Introduction

SAWAI Hidefumi

In a sense, designing and constructing information communication systems inspired by life will establish a new paradigm in the history of science and technology. Given the four billion years required to evolve intelligent life with the superb structures and functions of human and animal brains, it's clear we have much to gain by studying, with an open mind, the deep, sophisticated structures and functions of life forms, as well as the mechanisms of the evolution of life.

This special issue introduces trends in research on information and communications technologies inspired by life, current trends in research on molecular communication technologies, and future prospects for research in these areas. My primary goal is to review and discuss the research being carried out at the Kobe Advanced ICT Research Center (KARC) at the Kobe Research Laboratories of the National Institute of Information and Communications Technology (Part 1: "Trends in research on information and communications technologies inspired by life") and research conducted at the University of California at Irvine (UCI), which is undertaking joint researches with KARC (Part 2: "Trends in research on molecular communication technologies"). I will also present relevant research currently underway in Japan and abroad.

The first chapter of Part 1, "Trends in research on information and communications technologies (ICT) inspired by life," seeks to provide an answer to the question: Why take inspiration from life? It then goes on to probe "information and communications technologies (ICT) inspired by life." This will help in describing trends in information processing research modeled on the brain, on the early evolution of cells, or inspired by the evolution of life itself, as well as trends in research involving complex networks (which is currently attracting attention). The second chapter focuses on research on a network-type computing machine based on intermolecular interactions, describing control flow clusters as active machines, network connection switching rules based on energy minimization, self-organizing network configurations based on programming of active nodes, molecular agents, and program-flow computing, with the goal of creating new algorithms based on molecular theory. The third chapter discusses bio-system signal transmission and potential applications to calculations and communication systems, drawing on cellular signal transmission networks and formal models, dynamic analysis of signal transmission networks, and error correction codes for cellular signaling pathways.

Part 2, "Trends in research on molecular communication technologies," introduces molecular communication technologies as bio-ICTs and describes bio-system molecular communication, molecular communication architecture, and molecular communication design, which represent molecular communication technologies within the scope of biological information and communications technologies.

These topics will help present the argument that designing information processing models inspired by the superb design and function of life forms will lead to the design of various information processing systems and information communication systems capable of solving real-world problems. They also

introduce the topic of using the functions of life forms at the molecular level to construct information communication systems based on molecules. Some of these technologies have already entered practical use, while others are expected to find practical applications in the near future.

SAWAI Hidefumi *Dr. Eng.*

Director, Project Promotion Office,
Kobe Advanced ICT Research Center,
Kobe Research Laboratories

Information Science, Computer Science