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A Design of Brain Sensory monitoring Thinking Activity inside the Knowledge System

JeongYon Shim

Div. of GS, Computer Science, Kangnam University, Kugal Dong 111, KiHeung Gu, YongIn Si, KyeongKi Do, Korea
(Tel : +82-31-280-3736; E-mail: mariashim@kangnam.ac.kr)

Abstract: For several recent years many studies adopting the brain functions have been studied for making efficient system in the dynamic complex environment. As one of brain based research, in this paper the new concept of Brain sensory was defined as 6th sensory organ and brain sensory monitoring thinking activity is designed which has various functions including selective sensory input signals, recalling the related knowledge and retrieving thinking chains. Especially DTAM (Dynamic Thinking Association Map) was designed for conditioned learning process and Emotional Switching concept for activating the matched knowledge from the large well structured memory with the control signal was proposed. The functions of DTAM and Emotional Switching make dynamic selective thinking chain retrieval possible. This system was applied to the virtual memory and tested with sample data.

Keywords: Brain Sensory, Thinking Activity,Emotional Switching

1. INTRODUCTION

For recent several years the studies in the brain inspired system have been activated and are rising as an area of blue ocean part. The main reason lies in the fact that brain is the final product which has been survived and evolved in the dynamic complex environments for several million years. The brain has developed the optimal structure of being adapted for the dynamic complex circumstances. The brain not only controls whole living system but also takes part in sensing, learning, memorizing,recalling and thinking process. And it is also known that the brain creates mind and emotion. According to the studies of emotion, emotion is closely related to the survival. Positive emotion makes the whole body system opened and be ready for production. On the contrary, negative emotion makes the body system closed and ready for defense. It means that the emotion plays a very important role of decision making. There are occurring many thinking activities as well as many kinds of emotion inside the brain when the brain is activated. During this phase the emotional factor performs an important functions. From this point of view, brain theory gives many clues for solving the complex problems surrounding human beings. Especially in the huge dynamic internet circumstance its functions can be usefully adopted and inspired to the process of implementing the artificial intelligent system.

Focusing on the activities inside the brain, in this paper as one of studies of brain inspired system the concept of 'Brain Sensory' is defined as 6th sensory organ which is monitoring Thinking Activity inside brain. Especially Dynamic Thinking Activity Map(DTAM) was designed as a space for containing the information about temporal associative relation related to the conditioned learning and Dynamic Thinking chaining threads extracted from the memory. For occurrence of Thinking Activity memory recalling process is necessary. In this system the concept of Emotional Switching is defined and used for activating the related knowledge in memory during the memory recalling process by Type matching Strategy. That is, Emotional switching takes part in the function of selecting the extracted thinking chaining thread. The knowledge based data in the virtual memory was applied to test this system and the processing step of monitoring the brain sensor was investigated.

2. THE OVERVIEW OF BRAIN SENSORY

It is known that Human being has five organs for sensing the external signals. But in our work,we define 'Brain Sensory' as the 6th new sensory which senses Thinking activities occurred inside the brain. We always experience that many thinking streams appear and disappear during the thinking process. There occur several thinking streams in parallel. They sometimes combine together or conflict with each other. The brain sensory is monitoring these thinking activity from the sensory input data to the occurring thinking streams inside brain. As shown in Fig.1,Brain Sensory is designed for monitoring whole process of Thinking Activity. Starting from the stimulus signal of input data which came from the five sensory organs, Thinking activity occurs in DTAM (Dynamic Thinking Activity Map) using Memory recalling mechanism from the knowledge Networks of the memory. DTAM consists of TAR(Temporal Associative Relation) and Thinking chaining thread space. TAR contains Associative Relations obtained by Conditioned learning temporally and is used for extracting the thinking threads. The Knowledge extracting strategy based on DTAM is described in detail in the paper[1].

3. THINKING CHAINING THREAD EXTRACTION AND EMOTIONAL SWITCHING

3.1 The structure of knowledge network in memory

The structure and its mechanism of knowledge network composing the memory is very important to design the efficient system. The knowledge network consists of knowledge nodes and their associative relations. It is represented as

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

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).

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

Knowledge node is an basic atom composing the Knowledge Network. It contains 'ID','Type','Emotional Factors' attributes which can identify itself. Knowledge node is represented as a form of 'struct'.

$$\text{struct k-node}_i\langle ID, Type, EmotionalFactors\rangle$$

Emotional Factors has three terms representing emotional state and are described in the next section.

3.2 Thinking chaining Thread extraction by Type Matching Strategy

The system extracts the related knowledge from the memory and makes Thinking chaining Threads using Type Matching Rule which is a proposed criteria of selecting the knowledge. Starting from the idea that everything has its own property,'Qualia',we define 'Type' as a factor representing the property of a thing. In this system, five types, M,F,E,K and S are defined. These five types can be flexibly designed according to the application area. Type Matching rule which is representing matching relations is also defined. There exists attractive force or repulsive force between two things. The attractive force means that two properties of things are matched well and the repulsive force says that they are mismatched and rejecting each other. The following tables depicts Attractive relation and Repulsive relation respectively.The knowledge extraction method using Type matching strategy is described in the paper in detail[2].

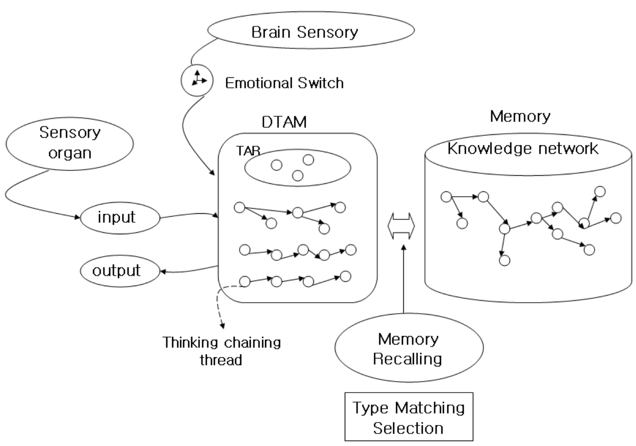

Fig. 1 Brain Sensory

Table 1. Type Matching Rule

Attractive Relation	Attractive 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
Repulsive Relation	**Repulsive 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 attractive degree of multiple relation is calculated by the following equation(2).

$$\text{d}_s\text{=}\begin{cases} \prod_{i=1}^{n}(-1)^{n+1}\text{d}_i & \text{if } Type_i \neq \text{Type}_j \\ 1 & \text{otherwise} \end{cases} \qquad (2)$$

If the value of d_s is positive, it is attractive relation. Otherwise, the minus value means repulsive relation.

3.3 Emotional Switching

During the process of Thinking Chaining thread extraction, several thinking threads are occurred. Brain sensor monitoring Thinking Activity checks the current emotional state activates the Thinking chaining thread selected by Emotional switching.

'Emotion' is represented by three dimensional values of E_{X_i},E_{Y_i} and E_{Z_i}. That is, emotional state of i-th thread E_i is :

$$E_i = (\text{E}_{X_i}, E_{Y_i}, E_{Z_i}) \qquad (3)$$

As shown in Fig.2, E_{X_i},E_{Y_i} and E_{Z_i} represent the emotional states and have a value of [-1,+1].

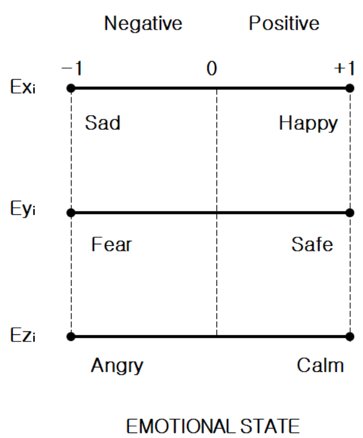

Fig. 2 Emotional State

The value of Emotional vector, $V(E_i)$, is calculated by equation (4).

$$V(E_i) = P * \sqrt{{E_{X_i}}^2 + {E_{Y_i}}^2 + {E_{Z_i}}^2} \tag{4}$$

$$P = \begin{cases} 1 & \text{if } t > 1 \\ -1 & \text{otherwise} \end{cases} \tag{5}$$

$$t = E_{X_i} + E_{Y_i} + E_{Z_i} \tag{6}$$

- **Thinking thread selection by Emotional Switching**

Based on calculating the value of emotion Brain Sensory checks whole emotion state of $E_0 = (E_{X_0}, E_{Y_0}, E_{Z_0})$. It turns on Emotional switch and activates the selected Thinking chaining Thread. During Emotional switching process Thinking thread is selected by the following equation (7) and activated.

$$Active(T) = argmin_k \frac{\sum_{i=1}^{n} \sqrt{{E'_X}^2 + {E'_Y}^2 + {E'_Z}^2}}{n} \tag{7}$$

where $E'_X = E_{X_i} - E_{X_0}$, $E'_Y = E_{Y_i} - E_{Y_0}$, $E'_Z = E_{Z_i} - E_{Z_0}$

where n is the number of chained knowledge nodes of Thinking thread k.

4. EXPERIMENTS

In this experiment, the designed Brain Sensory was applied to the Virtual memory and its monitoring process was tested. Fig. 3 shows the initial state of testing knowledge network composing the Virtual memory. As shown in Table 2 the knowledge node has the Emotional factors which represents the current Emotional state.

Table 2. Emotional factor of Knowledge node

$K - node_i$	E_{X_i}	E_{Y_i}	E_{Z_i}
K_1	0.7	0.8	0.9
K_2	0.8	0.7	0.5
K_3	0.8	0.7	0.5
K_4	0.9	0.4	0.7
K_5	1.0	0.2	0.3
K_6	1.0	0.3	0.4
K_7	0.2	0.0	0.1
K_8	0.1	0.1	0.2
K_9	0.2	0.1	0.2
K_{10}	0.1	0.0	0.0
K_{11}	-0.7	0.1	-0.5
K_{12}	-0.8	-0.7	-0.5
K_{13}	-0.6	-0.3	-0.2
K_{14}	-0.9	-0.2	-0.1
K_{15}	-1.0	0.0	0.1

Fig. 4 depicts the process of Type Matching Selection from the initial knowledge network. In the case of Input type,'M',the matched knowledge nodes with type 'M' were selected and activated. Using Type Matching Selection strategy,three Thinking chaining threads were extracted in the experiment as shown in Fig.5. Especially Fig.6 describes the result of Thinking Chaining Thread Selection by Emotional Switching. In the case of Emotional state which has Emotional factor E0, namely, Ex0=0.9,Ey0=0.7 and Ez0=0.6, Thinking chaining thread 1 was selected. Fig.7 also shows the changing results of Emotional Switching according to the current Emotional state of whole system,E01,E02,E03,E04 and E05.

Table 3. Emotional state of whole system

E-state	$E0i_{X_i}$	$E0i_{Y_i}$	$E0i_{Z_i}$	E-value
E01	0.900000	0.700000	0.600000	1.288410
E02	0.500000	0.500000	0.500000	0.866625
E03	0.000000	0.000000	0.000000	1.191385
E04	-0.300000	-0.400000	-0.500000	-0.707107
E05	-0.800000	-0.300000	-0.500000	-1.024695

As a result of experiments we could find that Brain sensory performs the monitoring function focusing on thinking chaining monitoring Thinking chaining thread extraction by emotional switching successfully.

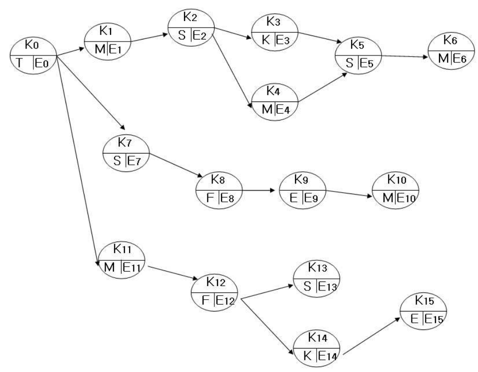

Fig. 3 The initial state of testing knowledge network

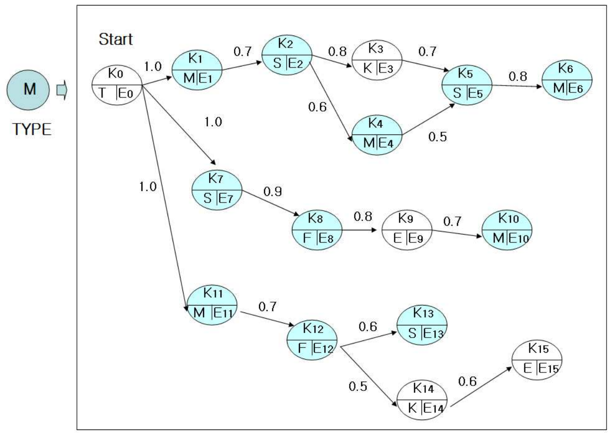

Fig. 4 Type Matching : Type= M

5. CONCLUSION

In this paper, Brain sensory monitoring Thinking Activity was designed. It is very meaningful that Emotional state was defined and the strategy of Thinking chaining thread extraction by Emotional switching was designed. This strategy was applied to the virtual memory and experimented with sample testing data and got the good testing results. This strategy can be usefully applied to design and construct core artificial brain of the Intelligent

System.

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Knowledge Extraction stage ...

Input Type(M/F/E/K/S)? M

Knowledge Extraction starts...

K0 1.0 K1 0.7 K2 0.6 K5 0.8 K6 0.0 Null
K0 1.0 K1 0.7 K2 0.6 K4 0.5 K5 0.8 K6 0.0 Null
K0 1.0 K7 0.9 K8 0.6 K10 0.0 Null
K0 1.0 K11 0.7 K12 0.6 K13 0.0 Null
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Fig. 5 Thinking Chaining Thread Extraction:Type=M

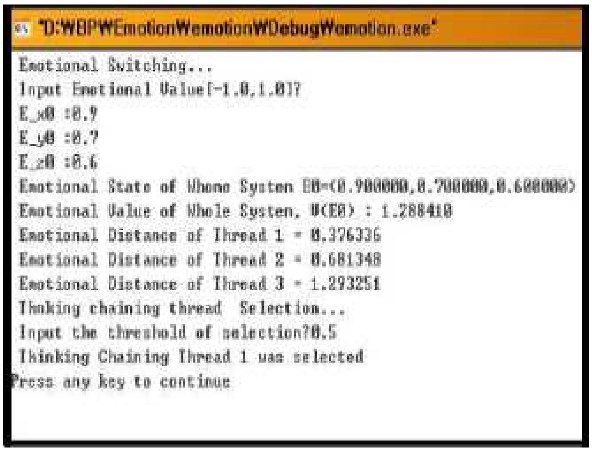

Fig. 6 Thinking Chaining Thread Selection by Emotional Switching

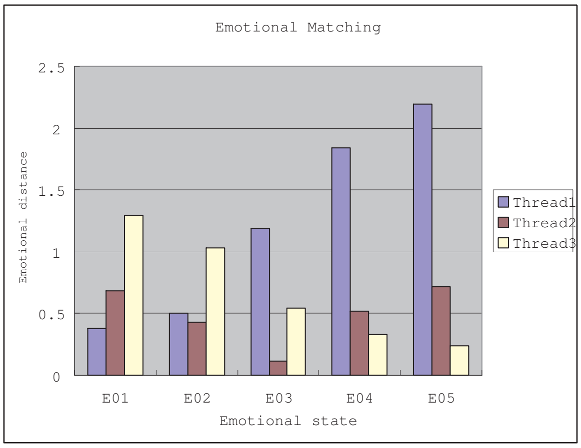

Fig. 7 The changing Emotional distance according to the current Emotional states, E01,E02,E03,E04 and E05