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Introduction of 5 Layer Structure for Information and Convergence Technology

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Abstract: In many applications, the information processing technology has been developed by soft computing method and other technologies. The recent works handle only a specific area, not tell the whole relations between input and output. On the other hand, the brain has been known as a whole structure to proceed the information processing. An introduction of a common standard for information processing, which can be applied to many application is strongly recommended. In this paper, we analyze the function of cerebral cortex that is a main processor in the brain and define the function of it in the engineering point. Finally, the standard form of brain information processing will be introduced by 5 layer structure for information convergence technology.

Keywords: Information Technology, Intelligent System, Convergence Technology, Layer Structure, Soft Computing

1 Introduction

Information processing, control technology, science and other subjects are currently converged according to specific needs and application. The speed of convergence technology between subjects has been boosted up as the society and industry grow fast and change rapidly. However, the engineering implementation has been developed in a specific area, not in a crossed area between industries. For example, the sensor technology has been achieved by material science and its simple software without being converged by semantic and context recognition or decision making and command generation. Now, we need to develop the whole structure for information convergence technology and its application based on the way how brain works for sensing, recognition, decision, learning and action.

The fundamental processing mechanism in biological brain system may be the best model in the world to accomplish a given performance. Many researches to generate an artificial information processing system have been proceeded by scientists and

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engineers. As a result, many facts such as active areas, signal flows and connectivity between neurons in the brain has been explained and summarized. From the 1870, the function of brain was introduced to people by experiments. The research to make a model for brain has been proceeded from the early 1940 with learning theory and neural network theory.

In this paper, the modules are designed by function and definition of biological information processing in brain. Furthermore, the standard structure will be developed by combination of the several modules. The basic idea to design the layer structure is to organize the several modules such as physical processing module, context conversion module, semantic generation module, state estimation module, behavior decision module, execution module, and learning module according to the functional features and relationships between them.

The characteristics of layer are to define the several functional modules mimicking the biological function of brain as a simple form and to combine and arrange the similar modules. Because of module based structure, moreover, if a new technology of information processing is developed, the adaptation of it to real information processing system is easy and the verification of the performance is observable. The last characteristic is to provide integrated artificial intelligence model based on biological brain information processing mechanism with the layer structure.

One of the advantages of layer is that the each layer operates independently by the provided information as a defined format by the protocol. The most advantage of the proposed layer is to solve the given complex problem efficiently because of the common property. The important thing is to design the functions in each module and to define the protocol with the specific data format.

2 Biological Information Processing in Brain

By the neuroscience, human being uses a part of brain to handle the sensory information. After analysis and decision of the information, human being can act according to the result of decision for behavior. Based on the neurophysiology, it is a general process that is performed in the cerebral cortex for human to feel, think and speech.

For a better understanding, we examine the process from the time when human experience a situation in normal case according to the steps that may occur in human brain. Generally, the sensory input can be received at the primary sensory area which is located in a thalamus of the cerebrum. The received sensory input is transferred to the multiple sensory association area and compared with the existed memory to be recognized and analyzed. After being compared with the memory, the sensory input finally can be recognized and the behavior related with the sensory input can be selected. In next step, the determined behavior command can be transferred to the primary motor area. In the primary motor area, the transferred command controls the motory organisms such as legs, eyes, arms and so on.

As mentioned above, the information process in the brain is represented with three parts those can be recognized as sensory area, association area and motor area. First, the sensory information is treated in the primary sensory association area. In this area,

the information is accepted and the recognition about the accepted sensory information is done. Secondly, the different types of sensory information can be combined together at the multiple sensory association area, the meaningful recognition among the different information is done. The process includes comparison with the memory and classification of the information with several pre-defined categories. Moreover, the other functions including semantic and context, learning and feedback, emotional decision, memory and motor system are defined by their own features and functions. The basic structure of cerebral cortex can be shown in Fig.1.

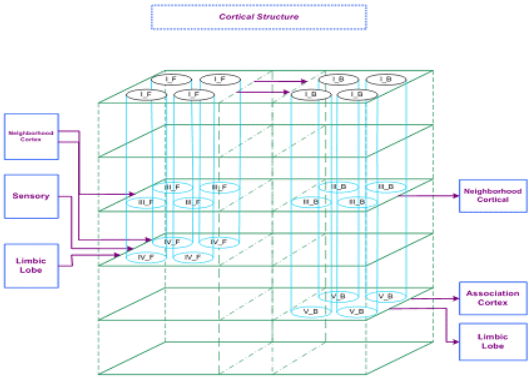

Fig. 1. The cortical structure in cerebral cortex

Artificial brain information processing model using neural network is introduced. The information process in the cerebral is separated 3 functional areas such as sensory information acquirement, behavior inference and decision based on association and motor command.

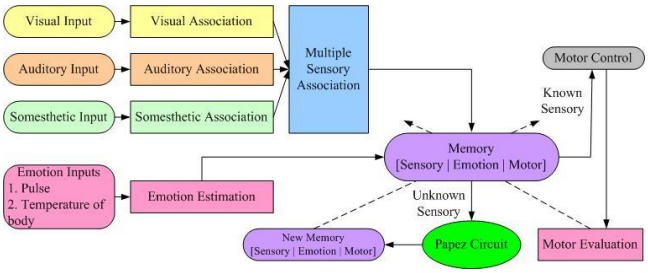

Fig. 2. Block diagram of behavior decision using Papez circuit

As we know from the figure 2, thalamus is connected to sensory organisms (eye, ear, nose, tongue and so on) and proceeds transfer function from sensory organisms to cerebral cortex. On the other hand, motor is connected to several motor organisms such as legs, arms, neck and so on through motor neurons. Motor area transfers the information about the motor organisms to cerebral cortex and also takes the behavior command from cerebral cortex. In this section, we found that a certain information stream can be existed in brain system and it will be similar with a module structure.

To make a model for them, we use the neural network shaped like module. Each module-type neural network learns the function of thalamus and motor area, respectively. With these neural networks, we make artificial models for cerebral cortex.

In the point of cerebral cortex, it acquires information about the sensory and motor organisms from thalamus and motor. Based on the received information, sensory association area in the cerebral cortex performs inference process after analyzing information from sensory and motor area using linguistic expression. The amygdale, Papez circuit and other organic function module input the output signal from former function module and output the result from the module. It will be hierarchical flow and all modules are connected relatively. Therefore, we make an engineering model for brain by introducing information process method and learning method for it.

3 5 Layer Structure for Information Process

In this paper, we propose 5 layer structures for information process in Fig 3.

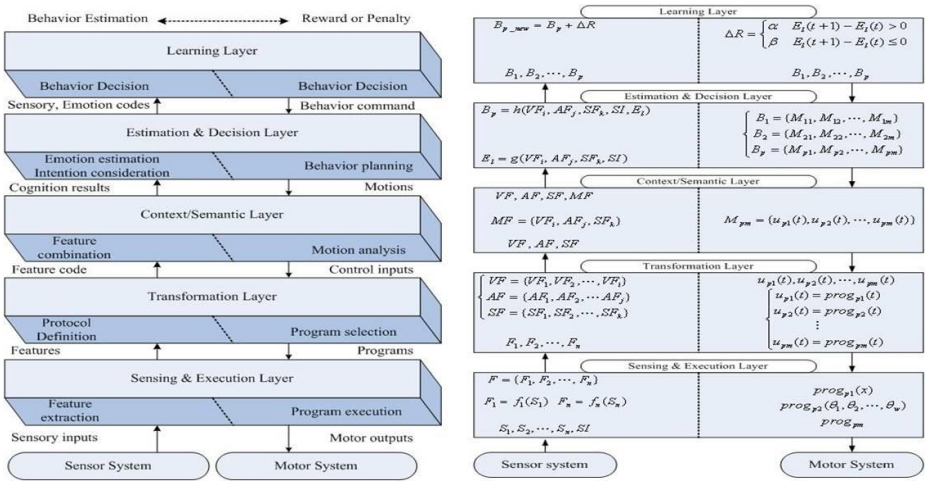

Fig. 3. 5 Layer structure with definition of functions and protocol

As like figure 3, we design 5layer structure with definition of functions and protocol and define the functions in each layer and protocol between layers. Each layer includes function, layer input, layer output and data format in forward and backward direction.

4 Conclusion

The information process in brain is explained and defined from biological theory to engineering application aspect. 5 layer structures can include many modules in software application, hardware implement and communication protocol so that it will be applied various subjects such as control, learning and inference system. The unique format can give engineers chance for convergence and merge of different research works.

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