ICT Breakthroughs Driven by Scientific Insights into Human Cognition and Information Processing

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Abstract

The mission of NTT Communication Science Laboratories (NTT-CSL) is to enable new methods of communication driven by fresh insights into human cognition and information processing. Our research projects encompass both human science and information science. This feature highlights recent NTT-CSL research on *technology for seeing* and *technology for showing*.

1. Introduction

With engineering playing a major role in the field of communications, it is not surprising that information and communications technology (ICT) development has conventionally focused on technology to increase speed and precision. But the quality of human communication is determined less by the objective criteria of speed and precision and more by the subjective criteria of values and emotions. Therefore, ICT research and development work should focus on depth and appropriateness to create a qualitatively richer ICT environment. To create the next ICT breakthroughs, NTT-CSL is working on communication science research based on insights into human cognition and information processing. This Special Feature describes NTT-CSL research on *technology for seeing* and *technology for showing*—two areas closely tied to subjective human experience.

2. Technology for seeing

What does it mean to actually see something? It may seem like a purely academic question, but finding a scientific answer to it is the first major step to understanding human cognitive mechanisms. One possible answer to this question is given in one of the articles in this feature entitled "Change Signals Provide Clues to Perception Mechanisms—Visual Illusions Reveal the Brain's Information Selection Strategy" [1]. The author used two optical illusions to uncover part of the brain's cognitive information processing mechanism. A potential application for the findings of this research could be a method of compressing video information by utilizing brain science knowledge. So this research could result in the *technology for seeing* that will support the next generation of ICT.

In another recent project, NTT-CSL researchers looked for ways to enable computers to correctly interpret the content of image information. Facial recognition and other technologies that extract specific target objects from images have long been the subjects of research, but image recognition technology still has not advanced to the point where computers can correctly interpret any type of image. Getting computers to perform this feat, which humans find very easy, will be a difficult task that will require a major breakthrough. NTT-CSL is tackling this difficult problem by using computer learning functions as a starting point. The same is true for audio. Here too, NTT-CSL is working on ways of enabling computers to correctly interpret the content of audio media. The results of this research are presented in the article entitled "Media Scene Learning: A Novel Framework for Automatically Extracting Meaningful Parts from Audio and Video Signals" [2].

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3. Technology for showing

Spurred by the recent growth of digital terrestrial broadcasts, picture quality has been improving at an increasing pace, and the picture quality that users now see on their displays has improved significantly in the past few years. For many years, it was mainly higher resolution that drove picture quality improvements, but today, higher color definition is also becoming an increasingly promising way to improve picture quality. It has long been known that objects themselves do not actually possess colors. Instead, we simply perceive colors with our eyes and brain as a result of the properties of the object's surface materials, which reflect particular wavelength bands of light. This was discovered by Isaac Newton 300 years ago, when he observed that beams of light have no colors.

Creating a mechanism compatible with the human cognitive system is thus a crucial requirement for faithful color reproduction—there are fundamental limits on what can be achieved with standard RGB (red-green-blue) cameras and displays. NTT-CSL researchers are working on methods of enabling faithful color reproduction that utilize new principles. This research is described in the article entitled "High-resolution Multiband Imaging for Accurate Color Reproduction" [3]. One day, this technology may enable wide-area network services for remote surgery and electronic museums—the ultimate high-tech services driven by *technology for showing*.

With the growth of the Internet, an increasingly vast number of people throughout the world are using the web to search for information. Japan alone is said to have over 60 million Internet users. But the information in web search results is currently displayed as lists, making it difficult to find useful information efficiently. The article entitled "Topigraphy Project" [4] describes an NTT-CSL research project that is seeking ways of displaying massive amounts of stored information content to users in a more easily understandable format. The technology was created through a joint research project between NTT-CSL and NTT Cyber Solutions Laboratories.

The developed technology optimally highlights the similarities among content items by automatically placing tags (keywords) classifying information content into a virtual topic space. It enables rapid visualization of many different types of data having similarities (connections) such as weblog (blog) data or posted image data. The project is also examining ways in which the system could be upgraded for use in services, such as by incorporating it into three-dimensional monitors or smartphones using OpenGL.

4. Viscuit

Though its approach differs slightly from technologies for seeing and showing, another related area of NTT-CSL research is the programming language described in the article entitled "Computer Programming Education Using the Visual Programming Language Viscuit" [5]. Viscuit's strength is its visually oriented notation system, which lets users create programs by moving pictures around according to preset rules. Since programs are created with pictures, even children with no computer or math knowledge can easily create programs in Viscuit. Since programming is an essential ICT software support technology, programming education is crucial for ICT engineers. Viscuit's pictures can be used to teach the key programming concept of inductive reasoning, making Viscuit a valuable tool for teaching and learning programming.

The topics described here are covered in more detail in the articles of this feature. NTT-CSL will continue to pursue the benefits that these technologies could provide and will take on ever greater challenges to meet the public's demand for ever more advanced technologies. In addition to the technologies covered here, NTT-CSL is also researching other basic technologies that could provide the next generation of ICT breakthroughs.

References

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