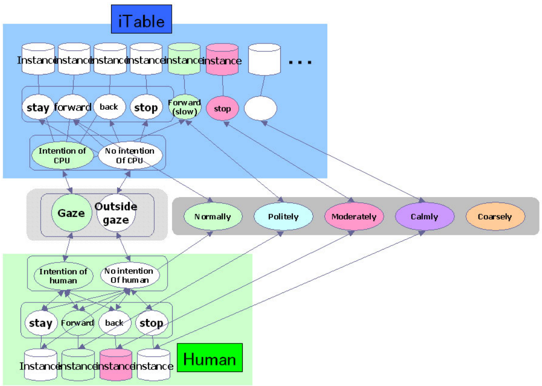

Fig. 11: Individuality differentiation ontology

When standing human raises the hand, the robot advances up to the side of human. On the other hand, when human raises the hand in the situation of "Moderately", the robot advances in front of human (Fig.12). And when human raises the hand in the situation of "Calmly", the robot advances in front of human (Fig.13).

When human is standing, the ontology considers the possibility of human moving at once. Therefore, the robot advances up to the side of human. When human is sitting, the robot advances in front of human to play the role of the table.

Fig. 12: Experiment of situation "Moderately"

Fig. 13: Experiment of situation "Calmly"

In this experiment, we researched two kinds of situations. However, we are researching more patterns now.

V. Conclusion

We reported a demonstration of a robot initiating a voluntary action that was achieved by using ontology. The action pattern for the symbiosis of a human and a robot was shown in a real machine experiment. As a result, this system showed its suitability to be used as a robot system that can correspond to many situations smoothly.

In this research, we used one iTable. However, in the future we would like to use robots with different mechanisms in the research. We will construct an ontological network system that enables communications of two or more human and two or more robots (Fig14).

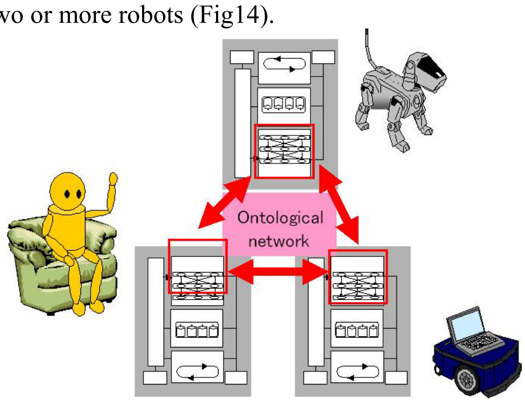

Fig. 14: Image of ontological network system

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