Stepwise up down Algorithm to Adapt the Action Parameters for Reliable Home Agents

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***Abstract*— Many researchers are going on to realize the helpful and reliable home agent software. Since users have their own life style, it is very important for the agent software to learn their users. The agent software predicts user's action. But, not all predicted the action is correct. So, almost the agent software calculates the confidence value to the predicted actions. Generally, if the confidence value of the predicted action is more than some parameter, the agent software supports the predicted action. The agent software sometime supports the incorrect predicted action. And, user complains about the agent. In this paper, the agent obeys with user's request and adjusts the action parameter. We suggest and evaluate the step up down algorithm to adapt the action parameters. Our algorithm doesn't use the statistics and reduces the computational complexity. Our algorithm adjusted the action parameter better than the statistic algorithm.**

***Index Terms*— Home Agent, Adapted Algorithm**

I. INTRODUCTION

Home agent learns the action pattern from the sensor or the home appliance in the house and executes the predicted user's action[3][4]. The agent doesn't predict everything about the user's action. So, the agent must tell user the predicted action before the agent executes. But, the agent interrupt user.

Pattie Maes [1] suggested that it is necessary for reliable agent that user check the predicted competence. First, user indicates the telling parameter and allows the agent to show the predicted action within the telling parameter. And, user checks whether the agent executes the predicted action. Secondly, user indicates the executing parameter and allows the agent to execute the predicted action. The agent executes the predicted action within the executing parameter. The agent actions are only three, nothing, telling or executing. So, user feels extremely altering the agent action.

When the agent actions are more than two, it is difficult for user to indicate these parameters. In this paper, we suggested the stepwise up down algorithm, which adapts the action parameter to user's request.

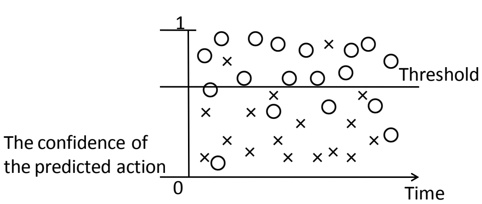

Fig.1 The distribution of the confidence and result of the predicted user's action

II. THE PROBLEMS OF THE ACTION PARAMETERS

A. *The adapting action parameter*

Figure 1 shows how the agent distinguish whether the agent execute the predicted action or not. The agent figures on the confidence for each the predicted action. The agent executes the predicted action that has the confidence over the threshold. The threshold is decided by the researcher or user. The agent infers from user's action whether the predicted action is correct or incorrect. The higher confidence the predicted action has is likely to be correct than lower. Perhaps the agent's execution is incorrect.

Above all, user worries about entrusting the agent with executing the predicted action. It's not the reliable agent.

B. *Pattie Maes's suggesting method*

For the intelligent agent, Pattie Maes suggested the agent interaction [1] to be reliable for the agents. In this interaction, user could check the predicting competence of the agent and allow the agent to execute the predicted action or not. Figure 2 shows agent action. Agent has two thresholds, one call "Do-it" that decide whether the agent executes the predicted action or not, anther call "Tell-me" that decide whether the agent tells the predicted action or not. The agent executes the predicted action that has the higher confidence than Do-it and tells the predicted action that has the confidence between Do-it and Tell-me. First, user checks the predicted competence on told the predicted action. Second, when user allows the agent to execute the predicted action, user reduces the value of Do-it. User could repeatedly check the predicted competence.

In telling to user, the agent tells the predicted action in detail. But, in executing the predicted action, the agent tells nothing.

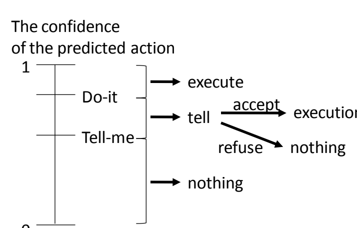

Fig.2 Pattie Maes's the predicted user's action

User feels extremely altering the agent action.

User adapts Tell-me and Do-it in Pattie Maes's interaction method. The confidence value doesn't indicate clearly the number of telling or executing, or the probability of correct or miss. The confidence value of 0.8 doesn't mean the probability of correct. The confidence value of 0.8 means more correctable than the confidence value of 0.7. So, when user changes tell-me from 0.8 to 0.7, user doesn't know how many the number of telling the predicted action the agent increase. User must carefully and repeatedly change Tell-me and Do-it. User stop adapting Tell-me and Do-it before user is reliable for the agent.

C. Problems

It is important that user can be reliable for the agent like Pattie Maes. In the recent study, we pointed the two problems.

(1) The agent actions are only telling and executing. The agent expressions are poor.

(2) The agent doesn't have enough actions to be reliable.

III. Approach

In this paper, we have two approaches.

1) The agent multistage actions

We increase the actions of telling and executing. If user teaches the agent each action, user must teach the action to any number of times. The agent must have a multistage action.

2) Adapting the thresholds with user's cooperation

We suggest that the agent adjusts the thresholds with user's cooperation. User has enough interaction to be reliable for agent. If the agent adapts the threshold, user couldn't interact to the agent. The agent doesn't see how reliable user is.

The agent has our algorithm that has the user's request parameter and adapts the threshold for the user's request parameter. General algorithm analyzes the confidence value and the result of the predicted action. But, the confidence value and the result of the predicted action don't agree with the fact. General algorithm couldn't adapt the threshold for the user's request parameter.

IV. Stepwise up down Algorism

We suggest the Stepwise up down algorism.

A. Agent's Actions

Figure 3 show that the agent has multi thresholds. The agent executes the choosing action comparing the confidence value with the thresholds. The higher the threshold is the more executive action the agent takes. For example, act 1 is the executing predicted action, act 2 is the alarm after executing the predicted action and act 3 is the reporting after executing the predicted action. The agent adapts the threshold from the user's reaction.

B. User's request parameters

Generally, user controlled the threshold. When user wants to increase the agent actions, user decreases the parameter of the threshold. When user wants to decrease the false agent actions, user increases the parameter of the threshold.

In the signal detection for the earthquake alarm system or security system, the result are classified to 4 types, hit-miss-false alarm-correct rejection and evaluated with the rate of correct and miss. User's request parameters also are the rate of correct and miss. Table 1 show that the agent actions are classified. User can indicate that user is dissatisfied with the false agent action and that user wants to be more the agent actions. When the rate of agent's correct is higher than the user's request and the rate of agent's miss is lower than use's request, the agent's competences satisfy the user's request.

The rate of correct: $P_{hit(a)} = \frac{N_{hit(a)}}{N_{hit(a)}+N_{false(a)}}$ (1)($P_{hit(a)} > P_{hit(a+1)}$)

The rate of miss:

$$P_{miss(a)} = \frac{\sum_{n=a+1}^{n} N_{hit(n)} + N_{miss}}{N_{hit(1)}+N_{hit(2)}+N_{hit(3)}+\cdots+N_{hit(n)}+N_{miss}} \quad (2)$$

($P_{miss(a)} > P_{miss(a+1)}$)

Table.1 The classification of the agent actions

		act 1	act 2	…	act a	…	act n	nothing
correct or false	○	hit 1	hit 2		hit a		hit n	miss
	×	false alarm 1	false alarm 2		false alarm a		false alarm n	correct rejection

C. Calculating Thresholds

Our stepwise up down algorithm doesn't analyze the confidence value and the result of the predicted action. Figure 3 shows our algorithm. When the agent action is correct, the agent decreases the value of the threshold. When the agent action is incorrect, the agent increases the value of the threshold [2]. In this paper, we indicate the condition of the convergent thresholds and show the calculating of the step-up value and the step-down value from the condition of the convergent thresholds and the rate of correct and miss.

1) The convergent thresholds

The threshold converges on same value. The value of the convergent threshold depends on the step-up value (Δth_{up}) and step-down value (Δth_{down}). We indicate the condition of converging threshold to satisfy user's request.

When the value of the threshold is moved up and down around same value, the value of the threshold converges. We define the state of the convergent threshold that the sum of the step-up threshold is equal to the sum of the step-down threshold. The sum of the step-up threshold is the step-up threshold (Δth_{up}) multiplied by the number of the step-up threshold. The sum of the step-down threshold is the step-down threshold (Δth_{down}) multiplied by the number of the step-down threshold. The formula (3) is the state of the convergent threshold. We calculate the formula (3) and result the formula (4). The formula (4) shows that the rate of the number of the step-up threshold and the step-down threshold is equal of the rate of the step-up threshold (Δth_{up}) and the step-down threshold (Δth_{down}). But, we don't know these numbers before the agent acts.

$$\Delta th_{up} \times N_{up} = \Delta th_{down} \times N_{down} \quad (3)$$

$$\Delta th_{up} : \Delta th_{down} = N_{down} : N_{up} \quad (4)$$

2) The value of step-up and step-down of the threshold

We found from the formulate (4) that the rate of the number of the step-up threshold and the step-down threshold is equal of the rate of the step-up threshold and the step-down threshold. These numbers is not clear before the agent acts. So, we indicate these numbers with user's request of the rate of correct and miss and the step-up and step-down threshold.

About the agent action of a, the number of the step-up threshold is the correct action a+1 ($N_{hit(a+1)}$) and the number of the step-down threshold is the incorrect action a ($N_{false(a)}$). The

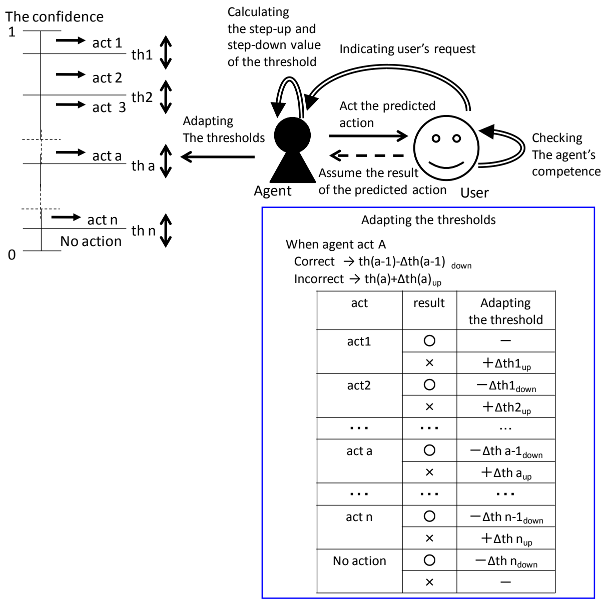

Fig.3 The stepwise up and down algorithm

formula (5) shows the convergent threshold a. Next, we express the correct action a+1 ($N_{hit(a+1)}$) and the incorrect action a ($N_{false(a)}$). We calculate the correct action a+1 ($N_{hit(a+1)}$)(6) and the incorrect action a ($N_{false(a)}$)(7) from the rate of the correct (1) and miss (2). The formula (6) and (7) has the correct action a ($N_{hit(a)}$). We calculate the formula (2) indicate that the correct action a ($N_{hit(a)}$) show the formula (8). We substitute the formula (5) for the formula (6)-(8). The formula (9) shows that we can calculate the rate of the step-up and step-down threshold from user's request.

When the result of the predicted action doesn't have the threshold satisfying the user's request, the agent' competence can't satisfy the user's request. The threshold converges on the value between the min of satisfying the user's request of the correct and the max of satisfying the user's request of the miss. We need to evaluate the convergent threshold.

$$\text{Threshold a} \ \ \triangle\, th(a)_{up} : \triangle\, th(a)_{down} = N_{hit(a+1)} : N_{false(a)} \quad (5)$$

The number of correct action a+1:

$$N_{hit(a+1)} = \frac{P_{miss(a)} - P_{miss(a+1)}}{P_{miss(a-1)} - P_{miss(a)}} N_{hit(a)} \quad (6)$$

The number of incorrect action a:

$$N_{false(a)} = \frac{1 - P_{hit(a)}}{P_{hit(a)}} N_{hit(a)} \quad (7)$$

The rate of each correct action:

$$\begin{aligned} &N_{hit(1)} : N_{hit(2)} : \cdots : N_{hit(a)} : \cdots : N_{hit(n)} \\ &= 1 - P_{miss(1)} : P_{miss(1)} - P_{miss(2)} \\ &\quad : \cdots : P_{miss(a-1)} - P_{miss(a)} : \cdots : P_{miss(n-1)} - P_{miss(n)} \quad (8) \end{aligned}$$

Action a:

$$\begin{aligned} &\triangle\, th(a)_{up} : \triangle\, th(a)_{down} \\ &= P_{miss(a)} - P_{miss(a+1)} : \frac{1-P_{hit(a)}}{P_{hit(a)}} \left(P_{miss(a-1)} - P_{miss(a)}\right) \quad (9) \end{aligned}$$

(When $P_{miss(0)}$=1 and a=n+1, $P_{miss(n+1)}$=0)

V. EVALUATION

We evaluate that the stepwise up down algorithm can adjust the agent competence to user's request. We computed the data set at the normal distribution. The data set in the evaluation is computed at the normal distribution. Figure 4 show that each forms of the distribution. The confidence distributions of correct and incorrect differ with each other. But, in a fact, it is impossible for the agent to know which all the predicted action is correct or incorrect. The agent assumes whether each the predicted action is correct or incorrect. Sometimes, the agent can't assume the result of the predicted action. So, in this paper, the actual condition is that the agent can assume a part of the result of the predicted action, which the agent doesn't act, and that the agent can assume all the result of predicted action, which the agent acts.

In our evaluation, we compare the stepwise up down algorithm with the statically algorithm. First, we confirm in the ideal condition that the stepwise up down algorithm can adjust the agent competence to user's request. Next, we evaluate the computing threshold in the actual condition.

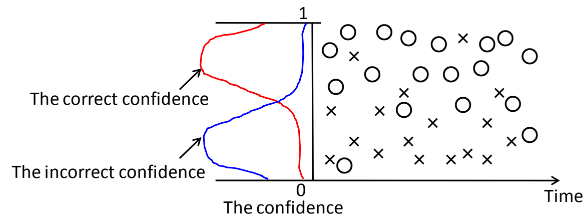

Fig.4 The image calculating dataset

Table.2 The conditions of dataset

	The rate of Correct to False	Correct Confidence		False Confidence	
		Ave	Div	Ave	Div
Data Set 1	1 : 1	0.8	0.2	0.3	0.2
Data Set 2	3 : 7	0.7	0.2	0.4	0.2

A. Condition

1) Data Set

Table 2 indicates the condition computing the data set. First, we decide the result of the predicted action with the rate of correct and incorrect. Second, we compute the confidence from the result of the normal distribution. Data set 2 is less the threshold adjusting the user's request than data set 1.

In the ideal condition, we prepare 5000 data each the data sets. In the actual condition, we prepare 20000 data to the data set 1 and on the data set 1 the agent could assume that the result of the predicted action is 10%. In the simulation, when the agent acts the action 1 or 2, the agent can assume the result of the predicted action.

2) User's request and the value of the up and down

Table 3 shows the three user's requests and the values of the up and down thresholds. The act 1 of the miss is smaller than the act2 from the formula (1) and (2). The act 1 of the correct is above the act 2 from the formula (1) and (2).

3) Statistically Algorithm

Figure 5 indicate the statistically algorithm. The general statically algorithm infer the distribution of the confidence of correct and incorrect from data base, calculate the rate of correct and miss and compute the value of the threshold satisfying user's request. Inferring the distribution of the confidence is too much calculation. In this paper, the statically algorithm don't infer the distribution of the confidence. The distribution of the confidence is the normal distribution. The rate of correct and incorrect is computed on the estimating rate in 95% confidence interval.

The value of the threshold takes the middle the value between the min value and the max value of the threshold satisfying the correct of 95% confidence interval. In user's request, the rate of correct and miss is important for user.

B. Ideal condition

We simulated adjusting the agent to user's request with the stepwise up down algorithm and the statistically algorithm. Figure 6 shows the value of the thresholds in the data set 1 and the user's request 1. The values of the threshold settle after the 3000 data. Table 4 indicate the rate of correct and miss from 3000 data to 5000 data. The stepwise up down algorithm is similar the statistically algorithm.

C. Actual condition

Figure 7 shows the value of the threshold. The value of the threshold adjusting with the statistically algorithm is more than with the stepwise up down algorithm. When the agent doesn't act, the agent assumes the part of the result of the predicted action.

Figure 8 indicate the rising the value of the threshold comparing the threshold in the ideal condition. In each user's request, the rising the value of the threshold adjusting with the statistically algorithm is more than with the stepwise up down algorithm.

In the actual condition, the stepwise up down algorithm is better than the statistically algorithm.

VI. CONCLUSION

We suggested the stepwise up down algorithm for the reliable home agent. We evaluate that our algorithm can adapt the agent to user's request.

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Table.3 User' request and the step-up and step-down values

User's request		1	2	3
act1	correct	90	90	90
	miss	90	90	70
act2	correct	70	70	70
	miss	70	50	50
Step up down (Fix)	$\Delta th(1)_{up}$	0.01	0.01	0.01
	$\Delta th(1)_{down}$	0.00056	0.00028	0.00167
	$\Delta th(2)_{up}$	0.035	0.0125	0.025
	$\Delta th(2)_{down}$	0.00429	0.00429	0.00429
Step up down (Exchange)	$\Delta th(1)_{up}$	0.02	0.04	0.02
	$\Delta th(1)_{down}$	0.00111	0.00111	0.00333
	$\Delta th(2)_{up}$	0.07	0.05	0.05
	$\Delta th(2)_{down}$	0.00857	0.01714	0.00857

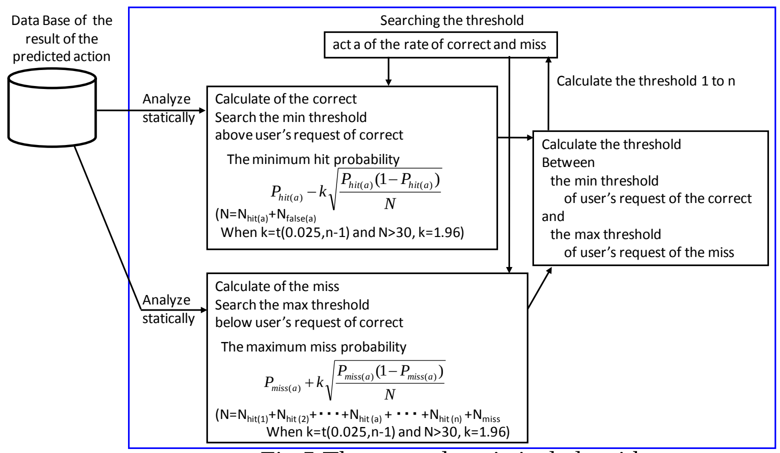

Fig.5 The general statistical algorithm

Table.4 The result of these probabilities

		request1				request2				request3			
		act1		act2		act1		act2		act1		act2	
	Data set	1	2	1	2	1	2	1	2	1	2	1	2
Correct	Step up down (Fix)	0.98	0.82	0.88	0.76	0.99	0.82	0.85	0.72	0.97	0.79	0.72	0.70
	Step up down(Exchange)	0.98	0.83	0.86	0.75	0.98	0.82	0.84	0.70	0.97	0.78	0.70	0.68
	Statically(2000)	0.98	0.78	0.89	0.77	0.98	0.78	0.88	0.74	0.97	0.84	0.74	0.72
	Statically(200)	0.98	0.82	0.92	0.78	0.98	0.82	0.89	0.71	0.97	0.88	0.71	0.67
	result	○	×	○	○	○	×	○	○	○	×	○	△
Miss	Step up down (Fix)	0.49	0.91	0.27	0.65	0.56	0.93	0.20	0.50	0.37	0.22	0.50	0.58
	Step up down(Exchange)	0.50	0.90	0.29	0.66	0.54	0.93	0.19	0.52	0.37	0.23	0.52	0.59
	Statically(2000)	0.50	0.96	0.35	0.66	0.50	0.96	0.26	0.56	0.40	0.29	0.56	0.62
	Statically(200)	0.56	0.87	0.35	0.69	0.56	0.87	0.27	0.60	0.44	0.31	0.60	0.57
	result	○	△	○	○	○	△	○	×	○	○	×	○

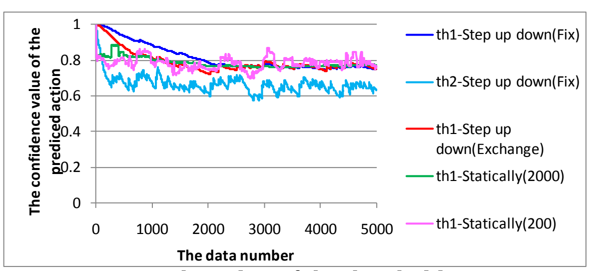

Fig.6 The value of the thresholds (Data set 1 and user's request 1)

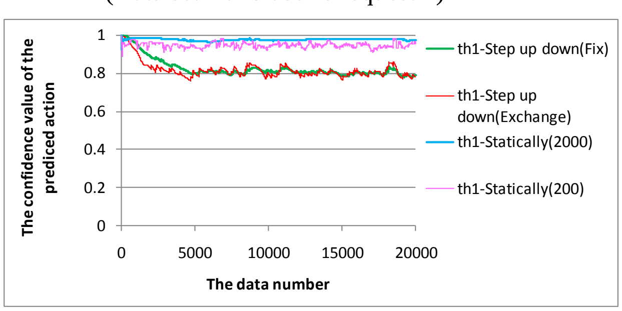

Fig.7 The value of the thresholds (Data set 1 and user's request 1)

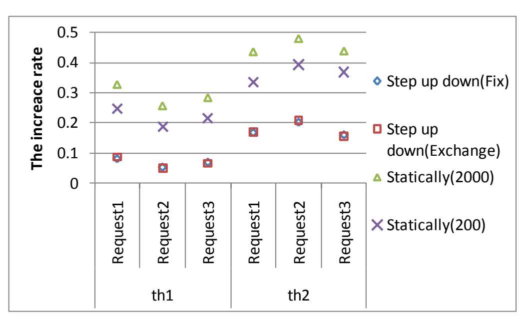

Fig.8 Rising the thresholds