Research on Humanized Behavior Decision of Service Robot

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Abstract: In order to solve the fuzzy and unspecific task instructions received by service robots when serving the elderly, a hierarchical human-like behavior decision-making model is constructed, which makes a fuzzy and unspecific task clear and concrete by simulating human thinking reasoning and decision-making. The decision-making framework based on human behavior includes perception layer, evaluation layer and decision-making layer. The fuzziness and uncertainty of human cognitive behavior are simulated by different modeling methods such as production system, Bayesian network and man-machine interaction. The feasibility of the reasoning algorithm flow chart of the human-like behavior decision-making model is verified by an example of the elderly eating fruit.

1. Introduction

With the continuous development of science, technology and economy, the aging of the population, and the protection of the daily life of the elderly and the disabled, service robots have played an important role. The demand for service robots is gradually increasing, and the service level of server people is expected to be higher. The service robots should not only complete their tasks on the premise of ensuring safety, but also complete their tasks in a more satisfactory way, so that the elderly can feel the comfort of the whole service process and achieve maximum satisfaction.

When serving users (the elderly), the service robot not only completes the task instructions of the elderly, but also reflects the intelligent analysis and decision-making of robots similar to human beings, thus making the elderly more satisfied and comfortable.In the literature [1], semantic knowledge is used to describe the robot's action execution sequence in detail, and it can realize the reasoning and supplement of fuzzy and uncertain information in the operation process. In literature [5], hierarchical task network (HTN) method is used to plan robot tasks, and memory-based reasoning method is added to deal with fuzzy and uncertain information Literature [10] puts forward a computational model for robots to realize housework intelligence based on cognitive behavior, which enables robots to solve problems with high flexibility and efficiency.In the task planning of the above documents, only the performance and completion degree of the robot for a single task are considered, and the satisfaction degree of the service object is not or rarely

considered. Many of them rely on people to program in advance to establish specific knowledge base and reasoning mechanism, which has obvious limitations. Therefore, it is of great significance for service robots to make vague and uncertain tasks clear and concrete by simulating human thinking reasoning and decision-making.

In this paper, a reasoning algorithm for human behavior decision-making is proposed, and the process of reasoning and decision-making simulating human thinking is emphatically studied,Constructing robots with reasoning and decision-making similar to human intelligence.

2. Humanoid Behavior Decision Model

The decision model based on human behavior includes three layers: perception processing, situation evaluation and decision planning, which are called perception layer, evaluation layer and decision layer respectively. This kind of human behavior decision-making model not only highlights the human perception process, but also adds feedback links between decision-making layer and each layer, and adds a learner to update the structure and parameters of Bayesian network in comprehensive database, rule base and knowledge base through feedback from decision-making layer to perception layer and evaluation layer. Figure 1 shows the hierarchical framework of the model.

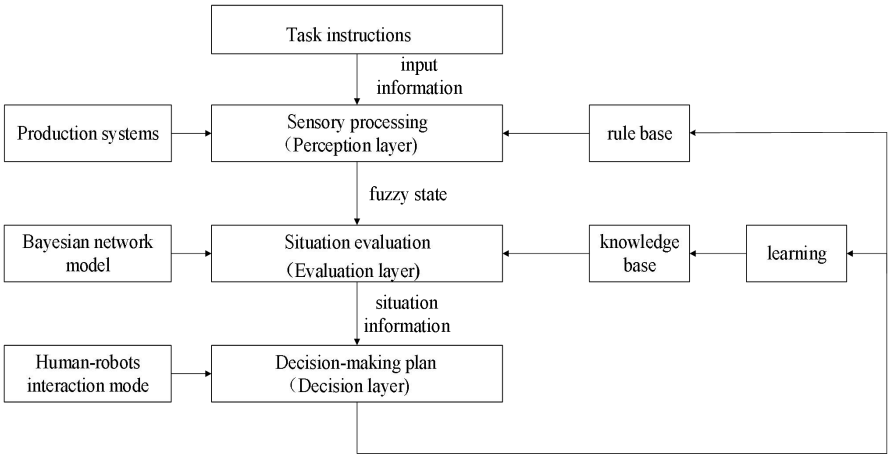

Figure 1: Hierarchical framework structure of humanoid.

Through the hierarchical framework of human-like behavior decision-making, the reasoning process of human logical thinking is simulated, and the reasoning algorithm flow of human-like behavior decision-making model is given. As shown in Figure 2, under the condition that all the reasoning conclusions exist, reasoning is carried out according to the variety and priority of attributes in the task object, with three attributes in the task object and two state representations of attributes respectively.

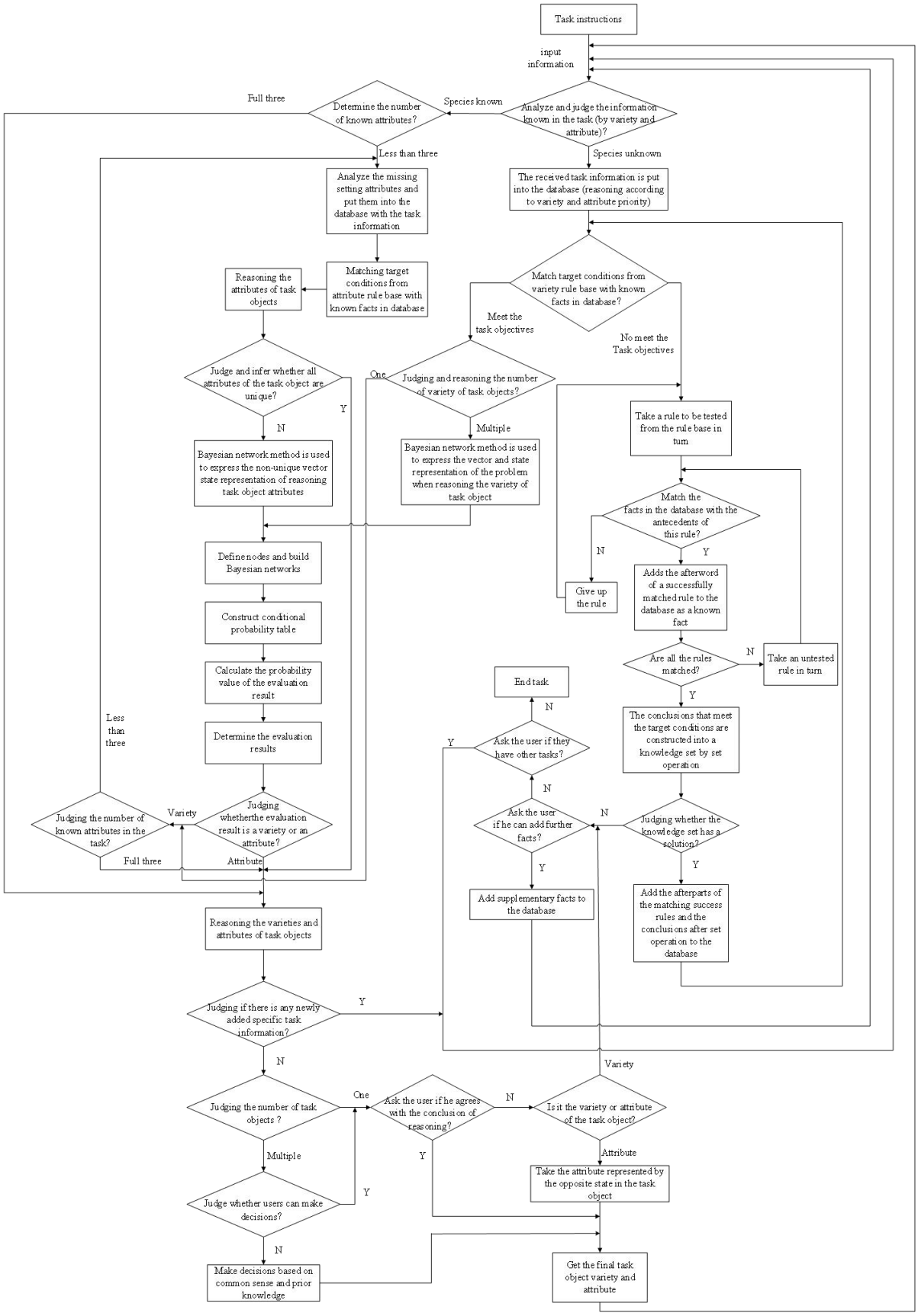

Figure 2: Flow chart of reasoning algorithm for humanoid behavior decision model.

2.1. Perceptual Reasoning

When judging and reasoning the received task information in the perception layer, we use the method of production system to model, and use production rules to express the reasoning process and behavior, so as to simulate the logical thinking reasoning process when solving problems.

In this paper, taking the task of the elderly eating fruit as an example, different methods are used to reason each layer to verify the feasibility of the reasoning algorithm of this kind of human behavior decision model.

The reasoning process through production system is as follows:

- Firstly, according to the known information in the task, it is concluded that the variety of the task object is unknown, and it is judged that the database does not contain the solution of the target task. The initial fact set obtained by the service robot according to the time period and environmental information is: spring season | afternoon, and Table 1 is the type rule base based on the task object.

Table 1: Variety rule base based on task object.

	IF	THEN
R1	Spring and Summer	Neutral OR Acidic
R2	Autumn and Winter	Acidic OR Warm
R3	Morning and Evening	Neutral
R4	Afternoon	Cold
R5	Neutral	Apple OR Strawberry
R6	Acidic	Apple OR Cherry
R7	Warm	Cherry OR Mango
R8	Cold	Strawberry OR Pear

- The rules in the variety rule base were selected successively, and the antecedents of the rules were used to match the initial fact set in the database, and the matching of rule R1 was unsuccessful.Match when you pick up the rules of the R2, the rules of the conclusions as a new fact added to the database of the initial fact concentration, initial fact set into: winter season | | afternoon neutral or acidic;When rule R3 is taken, it is unsuccessful;Take rules when R4 is successful, get initial fact set into a winter season | | neutral or acidic | cool afternoon;Rules R5 and R6 are both successful;When rule R7 is unsuccessful and rule R8 issuccessful, it can be inferred that the variety of task object is strawberry;
- According to the task information in the comprehensive database, it is judged that the attributes of task objects are less than three, and then according to the inferred variety of task object, an attribute database based on strawberries is established. By matching the known facts in the comprehensive database from the attribute rule base based on strawberries, can be concluded that the old man eat soft or hard, small, normal temperature of strawberry.Table 2 is the attribute rule base based on strawberry.

Table 2: Attribute rule base based on strawberry.

	IF	THEN
R9	Strawberry AND Good mouth	Soft or Hard
R10	Strawberry AND Bad mouth	Soft
R11	Strawberry AND Good Stomach Intestines	Big OR Small AND Normal
R12	Strawberry AND Bad Stomach Intestines	Small OR Normal Temperature

2.2. Situation Assessment

The evaluation layer model judges the current situation information and evaluates the possibility (probability) of the situation condition according to the current state information output by the perception layer, referring to the experience and prior knowledge contained in the knowledge base and the Bayesian network structure and parameters.

Bayesian network method is used to express the vector and its state representation of reasoning task objects, define nodes, and construct directed acyclic graph according to the relationship between nodes, as shown in Figure 3.

Bayesian network method is used to express the vector and its state representation when reasoning attributes based on task object types, define nodes, build Bayesian network, and build directed acyclic graph according to the relationship between nodes as shown in Figure 4.

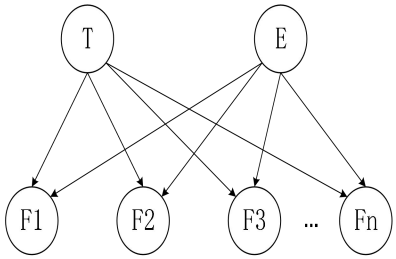

Figure 3: The varieties of task objects are directed acyclic graphs.

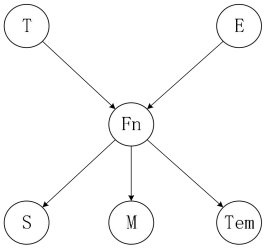

Figure 4: Directed acyclic graph of attributes based on task object variety.

In Fig.3,T represents a time variable, E represents an environment variable, and F1, F2...Fn represents the variety of task object.

In Fig.4, T represents time variable, E represents environment variable, Fn represents the specific task object variety,S represents shape variable, M represents taste variable and Tem represents temperature variable.

Taking the task of eating fruit for the elderly as an example, assuming that the elderly have good mouth and bad stomach, the elderly can eat soft or hard strawberries at normal temperature through the fuzzy state information perceived by the perception layer.

Bayesian network method is used to calculate the probability of soft strawberries. Assuming that the decision-making layer decides that the probability of soft strawberries is high according to the probability, the evaluation result of the evaluation layer is that the elderly eat soft, small strawberries at normal temperature.Finally, the evaluation results of the evaluation layer are sent to the decision-making layer for decision-making.

2.3. Decision Planning

In the decision-making layer, according to the current fuzzy situation information given by the evaluation layer, the decision-making rule is to make decisions by reasoning the probability of task object varieties and attributes based on Bayesian network in the evaluation layer, and to obtain more information in the way of man-machine interactive inquiry with the least number of interactions to complete the final decision, so as to determine the final task object variety and attributes.

Assuming that there is no newly added task information, it is inferred that the number of task objects is one, the old people can make decisions, and the old people agree with this conclusion, and finally it is concluded that the old people should eat soft, small and normal temperature strawberries,And the final results are fed back to each layer to update the information stored in the comprehensive database and the structure and parameters of Bayesian network in the knowledge base, so that the whole decision-making process of human-like behavior is more perfect.

3. Conclusions

In this paper, a human-like behavior decision-making reasoning algorithm is proposed, which makes the service robot simulate the way of human thinking reasoning and decision-making, and makes a vague and non-specific task clear and concrete. Taking the elderly eating fruit as an example, the final conclusion is deduced and the feasibility of the algorithm is verified.

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