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Robot Personality from Perceptual Behavior Engine : An Experimental Study

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Abstract - In the service robot environment, the dependability of robot is more important than the strength of singular perception component. In the previous works, the authors proposed “Cognitive Robotic Engine”, to ensure the dependability of robot perception and recognition. From the works, we found that any change of one parameter effects on the character of the robot. In this paper, our purpose is to implement robot personality, especially in adjusting several parameters. We implemented our proposal into real robot to experiment and observe the variation of robot behavior, in the point view of mission achievement.

Keywords - Personality, Perception, Action, Dependability, Cognitive Robotic Engine, Caller identification

1. Introduction

Cognitive Robotic Engine (CRE) [1, 2] aims for robust perception by combination of imperfect perceptual processes and/or proactive actions, because many of human-robot interaction components have uncertainty about their processing results.

The result of perception can be varied according to the fusion methodology of information. This makes behaviors of the robot dynamic when it performs the given mission. Some of robots may think and think to take an action, while the others may be more active. The both way can be correct in spite of the difference of approaches. So we can vary the way of selection and estimation. Moreover, the robot itself would change the way.

In this paper, we define robot personality as ‘which way the robot selects?’ Accordingly, we carried out some experiments and comparisons the variations of the behaviors of robot by adjusting the real parameters.

2. Cognitive Robotic Engine

The reason why service robots are staying in laboratory is the robust perception is not insured yet. To get the robustness of robot, there should be lots of constraints like limitation of mission range, safety, and so far.

We presented the concept of CRE as the primitive solution of that problem [1, 2]. The main features of CRE are explained below.

A. Process

A perception process of CRE means basic building block for the entire perception. The available perception process for caller identification is shown in “Table 1.” Each process is assumed independent as long as they are not under precedence restrictions. Each one has outputs certainty factors of the evidences, the action candidates and processing time.

Table 1. Definition of Perceptual Processes for Caller Identification

Novel Sound Direction (NSD)	
Definition	When the sound volume exceeds the threshold. estimates the direction of source
Frontal Face Detection (FFD)	
Definition	Finds face region by image feature
Skin Color Blob (SCB)	
Definition	Distinguishes skin region by RGB condition and makes others black in image
Calling Hand Posture (CHP)	
Definition	Estimates calling hand by skin color in face adjacent area

B. Precedence relation

If the outputs of one or more processes are necessary as an input or inputs of another for processing, a relationship between the processes defines precedence relation.

C. Evidence Structure

Evidence structure represents the network which enables the control to probabilistic estimate using the incoming sensing cues.

3. Personality

A. Human Personality

Human personality is divided into genetic factor and environmental factor. [3, 4] The genetic factor is inborn personality which may inherited from parents. Meanwhile, the environmental factor is formed by learning and experiences. Basically, we considered those factors to establish this research.

B. Robot Personality

In the most of researches, robot personality is about an emotional expression imitating the human. [6, 7] However we focus on the behaviors of the robot as the robot personality. We diversify the personality by changing some parameters based on CRE. This is not for the optimal

solution of service/mobile robot as general, but only for the robot personaity.

C. What is Genetic Personality?

Genetic personality is gifted personality as the literal meaning of a word. Let us assume two robots, security robot and hazard robot. The security robot which keeps watch some place is sensitive at external environment. It should estimate and react as soon as possible. On the other hand, the hazard robot should be more deliberative. It must safe rather than fast. It seems to similar as human. Some of them tend to vague at the outside inference. But the others are not.

Summarizing the above, robot personality is the way how sensitive at the environment, how to select the processes and search the solution space, and how to act to accomplish the mission. This is what we call genetic personality of robot. It is different from the others since they have focused on the expression of artificial mentality or emotion while we aimed at behavior of robot.

D. What is Environmental Personality?

There is environmental personality that is not decidable like the genetic personality. It maybe almost same in initial, but as time goes by, it will be different. According to the situation and environment, each robot learns different contents, respectively. And then the robot personality becomes different from the initial and more specific. While the variable personality influences the essential personality, it just changes some of them.

4. Robot Personality System based on CRE Architecture

Overall architecture for implementation of robot personality is represented in “Fig. 1.” In this research, we didn’t complete Personality Generate Function in “Fig. 1” yet. Instead of this, we manually changed some parameters of robot to observe the variation of robot personality.

We assume there are 3 main features that decide the robot personality below:

- 1) parameters for mission invocation and termination in mission manager,
- 2) control part which calculate the probabilistic certainty and estimate,
- 3) action selection part that take action which is heighten the mission certainty best.

We performed the experimentation following them.

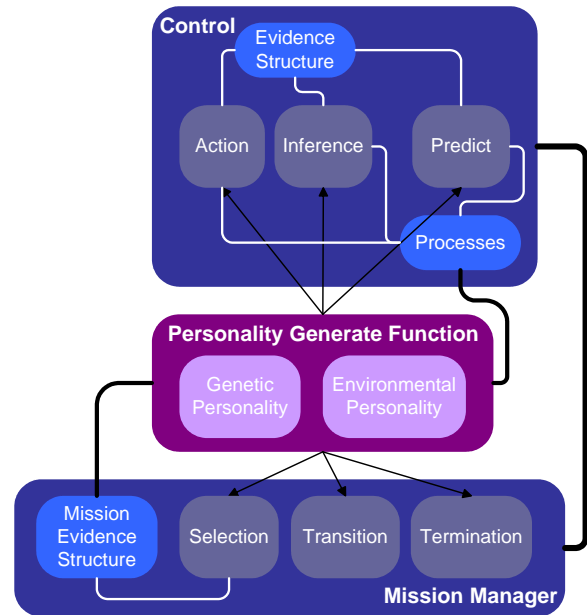


Fig. 1. Overall architecture of personality system based on CRE

A. Mission Manager

In mission manager, it determines which kind of mission to be invoked. It can be very sensitive or dull at the stimulation. We can implement this by adjusting the parameters.

Among them, there is forgetting function parameter available. Like human do, robot must forget something when it doesn’t get similar information anymore. This function is proposed in psychology field. We applied this at the certainty accumulation of mission. Accordingly, mission certainty will decrease if any important information is not acquired for a while. The robot would take an action to collect sensing data, but it will cancel the mission with continuous failure. Finally, we could change the sensitiveness of robot by changing this parameter.

B. Control

In single perceptual process, there is threshold level to suppress generation of meaningless data. The robot can be more susceptible at the sound or the image if the threshold level is lowered. In control, there is other threshold value that estimates whether the mission is complete or not. The picky robot may accomplish the mission hardly.

C. Action Selection

For the last, action behavior which used is shown in Table 2. All the behaviors are taken to improve the certainty of perceptual process and mission. In a particular situation, we can vary the selection of behavior.

Table 2. List of action behavior

Voice inquiry (VI)	Searching (SE)
Wandering (WA)	Look around (LA)
Turning (TU)	Heading (HE)
Approaching (AP)	Caller Following (CF)

5. Experimental Results

In this chapter, we analyzed the character of robot behavior. The Y-axis from the graphs below represents the sorts of actions or mission certainty. The diamond features in “Fig. 2-a” means the time when the control gave the order to the behavior generator.

All the experimentations are performed 3 times for each. The graphs show that the mission of caller identification is invoked at time 0, and then the mission is changed to caller following when the robot recognized the caller. In the result, the parameters of MODE1 are lower than average as shown in “Fig 2-a” and “Fig. 2-b.” On the other hand, those of MODE2 are higher than the others. The graphs below

“Fig. 2” shows action transition and certainty accumulation in standard parameter setting.

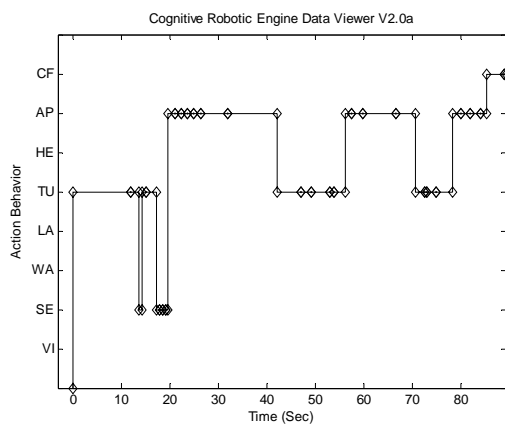


Fig. 2-a. Action transition graph of standard parameter setting

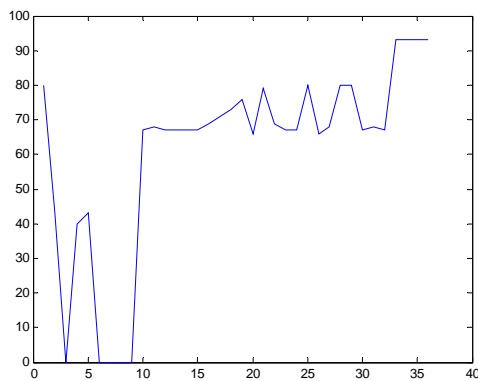


Fig. 2-b. Accumulation certainty transition graph of standard parameter setting

First, “Fig. 3” and “Fig. 4” show the result of mission parameter change. In these graphs, mission certainty was changed drastically. See “Fig 4-a” and “Fig 4-b”

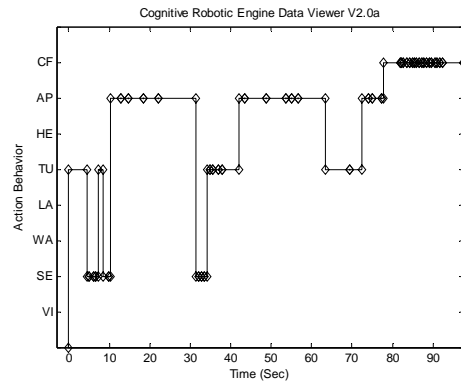


Fig. 3-a. Action transition graph of MODE1

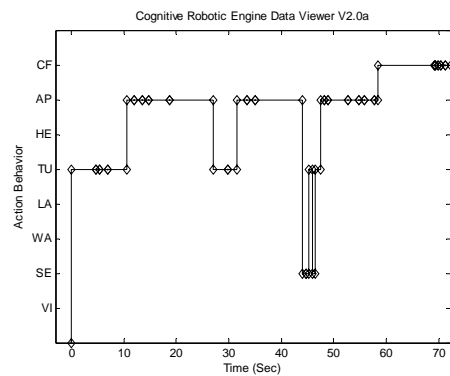


Fig. 3-b. Action transition graph of MODE2

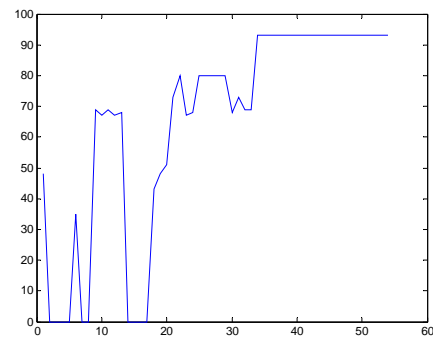


Fig. 4-a. Accumulation certainty transition graph of MODE1

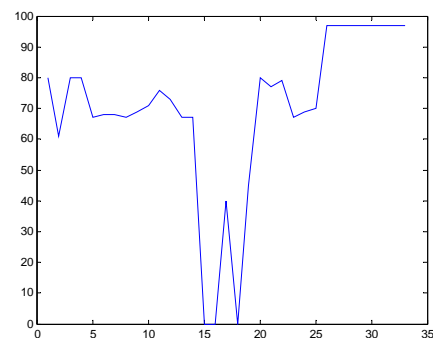


Fig. 4-b. Accumulation certainty transition graph of MODE2

Second, “Fig. 5” and “Fig. 6” are the results of forgetting function parameter change. The shorter function interval, the more change of behavior pattern in “Fig 5-a.” And also we found that the accumulated certainty is oscillated in “Fig. 6-a.” In opposite site, the variation of behavior became monotonic when the function is adjusted longer in “Fig. 5-b” and “Fig 6-b.” The oscillation of accumulated certainty is also gone down.

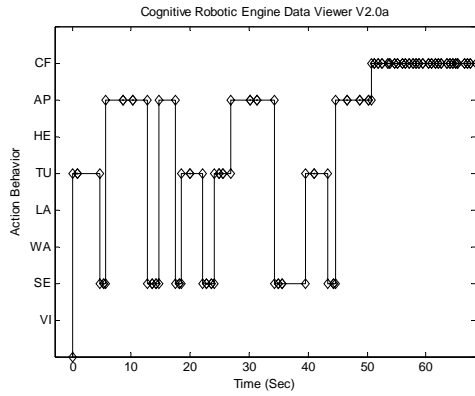


Fig. 5-a. Action transition graph of MODE1

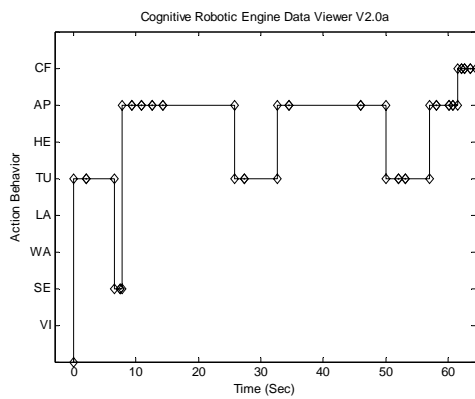


Fig. 5-b. Action transition graph of MODE 2

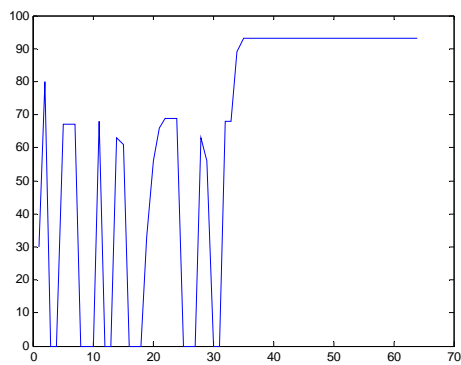


Fig. 6-a. Accumulation certainty transition graph of MODE 1

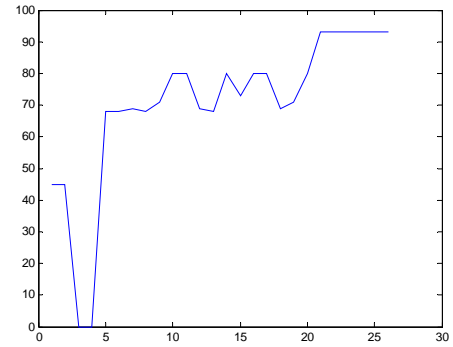


Fig. 6-b. Accumulation certainty transition graph of MODE 2

Third, “Fig. 7” and “Fig. 8” are the results of mission threshold change. The cancellation of mission occurred easily and several time. Owing to this, the behavior also changed often.

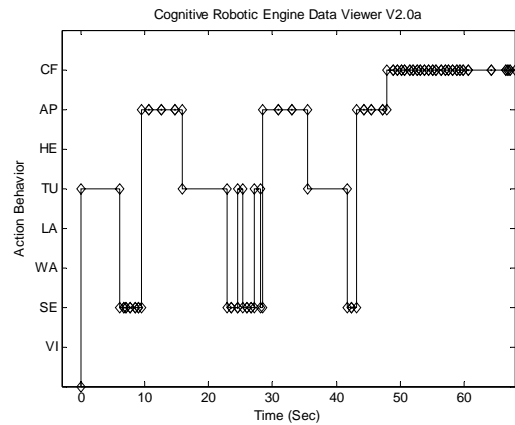


Fig. 7-a. Action transition graph of MODE 1

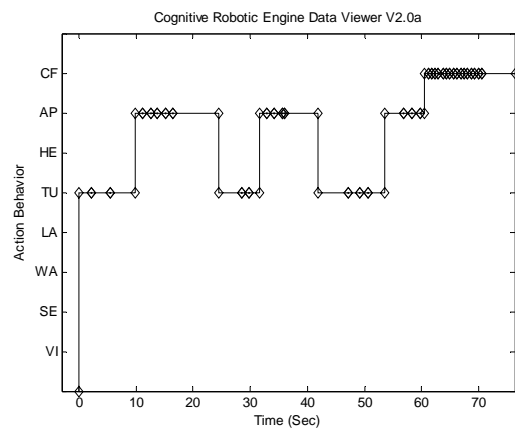


Fig. 7-b. Action transition graph of MODE 2

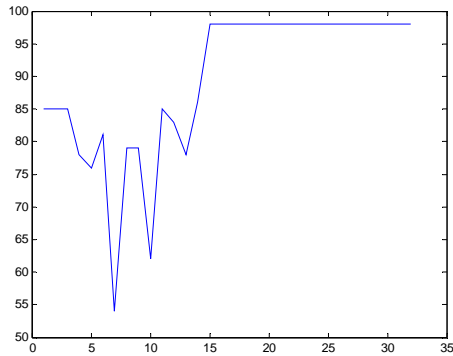


Fig. 10-c. Accumulation certainty transition graph of
MODE 2

6. Discussion and Conclusions

In this paper, we examined robot personality in behavior. From the experiments, we observed the variations of patterns, selection, and transition of behaviors. We also observed time of mission invocation, and completion.

In the bottom line, we showed that by adjusting the parameters related to robot perception, the robot can be varied in its personality.

As the future works, the sorts of missions should be more in number. The parameters to be adjusted also must be more. The system architecture also need to be improved. Furthermore, behavior personality generation function should be studied and implemented to make robot personality specific.

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