A study on the convergence of brain science and artificial intelligence in terms of highly reliable trustworthy IoT ecosystem

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Abstract Modern computers, starting with Von Neumann, have played an innovative role in technological development of mankind and are an indispensable technology field in modern information society. In recent decades, computer performance has evolved at the speed of light, but analysts have argued among experts that this age of computer performance has reached its limit. Semiconductor chip-based computing can mimic intelligence but cannot create a mind. Artificial intelligence research has not escaped the limitations of this von Neumann type of computing. However, artificial intelligence, which has received much attention in recent years, is largely due to the appearance of deep learning that is similar to that of the brain. Already in the United States and Europe, AI leaders recognize the importance of human brain understanding in artificial intelligence research and are carrying out large projects. In this paper, we review the fusion aspects and development prospects of artificial intelligence research based on brain science, and examine the aspect of object intelligence ecosystem creation in its highly reliable trustworthy society.

Keywords*: AI, trustworthy, convergence, Brain, Cognitive computing*

1. Introduction

At present, the core pursuit direction of artificial intelligence researchers is "intelligent robots with love, emotion, and mind" like people. Like Samantha in the movie "Her" that falls in love with a computer, she pursues a genuine computer that answers every question and understands and expresses human emotions. This requires an electronic circuit that can be learned and remembered like the "synapse network" of the human brain. The brain is a complex circuit of about 100 billion neurons. One neuron is connected to 10,000 neurons and sends and receives signals. The area where neurons and neurons are connected is called synapse. This complex network shows the brain's excellence.

Computers are becoming more and more smart, but human greatness is not the ability to sweep massive amounts of data in an instant to derive correct answers, but the ability to cast such questions. Artificial intelligence experts point out that it is almost impossible for a computer to think like a human being unless we have brain map. The brain works by changing the connection structure of nerve cells from time to time. In the end, understanding how the human brain works can truly embody artificial intelligence.

Cognitive computing, defined on the basis of this understanding, is an intrinsic research area that includes interdisciplinary fields such as psychology, biology, signal processing, physics, information theory, mathematics, and statistics for the purpose of developing a computer system modeled after the human brain.

Figure 1. Cognitive Computing Concept

Cognitive computing is an information processing technology that imitates the cognitive ability performed by the human mind. It imitates the cognitive functions of the human being such as perception, behavior, language, vision, memory, learning and reasoning. It is a technology that performs environmental awareness and behavior, visual and language processing ability, associative memory, flexible learning and reasoning, and stable decision making. From practical point of view, it is

cognitive, behavioral, and emotional skills that analyze and predict behavior patterns. Cognitive computing can be classified into the discipline of convergence of brain science aspects to artificial intelligence.

2. Research Trends

In recent years, the United States, the EU, and Japan have recognized that securing the artificial intelligence technology for knowledge and intelligence processing will influence the future competitiveness of the nation, and are pursuing large-scale R & D under the leadership of the government and global conglomerates. Gartner and IDC selected Big Data based artificial intelligence technology as one of the mega trends of IT technology in 2013, and MIT selected artificial intelligence technology capable of communicating through learning and reasoning as the top breakthrough technology in 2013.

In the United States, research on artificial intelligence, which simulates both corporations and state-led human beings, is under way along with small-scale research by universities. Through a SyNAPSE project led by DARPA, IBM has developed a computer-aided architecture that resembles a human brain with 256 electronic neurons. The new architecture of this chip will be used for low-power, human-like knowledge inference. Google is working on a Google Brain project and is working on a human-perceived autonomous learning model with a nine-layer neural network, one billion connections.

Europe selected the Human Brain Project for knowledge processing using the cognitive form of the human brain as the promising technology for the EU six plan to develop it for the next 10 years. Through the EU FP7 Cognitive Systems & Robotics Program (2007 ~ 2012), a project including intelligence such as learning and understanding for the robot's perception ability was conducted. In the Human Brain Project, they plan to develop artificial intelligence with human knowledge processing form by programming human cognitive form.

Global companies are also working on challenges to process knowledge and intelligence. IBM is developing Watson to surpass humans in the quiz show, and want to expand the domain into specialized fields such as finance and medicine. Google is developing a self-learning artificial neural network using Big Data. Apple has developed artificial intelligence-based speech recognition technology Wolfram Alpha search-based Siri.

3. Challenge Fields

3.1 Natural Intelligence Technology

It is a technology based on mimicry of biological and human natural intelligence as opposed to artificial intelligence based on a mathematical approach.

Artificial intelligence is a representative intelligent mimicking technology that simulates intelligence based on mathematical modeling. Typical examples are neural network models and computer vision models. But mathematical models can simulate human intelligence alike, but cannot have the same human knowledge and information processing procedures.

In addition, the processing methods of the human brain are processed in parallel and concurrently, so that a lot of information is recognized and processed in a short time. Analysis of brain information processing results shows uncertainty and probabilistic aspects unlike the certainty of computer. This difference is the reason that many mathematical models have been presented through artificial intelligence but there is no apparent result to simulate human intelligence.

In order to overcome these problems, it is necessary to determine the direction of cognitive computing in the direction of intelligent processing based on accurate recognition of human information processing mechanism. It is necessary to study the mechanism of neurons and synapses, to understand the connection mechanism.

3.2 Field of biological visual processing technology

The visual system is part of the central nervous system responsible for vision. This organ receives visible light and forms an image of the environment surrounding the body. Visual organs perform a variety of complex functions such as sensing light, forming a single image, depth and spacing of two-dimensional shapes, grasping and classifying objects, and delivering body motion. In addition to this information, the psychological manifestation through it is called visual perception or visual system.

The visual information entered through the eyes is transmitted to the brain through the visual nerves. Of these, 90% of the axons go to the lateral knee of the thalamus. These axons come from M, P, K cells of the retina. Thus,

each piece of information is made up of different senses. Then it is transferred to the secondary visual area to process various visual information.

The problem of the existing mathematical computer vision is that there are limitations in making a number of functions of the biological vision into a mathematical model. In addition, the biological view adapts to the new visual perception method and learns new methods while the mathematical model has the problem that this evolution is impossible.

Biological visual processing technology imitates human visual processing methods and aims to realize a flexible and immediate visual cognitive function that cannot be achieved by existing mathematical computer vision technology. Research and imitation of the biological visual processing method through the progressive connection of the optic nerve is essential in the visual processing field.

The intelligent robot and the intelligent computer equipped with such biological visual processing technology can automatically perform the existence of the object, the identification of the individual object, the classification of the object category, and the positioning by using the image information like a human being.

3.3 Environmental Intelligence Technology

As information technology develops, home appliances and mobile phones with advanced technology that are closely related to our lives are being used. Usually, in order to use these devices, users need to learn about the device's interface and how to operate it. The use of the device was usually done by using a simple interface such as a button, but the more complex the device, the more confusing the user with the many buttons. Therefore, researches on advanced interface technology and design such as voice recognition and gesture recognition that are intuitively usable instead of button center, and research on user usability reflecting the opinions of users are underway. These technologies play a role in environmental intelligence.

IoT and ubiquitous, which is a concept of helping people by ubiquitous devices, will become another environmental pollution if device intelligence is not provided. If the device cannot adapt to human behavior, there will be a problem that the human should learn the behavior of device eventually.

In the end, environmental intelligence is an electronic environment that responds to a person's existence. It is at the core of our research that all things around us have intelligence. Currently, technology is in the design stage in Europe and America for the future information society (target 2010-2020). One of the themes of the research is to provide a more natural and intelligent interface based on sensors embedded in computers and environments. Other topics focus on auditory, visual, language, and knowledge related to human intelligence. ISTAG (Information Society Technologies Advisory Group), which defines and conducts policies on related research in the field of Information and Computing Technology (ICT), defines environment intelligence and business model for it.

3.4 Intelligent Agent Technology

An agent is an autonomous process that performs work on behalf of a user for a specific purpose. An agent is a system that does not exist on its own, but is part of or operates within an environment. The environment here refers to an operating system, a network, and the like. The agent has knowledge base and reasoning function and it solves the problem through information exchange and communication with user, resource, or other agent.

Agents have the ability to recognize changes in the environment themselves, take action in response to them, and learn based on experience. Agents do not only perform tasks manually, but also have an active attitude to pursue their objectives with their own goals. As a result of the agent's actions, it can bring about changes in the environment. The agent's behavior is not done at one time, but is done continuously.

A computer program that is located in a virtual space environment and automates repetitive tasks to help users deal with specific applications is called a software agent or an intelligent agent.

The problem with existing intelligent agents is that they have to predict all situations. In a completely unexpected situation, it did not function properly and did not function as a perfect intelligence.

The solution of this problem is solving the problem by applying cognitive computing based on cognition, analysis, and learning, and learning the method with flexibility about the problem.

Agents that help people in their daily life are expected to accelerate their intelligence by applying cognitive computing technology.

4. Conclusion

Artificial intelligence has not been developed for decades due to the limitations of the existing von Neumann structure, but recently it is experiencing new electricity due to the emergence of deep learning. However, since deep running also has mathematical limitations, it is essential to study fusion with the brain science to develop artificial intelligence suitable for the fourth industrial revolution era.

In addition to the convergence prospects discussed in Chapter 3 above, convergence with the cloud and Internet intelligence are expected to prospect. The cloud is evolving from cloud computing to intelligent cloud intelligence.

The field of artificial intelligence that is expected to be widely used in the near future is IoT, and it is still difficult to mount intelligence due to the limitation of resource utilization, but the breakthrough of HW will overcome this in a short period of time.

When artificial intelligence is installed on all objects, it will become a very important issue to provide reliability and measurement of human-machine connection and machine-machine connection. This area includes trust modeling, trust big data processing, and trust awareness, and the development of brain engineering and artificial intelligence technologies for trust analysis will become a priority task.

The artificial intelligence used in various fields will become a major issue, and automatic execution of program and operation will be essential rather than simple data analysis level automation. In order to create practical results such as simplicity or slogan about the necessity of the field of artificial intelligence, it is essential to study brain science and its application to artificial intelligence.

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