Emotion Inspired Mechanism in the intelligent system

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Abstract: In this paper, for designing more sophisticate Emotional process considering the personality Emotional Inspired mechanism in the intelligent system is studied. We propose the mechanism for implementing the connection between knowledge and emotion, personality and emotional reaction process. Also personally different emotional reaction mechanism about the same external emotional stimulus is designed and tested with virtual memory.

Keywords: Emotional Reaction, Type matching Selection, Thought thread, personality

1. INTRODUCTION

Why does a human being have a different emotional reaction to the same stimulus individually? This is not a solvable problem but it is guessed that the main reason is caused by personality and current emotion. The personality is the own property which the individual person has. It is thought that the personality is formed by inherent characteristics and acquired characteristics. The acquired characteristics mean the obtained knowledge and experience. Human being percepts the things on the basis of neural network in the brain which is obtained by learning and experience. That is to percept and process the things in the own viewpoint.

Recently as one way of implementing Human-Computer-Interface the research on emotion has started in the engineering part for implementing more human friendly computer system. However the main problem of Emotional process is that it is difficult to formalize the emotional factor because its characteristic is too personal and subjective. In order to overcome this shortcoming, the personality should be quantified as concrete as possible and designed sophisticatedly. Suppose that the personality depends on the structure, contents and type of neural network in the brain, we should investigate these factors. Every person has his own type and receives the matching typed knowledge and makes the structure of memory. According to the research of Neuro-Science, it is known that there are two pathways in the process of memorization. One is a pathway to memorize the knowledge including the Emotional state and the other is a pathway to store the knowledge without emotional factor. In the brain hippocampus takes part in the main memorizing process and amygdaloid nucleus plays an important role of emotional process. In the first pathway, both of hippocampus and amygdaloid nucleus are working but in the second pathway only hippocampus takes part in the memorizing process. It is known that the knowledge including the emotion lasts longer. Nobody can deny the fact that the emotion has much effects on the memorizing process, reasoning, and decision making process.

The main issue is how to design and implement the emotional state which has much personal tendency. Fortunately we can find some clues from the brain function. First key is to make the emotion state quantified, second is to connect emotion factor to knowledge and third is to qualify the type to the knowledge.

In this paper,considering the above three points of view Emotion inspired system is designed for making more sophisticate intelligent system. The emotional reaction mechanism is proposed and its experimental results are investigated.

2. THE DESIGN OF EMOTION, KNOWLEDGE AND TYPE MATCHING

2.1 Emotional factor

Many studies on the Emotional modeling have been made for these decades, for example, valance-arousal-plane of Emotion space based on Russells circomplex model of affects[4], The Tellegen-Watson-Clark model of mood[5],OCC model[6]. The most popular example of this is the Ortony, Clore and Collins(OCC) model. The OCC model divides a character's concerns in an environment into goals(disired states of the world), standards (ideas about how people should act) and preference(likes and dislikes).

In this study,we differentiate moods and Emotions on the basis of three criteria: like, excited and stable. Emotion state is represented by three dimensional space as following figure 1. The emotion state is specified as the degree of three factors.

Emotional State E_i=(a degree of 'like', a degree of 'excited', a degree of 'stable') where the degrees of three factors have values of [-1.0,+1.0].

For example, the six emotional states can be expressed by the following space. The value of degree is not fixed and can have a variation depending on the situation.

happy=(+1.0,+0.8,+1.0)
surprise=(0.0, +1.0, -1.0)
sad=(-1.0,-1.0,-0.5)
fear=(-1.0,+1.0,-1.0)
disgust=(-1.0,+0.5,-0.5)
interest=(+1.0,+0.5,+0.8)

2.2 The knowledge network design

We designed knowledge network as a structure of memory for efficient processing. The knowledge network consists of knowledge nodes and their associative rela-
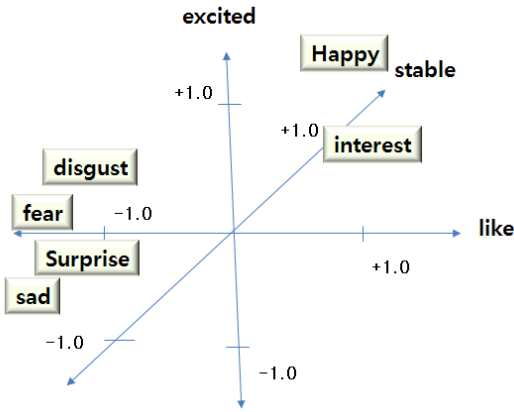
Fig. 1 Emotion space

tions[1]. It is represented as a form of

$$\langle \text{K-node}_i, R_{ij}, K-node_j \rangle$$

where $K-node_i$ is the name of knowledge node and R_{ij} is connection strength between two knowledge nodes. R_{ij} is calculated by equation (1).

$$R_{ij}=P(K-node_i \mid K-node_j) \qquad (1)$$

Knowledge node is an basic atom composing the Knowledge Network. It contains 'ID','Type(T)','Self Energy(S)','Retained Emotional Energy(E)' attributes which can identify itself. Knowledge node is represented as a form of 'struct'.

$$\text{struct k-node}_i\langle ID,T,S,E\rangle$$

Type,T,represents its own property of knowledge which is base factor for the personality and Self Energy,S,is used for the forgetting or incarnation mechanism. The term of Retained Emotional Energy,E, is used for processing the emotional part. Emotional energy has a value between -1.0 and +1.0. The value 0.0 means that emotional energy is in the neutral state. The explanation about this emotional factor will be described in the next section in detail.

2.3 Type Matching Selection

Type is defined as a factor representing the property of a thing and is classified to five types, M,F,E,K and S. These five types can be flexibly designed for the application area. We also defined Type matching rule. Type matching rule is used for selecting the knowledge from master Knowledge Network. There are two types of matching relations,Attracting Relation and Rejecting Relation[1].

Attraction Relation	Attracting degree d_i
M $\oplus \gg$ F	d_1=0.5
F $\oplus \gg$ E	d_2=0.5
E $\oplus \gg$ K	d_3=0.5
K $\oplus \gg$ S	d_4=0.5
S $\oplus \gg$ M	d_5=0.5

Rejecting Relation	Rejecting degree d_i
M $\ominus \gg$ E	d_1=-0.5
E $\ominus \gg$ S	d_2=-0.5
S $\ominus \gg$ F	d_3=-0.5
F $\ominus \gg$ K	d_4=-0.5
K $\ominus \gg$ M	d_5=-0.5

The matching rule 'M $\oplus \gg$(0.5) F' means that M type helps F type with attracting degree 0.5. The value d_s of 'M $\oplus \gg(d_s)$ S' is derived from 'M $\oplus \gg$(0.5) F $\oplus \gg$(0.5) E $\oplus \gg$(0.5) K $\oplus \gg$(0.5) S'. The attracting degree of multiple relation is calculated by the following equation(2).

$$d_s=\begin{cases} \prod_{i=1}^{n}(-1)^{n+1}d_i & \text{if } Type_i \neq Type_j \\ 1 & \text{otherwise} \end{cases} \qquad (2)$$

If the value of d_s is positive, it is attracting relation. Otherwise, the minus value means rejecting relation.

3. THE DESIGN OF EMOTION INSPIRED SYSTEM

3.1 The Emotional process

As described in the previous section, the knowledge network consists of ID, Type,Self Energy and Retained Emotional Energy. In the process of structuring the memory,the system acquires the knowledge including the emotional factor. There are two pathways to receive the learning data for constructing the knowledge network. One is to get the knowledge including the emotion factor and the other is to receive only knowledge. In the first case including the emotional factor, the value of emotional Energy is represented as a vector form as follows.
$E_i =(E_x, E_y, E_z)$,
where E_x is 'like' term, E_y is 'excited' term and E_z is 'stable' term.

In the second case, the value of Emotional energy is $E_i =(0.0, 0.0, 0.0)$

The learning structure and mechanism are described in the paper[1,2,7] in detail. In this section we 'll explain the mechnism focusing on the emotional reaction by the personal perspective and emotional state. For deciding the reaction emotional state, three factors of input emotional stimulus,E_s, and the emotional energy of retrieved Thought thread, E_i^M, are considered.

The figure 2 shows the Emotional reacting process. when the emotional stimulus, E_s, comes into the system, the system receives the stimulus knowledge and its type together and starts the emotional reaction process. First of all, the system extracts the related Thought threads from the Emotion inspired knowledge network using Type Matching Selection mechanism. Through this extracting mechanism, several Thought threads can be
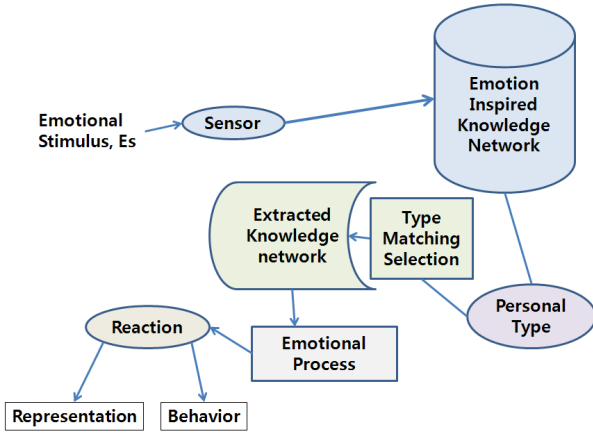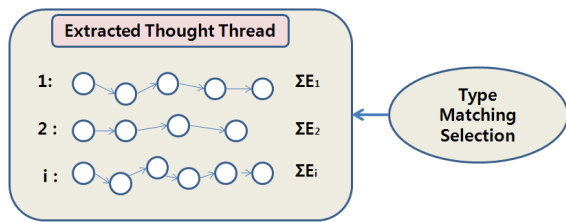
Fig. 2 Emotional reacting process

Fig. 3 Extracted Knowledge Network :Thought thread

retrieved. As shown in Figure 3, the related Thought threads are extracted by Type Matching Selection mechanism. In this step the system should select one Thought thread for reaction and Decision making. For emotional process, the system evaluates the mean value of the emotional energy in the extracted Thought threads. The mean value of Thought thread,E_i^M, can be calculated as following equation.

$$E_i^M = (E_{ix}^M, E_{iy}^M, E_{iz}^M)$$
$$= (\frac{\Sigma_{i=1}^n E_{ix}}{n}, \frac{\Sigma_{i=1}^n E_{iy}}{n}, \frac{\Sigma_{i=1}^n E_{iz}}{n}) \quad (3)$$

After calculating the mean value of emotional energy in the retrieved Thought thread, one Thought thread matched with stimulus emotional stateshould be selected. Suppose that the stimulus emotional state is $E_s=(E_{sx},E_{sy},E_{sz})$, the choosing rule is as following equation(4).

$$T = \sqrt{(E_{sx} - E_{ix}^M)^2 + (E_{sy} - E_{iy}^M)^2 + (E_{sz} - E_{iz}^M)^2} \quad (4)$$

$$p = argmin_i T \quad (5)$$

From this calculation, the Thought thread,p, is selected. The final emotional state,E_f is calculated by equation (6).

$$E_f = (E_{fx}, E_{fy}, E_{fz}) \quad (6)$$

$$E_{fx} = \begin{cases} E_{sx} + E_{px} & \text{if } -1 <= E_{sx} + E_{px} <= 1 \\ 1 & \text{if } x > 1 \\ -1 & \text{otherwise} \end{cases} \quad (7)$$

$$E_{fy} = \begin{cases} E_{sy} + E_{py} & \text{if } -1 <= E_{sy} + E_{py} <= 1 \\ 1 & \text{if } x > 1 \\ -1 & \text{otherwise} \end{cases} \quad (8)$$

$$E_{fz} = \begin{cases} E_{sz} + E_{px} & \text{if } -1 <= E_{sz} + E_{pz} <= 1 \\ 1 & \text{if } x > 1 \\ -1 & \text{otherwise} \end{cases} \quad (9)$$

3.2 Emotional Reaction Algorithm

Based on the the calculation of Emotional state in the previous section, Emotional Reaction process is performed by following algorithm.

Algorithm 1 : Emotional Reaction Process

STEP1 input Type T, Emotional stimulus E_s;
STEP2 Type Matching selection;
STEP3 i=1;
STEP4 while(queue != Empty) do
  begin
  Calculate the mean value of Emotional state, E_i^M
  end
STEP5 Select Thought thread p;
STEP6 Calculate reaction Emotion;
STEP7 Interpretation;
STEP8 : Stop.

4. EXPERIMENTS

In this experiment, we tested the emotional reaction process with the virtual memory which consists of 15 knowledge nodes as shown in Figure 4. Input condition is set that the Type of input data is 'M' and input stimulus comes variously. Figure 5 shows the four extracted Thought threads about Type 'M' by Type maching selection. In this step, the mean values of emotional states in the Thought threads were calculated. As shown in Figure 6, the emotional distance between 5 incoming emotional stimulus and the mean value of emotional state of Thought thread. As a result of experiment, the closest Thought thread was selected and reacted. From the data in Figure 7, we can check that when the incoming input stimuli is E_1(-1.0,-1.0,-1.0) Thought thread4 is selected and its reaction value is also (-1.0,-1.0-1.0). In the case of E_3(0.0,0.0,0.0), Thought thread3 is choosed and it reacts as (0.18,0.40,0.35). It means that there is no emotonal stimulus but the emotional state stored in memory is represented. This experiments have a meaning that this mechanism connsiders not only external emotional stimulus but also internal emotional state stored in the memory.

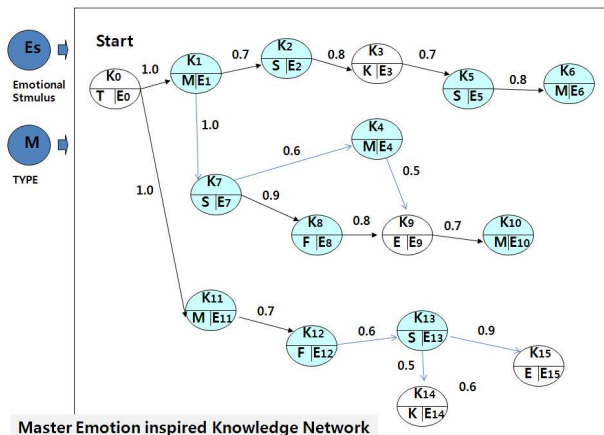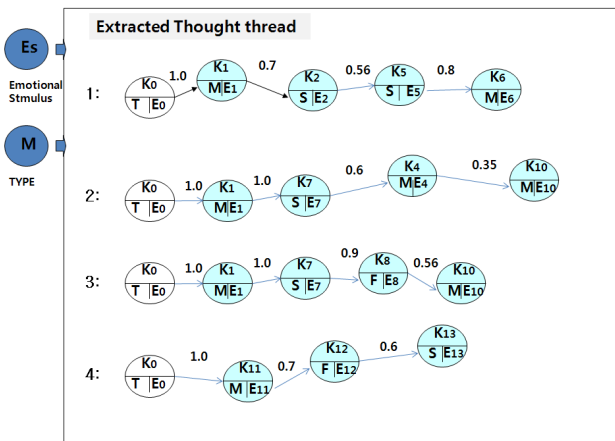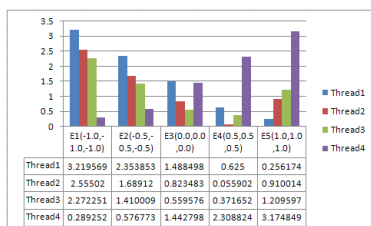|	E_x	E_y	E_z
E_1	1.0	1,0	0.9
E_2	0.8	0.9	0.7
E_3	0.5	0.5	0.3
E_4	0.2	0.0	0.1
E_5	0.6	0.7	1.0
E_6	0.8	0.9	1.0
E_7	0.3	0.3	0.3
E_8	-0.1	-0.2	-0.5
E_9	0.1	0.1	0.0
E_{10}	0.4	0.5	0.7
E_{11}	-1.0	-1.0	-1.0
E_{12}	-0.8	-0.7	-1.0
E_{13}	-0.7	-0.8	-0.5

Fig. 4 Master Emotion inspired Knowledge Network

Fig. 5 Extracted Thought threads

Fig. 6 Emotional distance

Emotional Stimulus	Selected Thread	Emotional Reaction
E1(-1.0,-1.0,-1.0)	Thread4	(-1.00 ,-1.00, -1.00)
E2(-0.5,-0.5,-0.5)	Thread4	(-1.00, -1.00, -1.00)
E3(0.0,0.0,0.0)	Thread3	(0.18, 0.40. 0.35)
E4(0.5,0.5,0.5)	Thread2	(0.98, 0.95, 1.00)
E5(1.0,1.0,1.0)	Thread1	(1.00, 1.00, 1.00)

Fig. 7 Emotional Reaction

5. CONCLUSION

In this paper, Emotional Inspired mechanism in the intelligent system was studied. We designed the mechanism for implementing the connection between knowledge and emotion, personality and emotional reaction process. Also personally different emotional reaction mechanism about the same external emotional stimulus was designed and tested with virtual memory. As a result, it shows the successful testing results. This strategy can be usefully applied to design and construct more sophisticate Intelligent System.

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