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Autonomic human support agent system used artificial ontology

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Abstract; Human support systems, such as computers and robots, are required to be changed to a machine equipment, independently operates and communicate with human, rather than non-sensitivity and obedient machine equipment. Therefore, we notice nonverbal language that human recognizes naturally. In addition, we show the validity and constitution of mechanism, that recognizes an intention of human using those several information to judge independently.

1 Introduction

Now, computers and robots are variously used in all situations. However, the interaction of human and their systems are permitted only for limited input-and-output systems. In contrast, human complexly uses various input-and-output channels for communication.

In this research, we show the construction of the autonomic human support agent system that independently judge and act. Its method is applying human's communication to between human and agent, and interpreting various situations and commands. To do so, we construct ontology which is the engineering model of an intention for human. Moreover, we present the ontological growth and the knowledge sharing, in order to correspond different examples, caused by the personal gap of intention expression.

2 Composition of a system

In Fig. 1, we show the appearance and the component of the autonomy type human-being support agent system, equipped with robot agent system. The system in this research is based on Rasmussen model that consists of three-layer structure. It can infer human intention. The procedure is, at first, we obtain human's movement using CCD-camera. Second, we change the obtained human's movement into the concrete input information with instance layer. At last, we input several obtained information to ontology layer.

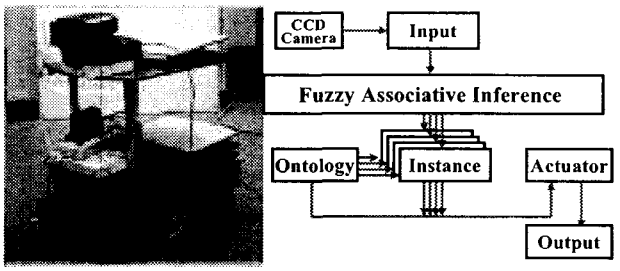

Fig. 1 Composition of autonomic human support agent system

2. 1 Inferencer and Instance

In this paper, we use the fuzzy associative inference for command, condition, and intention recognition mechanism, shown in Fig. 2. It is expressed by bi-directional associative memory (BAM). In addition, we inferred the movement and condition from the distinctive point of human's movement. We obtained color information (hand and face color) based on color information from CCD-camera.

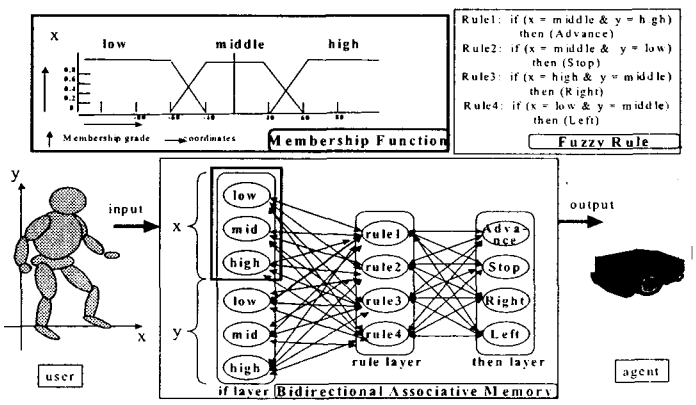

Fig. 2 Fuzzy associative reasoning

2. 2 Ontology

The word "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. 3.

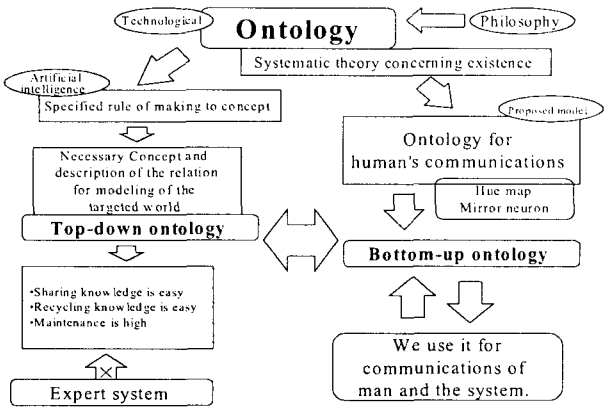

Fig. 3 Ontology and proposed model

2.2.1 BAM

Bi-directional associative memory (BAM) is an associative memory model of a neural network. Hop field network is known as well to same model. In this study, ontologies are constructed using BAM, a hierarchical network composed of two layers and all layer united.

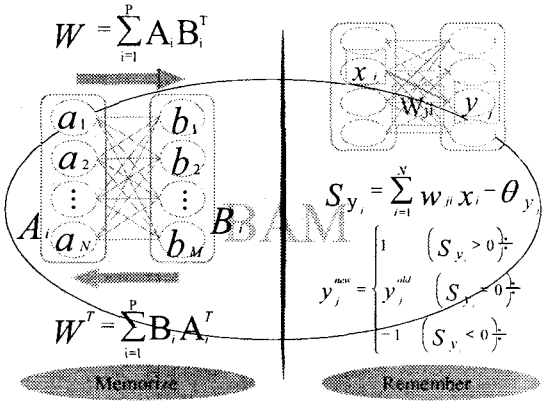

Fig.4 BAM

2. 2. 2 Ontology and conceptual fuzzy set

An ontology is composed of conceptual fuzzy sets. The label of a fuzzy set represents the name of a concept, and the fuzzy set itself represents the meaning of the concept. According to the theory of meaning representation proposed by Wittgenstein, the various meanings of a label (word) may be represented by other labels (words), and thus grades of activation that show the degree of compatibility between different labels can be assigned. Because the distribution change depends 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. CFSs are composed using BAM that "unites" all layers.

A CFS can be used to represent a whole concept by combining separately formed concepts. A CFS is composed of individual association matrices $M_i (i = 1,2,....,n)$ and can be synthesized according to expression (1). $norm[...]$ is invalid-data conversion rule operation of an association matrix.

$$M = norm[M_1 + M_2 + M_3 + ... + M_n] \qquad (1)$$

Ontologies are composed by using CFSs from the above-mentioned feature.

2. 2. 3 Construction process of ontology

Step 1 Base of agent's ontology is composed by BAM, CFS, observation of human and experiment. (Figs. 5, 7, step 1) This ontology is easiest prototype and intelligent agent is composed by sharing information and synthesis. Many operations can be stored in one "instance". In this experiment, an instance is one robot operation, and robots learn instances through "O-learning".

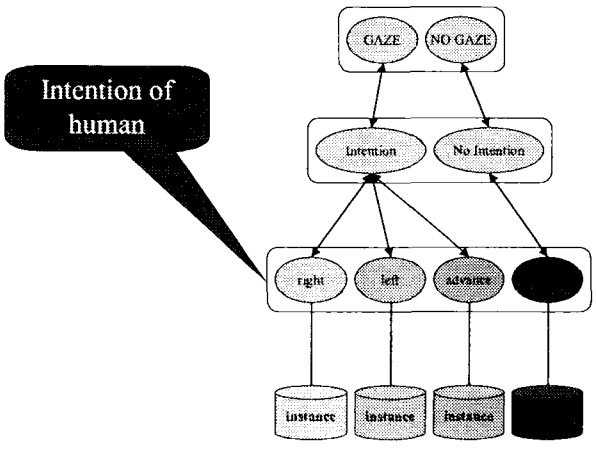

Fig. 5 Step1

Step 2, Apply the ontology of input from human and from corresponding agent, compose the ontology of output from human. (Figs. 6, 7, STEP 2)

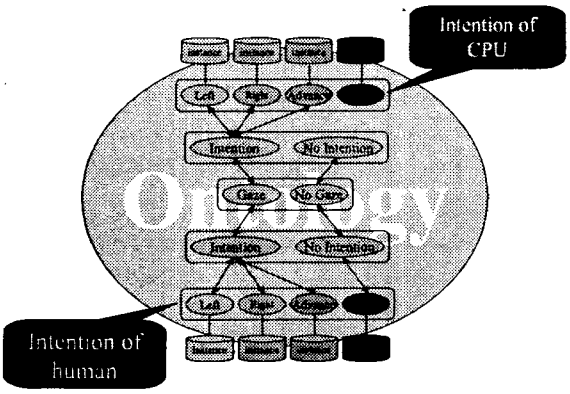

Fig. 6 Step 2

Next, construct a new ontology by using a new instance. If other agents have ontologies with the same patterns, a new ontology is constructed by synthesizing ontologies with the same pattern .(Fig. 6: STEP 3)

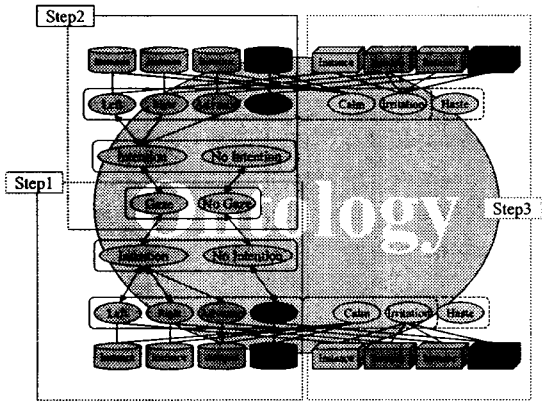

Fig. 7 Ontology (final)

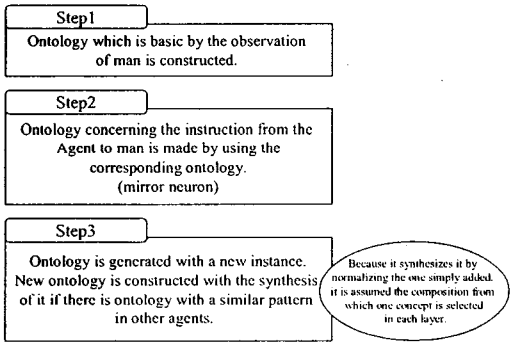

Fig.8 Flow of ontology construction

3 Growth of ontology

Fundamental thing is the main for generated prototype ontology. And, it should grow up so that it may correspond to various situations and new case. In Fig. 7, ontology generates new instance and new concept (node of ontology) with the diversity with other instance. In addition, we assume united concepts newly generated to be half of united concepts already acquired. And by human's value, the new concepts and old concepts refines.

4 Knowledge sharing by ontology

Instance, consist of concrete information, has a different scene by individual variation of intention expression. To solve this, we use search method for ontology composed of an abstract concept. Then, we make the system search with the other agents instance, which has the context of ontology equal to your self. Finally, we share knowledge in the lower layer. For above reasons, the system can acquire knowledge smoothly.

5 Real machine experiment

We show the condition and the result of the real machine experiment in this system below. In this experiment, we prepared two robot-agents that installed constructed ontology. Then, we do the intention recognition experiment, the study experiment of ontology, and .the knowledge sharing experiment, by robot A that acquires knowledge and robot B that does not acquires knowledge.

W e show the display screen of ontology of action state in Fig. 9, the characteristic and the inference result of command recognition in Table 1,and the output value of ontology in table 2.

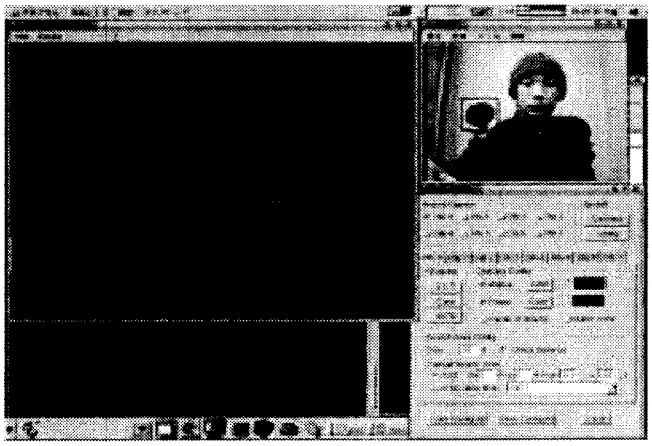

Fig. 9 Ontology of action state

X	Y	GO	STOP	RIGHT	LEFT
13	52	1.165	0.754	-0.295	-0.295
61	-24	-0.341	-0.341	1.136	0.878

Table.1 Characteristic and inference result when command is recognized

GO	STOP	RIGHT	LEFT	ON	OFF	GAZE	NO GAZE
1.165	0.754	-0.295	-0.295	0.820	0.130	2.686	2.019
-0.341	-0.341	1.136	0.878	1.120	4.270	-2.019	2.686

Table.2 Input value and inference result in ontology

Mean value in intention recognition rate was 92%. In the study experiment, we succeeded in the refinement of new concept by giving robots reward of dissatisfaction and satisfaction. In addition, in the knowledge sharing experiment, robot B acquired the knowledge of robot A, and succeeded in intention recognition equally with robot A.

6 Conclusion

We proposed the ontology as the system for human recognition purposes, and showed the effective of the agent system that is constructed in order to become more intelligent by the ontology and that automatically recognizes the purpose of humans by the intuitive interface such as movements of hands or faces.

In addition, we can consider ontology set to be one new ontology. After this, we will make mechanism that generates ontology of parking, in fig.10.

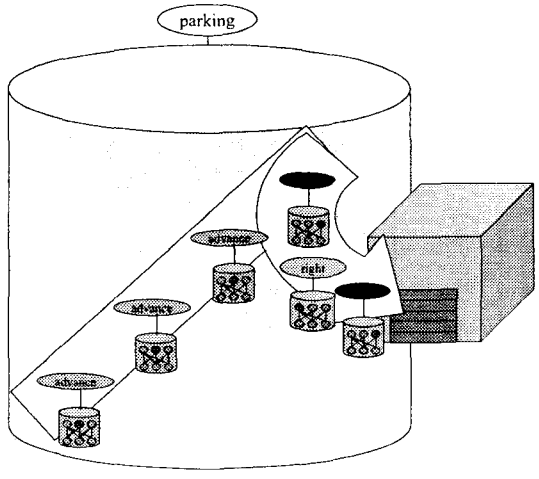

Fig. 10 Ontology set

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