

Group Behavior of Agents with Emotional Model

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Abstract: Recently, attention has gathered in the study on the form formation of agent group that causes the interaction by agents and invents new functions. We gave agents the action rule based on the interaction of human feelings by using circumplex model. The parameter of feelings had been decided to this model only by two axes. In this report, eight basic action dimensions and pure feelings of four axes corresponding to respectively were given to agents as model of feelings and action based on the multiple factor analysis theory of R.Plutchik, and behavioral characteristic of agent group was examined.

Keywords: Multi Agent System, Emotion Model, R.Plutchik

I. INTRODUCTION

These days, a study on the care robot which is expected in a field of the medical care and the welfare and the petting robot for the purpose of mental healing and entertainment characteristics is prosperous. These robots are different from the robot operating apart from a human being in isolated space such as the industrial robot. The cooperative task in a positive relation with the human being is demanded from these robots. Because the human communicates with emotion, it is important that we design the system that these robots can understand emotion and feeling and can perform cooperative task [1]. On the other hand, there is the study of the multi agent system that plural agents give interaction and produce new functions. This system has the characteristics such as adaptability for the environmental change, flexibility for the work demand, the fault tolerance that some trouble is not connected for total trouble, and the rise of the efficiency by multiple work. The decentralized coordination problem solving by the multi agent system is said to be effective for a complicated large-scale problem. By cooperative relations and organized behavior, the agents achieve a useful purpose as the agent group. The purpose of the study is to design the robot system can understand emotion and perform cooperative task by making use of such a characteristic in a relation with a human being and the robot. If we are able to design the system, we can achieve a purpose without giving a careful order. And the convenience of the robot can improve drastically. We suggest the autonomous action algorithm

of a plural number mobile robot new at all which got analogy to the interaction itself of the feelings that were different from the conventional emotion type robot system to choose a task depending on emotion till now. So far, we enabled a morphosis of the agent group by using Circumplex Model expressing two-dimensional structure of feelings that Larsen & Diener proposes as feelings model and giving the agent an action rule based on the interaction of human feelings. In this model, the parameter of feelings was decided only in two axes of a pleasantness value "pleasantness – unpleasantness" and the activity value "activity - non-activity" [2]. In addition, in communication with the human being, the interaction for feelings is possible and can expect that we perform smooth cooperative task by using this model.

In this report, we gave the agent eight basic action dimensions and pure feelings of four axes corresponding to each as a model of feelings and actions by being based on a multiple factor analysis theory of R.Plutchik. Then we examined an action characteristic of the agent group. As a result, because an action about the morphosis such as the set of the agent, disintegration, the running after were seen, we report it.

II. A multiple factor analysis theory of R.Plutchik

The study about human feelings is prosperous in a psychological domain. There are various opinions about the classification method of feelings. For example,

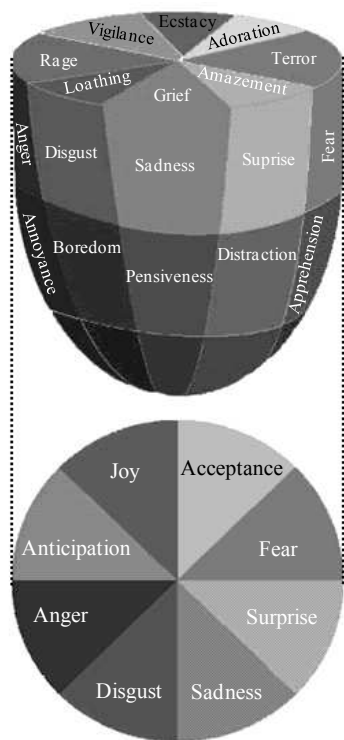


Fig.1. Feelings solid model of R.Plutchik

R.Plutchik is known by having proposed the solid model of feelings. R.Plutchik thinks that we can analyze the complicated feelings to be seen among people in everyday life into some factors and can unify these. R.Plutchik made eight basic emotions and the feelings to belong to a solid by multidimensional scaling method. Feelings structure is expressed by three-dimensional structure such as fig.1. At first R.Plutchik assumed eight basic feelings (acceptance, disgust, anger, fear, joy, sadness, surprise, anticipation) to be common to both an animal and a human being pure feelings. And R.Plutchik assumes that various mixture feelings are made by these strength and a pair. In fig.1, adjacent feelings are the things which are easy to be tied, and the thing in opposite poles is symmetric feelings. In addition, R.Plutchik paid off this adaptation form and assumed it a basic action dimension, and submitted eight action models (union, refusal, destruction, protection, reproduction, reunification, normal position, search). And R.Plutchik make eight pure feelings agree with them. In other words R.Plutchik have it as acceptance for union, disgust for refusal, anger for destruction, fear for protection, joy for reproduction, sadness for reunification, surprise for normal position and anticipation for search. In this study, we used a multiple factor analysis theory of R.Plutchik as feelings model and gave "acceptance - disgust", "anger - fear",

"joy - sadness" and "anticipation - surprise" as inside variable of the agents.

III. The definition of the agent

Each agent uses feelings model based on a multiple factor analysis theory of R.Plutchik, we define each axis as "acceptance⁽⁺⁾ - disgust⁽⁻⁾ value : A", "anger⁽⁺⁾ - fear⁽⁻⁾ value : B", "joy⁽⁺⁾ - sadness⁽⁻⁾ value : C" and "anticipation⁽⁺⁾ - surprise⁽⁻⁾ value : D" and we give A, B, C, D ($-100 \leq A, B, C$ and $D \leq 100$) as inside variable of feelings. We assume the general term of A, B, C and D feelings value and feelings value becomes the feelings of (+) in the case of the plus and becomes feelings of the (-) in the case of the minus number. We give the agent field of vision E as a search range. Based on a multiple factor analysis theory of R.Plutchik, we gave each agent following action rule (a) - (h).

- (a) If other agent j in the field of vision is acceptance ($A > 0$), agent i approaches agent j
- (b) If other agent j in the field of vision is disgust ($A < 0$), agent i grow away from agent j
- (c) If agent i is anger ($B > 0$), agent i approaches other agent j in the field of vision and act on destruction
- (d) If agent i is fear ($B < 0$), agent i grow away from other agent j in the field of vision
- (e) If agent i is joy ($C > 0$), the movement speed of agent i becomes fast
- (f) If agent i is sadness ($C < 0$), the movement speed of agent i becomes slow
- (g) If agent i is anticipation ($D > 0$), the field of vision of agent i becomes large
- (h) If agent i is surprise ($D < 0$), the field of vision of agent i becomes small

We show a rule about the change of the feelings value in (i) - (l).

- (i) When there is other agent in a field of vision, A decreases, B increases, C increases and D decreases
- (j) When there is not other agent in a field of vision, A increases, B nears 0, C decreases and D increases
- (k) When agent was acted on destruction, A decreases, B decreases, C decreases and D decreases
- (l) When agent acted on destruction, B becomes 0

Based on the above-mentioned rule, we set movement vector of an agent V, position vector R and

field of vision E of expression (1) - (5). We set a change of the feelings value when there are other agents in a field of vision of expression (6) - (9).

$$V_{Ai(s)} = \sum_{j=0}^n A_j(s) \cdot \frac{r_{ij}}{|r_{ij}|} \quad (1)$$

$$V_{Bi(s)} = \sum_{j=0}^n B_j(s) \cdot \frac{r_{ij}}{|r_{ij}|} \quad (2)$$

$$V_i(s) = \left(V_i(s-1) + \frac{V_{mi(s)}}{|V_{mi(s)}|} + l \cdot V_{Ai(s)} + l \cdot V_{Bi(s)} \right) \cdot \left(\frac{Ci(s)}{100} + 1 \right) \quad (3)$$

$$R_i(s) = R_i(s-1) + V_i(s-1) \quad (4)$$

$$E_i(s) = \frac{Di(s) + 100}{200} \cdot 360 \quad (5)$$

$$Ai(s) = (1 - R_A)Ai(s-1) - 100R_A \quad (6)$$

$$Bi(s) = (1 - R_B)Bi(s-1) + 100R_B \quad (7)$$

$$Ci(s) = (1 - R_C)Ci(s-1) + 100R_C \quad (8)$$

$$Di(s) = (1 - R_D)Di(s-1) - 100R_D \quad (9)$$

n : The number of the agents

i : ID-Number of the self

j : ID-Number of the other agents existing in a field of vision

s : The number of the steps

V_A : Approach and estrangement vector by feelings value A

V_B : Approach and estrangement vector by feelings value B

r_{ij} : Direction vectors from agent i to agent j

V : The movement vector of the agent

V_m : The direction vector to the destination of the agent

l : The influence degree of feelings

R : The position vector of the agent

R_A : A value regulation

R_B : B value regulation

R_C : C value regulation

R_D : D value regulation

IV. The basic action characteristic experiment of the agent

We performed an experiment to examine what kind of action plural agents generated by interaction.

1. Experiment environment and setting

The space builds 700×700 two dimensions space. The agent moves from the initial position to the

destination. An initial position and the destination assume it random. An initial value assumes it $n=30$ and $l=0.1$, A , B , C and D assume it random. All feelings regulation R_A , R_B , R_C and R_D assumes it 0.001. We observed the action of the agent to $s=3000$.

2. An experiment result and consideration

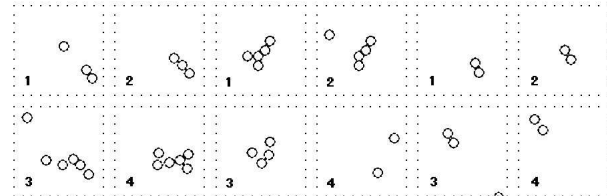


Fig.2. Set

Fig.3. Disintegration

Fig.4. Running after

As a result of simulation experiment, an action of the set, disintegration and running after such as fig.2, fig.3, fig.4 was confirmed. The number of the lower left in each figure expresses observed order. In fig.2, at first agents of $A>0$ or $B>0$ form a set, and then agents having various feelings value gather. In fig.3, agents of $A<0$ or $B<0$ increase in the agents which gathered, and then the agent breaks up. In fig.4, in the case of "agent approaches other agent in $B>0$ and that there is not agent in a field of vision of other agent or that other agent is $B<0$ or that agent is $A<0$ is filled" or "other agent approaches agent in $A>0$ and that there is not agent in a field of vision of other agent or that other agent is $B<0$ or that agent is $A<0$ is filled", running after is observed.

V. An evaluation experiment of the feelings value and action characteristic

We performed an experiment to examine relations of feelings regulation (R_A , R_B , R_C and R_D) and the action characteristic observed with III. The basic action characteristic experiment of the agent.

1. Experiment environment and setting

The space builds 700×700 two dimensions space. The agent moves from the initial position to the destination. An initial position and the destination assume it random. An initial value assumes it $n=30$ and $l=0.1$, A , B , C and D assume it random. We changed feelings regulation and performed simulation to $s=3000$ ten times in each condition of (i) - (v).

- (i) Condition 1 : $R_A=0.001$, $R_B=0.001$, $R_C=0.001$, $R_D=0.001$
- (ii) Condition 2 : $R_A=0.1$, $R_B=0.001$, $R_C=0.001$, $R_D=0.001$

- (iii) Condition 3 : $R_A=0.001$, $R_B=0.1$, $R_C=0.001$, $R_D=0.001$
- (iv) Condition 4 : $R_A=0.001$, $R_B=0.001$, $R_C=0.1$, $R_D=0.001$
- (v) Condition 5 : $R_A=0.001$, $R_B=0.001$, $R_C=0.001$, $R_D=0.1$

2. An experiment result and consideration

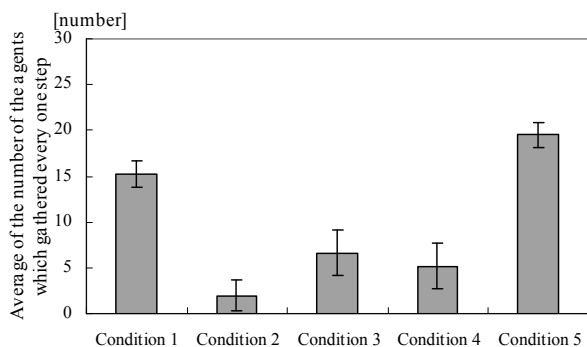


Fig.5. Average of the number of the agents which gathered

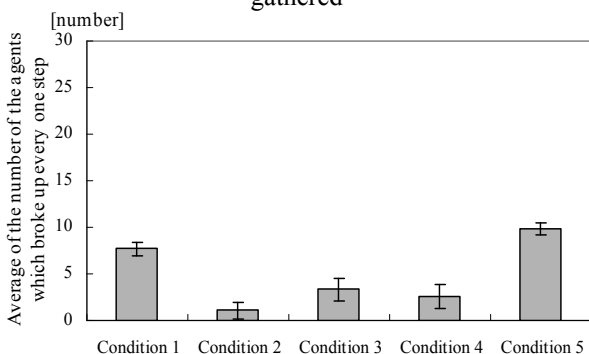


Fig.6. Average of the number of the agents which broke up

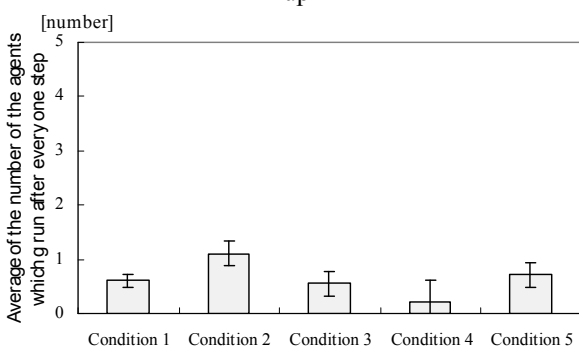


Fig.7. Average of the number of the agents which ran after

Fig.5 expresses average of the number of the agents which gathered every one step in each condition. As a result of having performed t-test between condition 1 and each condition, significant difference was confirmed in a level of significance of 1% between all conditions. From this, when we made R_A , R_B and R_C big, a set is hard to come to happen. And when we made R_D

big, a set is easy to come to happen. Fig.6 expresses average of the number of the agents which broke up every one step in each condition. As a result of having performed t-test between condition 1 and each condition, significant difference was confirmed in a level of significance of 1% between all conditions. From this, when we made R_A , R_B and R_C big, disintegration is hard to come to happen. And when we made R_D big, disintegration is easy to come to happen. Fig.7 expresses average of the number of the agents which ran after every one step in each condition. As a result of having performed t-test between condition 1 and each condition, significant difference was confirmed in a level of significance of 1% between condition 1 and 2. Significant difference was confirmed in a level of significance of 5% between condition 1 and 4. Significant difference wasn't confirmed between other conditions. From this, when we made R_A big, running after is easy to come to happen. And when we made R_C big, running after is hard to come to happen.

VI. CONCLUSION

In this report, we gave agent new model of feelings and action based on a multiple factor analysis theory of R.Plutchik and observed analyzed an action as a group. As a result, we understood that the agent group performed action of set, disintegration, running after. In addition, we assumed this action a basic action characteristic of the agent group and examined and the relations of feelings regulation and the basic action characteristic by changing feelings regulation. As a result, we understood that the probability that an action of set, disintegration and running after happens changes. We will examine method to control this set, disintegration, running after in future.

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