

Title of Project : Development of Molecular Robots equipped with sensors and intelligence

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【Purpose of the Research Project】

This project aims to establish the field of molecular robotics by means of promoting the engineering of molecular devices up to the level of molecular systems. Molecular robotics requires the systematic integration of scientific and technological accomplishments of various fields, especially those of chemistry and DNA nanotechnology. The methodologies of systems science, such as control theory and numerical simulation, play an important role in the design and implementation of molecular robots.

To achieve this aim, we focus on a revolutionary way of artifact production, a bottom-up methodology in which material molecules are programmed so that they become a desired product by a self-assembling process.

Artifacts will be more useful if they provide not only atomic-level resolution of shape but also advanced functions such as self-repair and self-reconfiguration at the molecular level. Such artifacts will be expected to make a large impact on solving problems in healthcare, food and energy.

【Contents of the Research Project】

A robot is an artifact that can exhibit intelligent behaviors by means of multiple sensing-processing-actuating cycles. It requires the facilities of sensors, actuators, and intelligence as well as a body to integrate these facilities. In molecular robots, those elements must be realized in the form of functional molecules (Fig.1). To achieve this, it is necessary not only to develop each element, but also to develop technology to integrate and organize the elements into one consistent system. All the component elements of the molecular robot must be assembled by bottom-up self-assembly, and behaviors of the robot must be controlled based on chemical reactions.

To realize this concept, the project is divided into four subprojects: (A01) subproject aiming at developing molecular sensing devices; (B01) subproject aiming at developing methodology to implement molecular control circuits; (C01) subproject to develop a micron-sized amoeba-like prototype; and (D01) subproject to develop a millimeter-sized slime-like prototype. Some additional projects will also be recruited for the purpose of reinforcing necessary

elements to realize the prototypes and also to search for their possible applications.

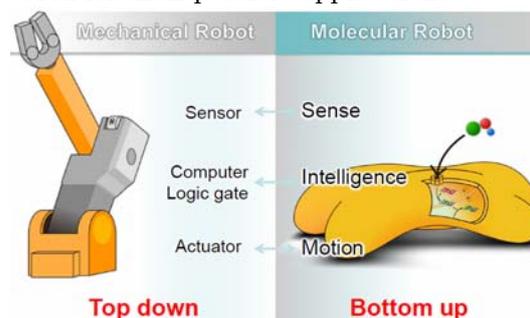


Figure 1 Architecture of Molecular Robots

【Expected Research Achievements and Scientific Significance】

The evolutionary process of the molecular robot will be something similar to that of the evolution of living organisms. Many technological hurdles await us, but when these hurdles are overcome, new possibilities will arise. Ultimately, the process moves toward hybridization of molecular and electric technologies (Fig.2).

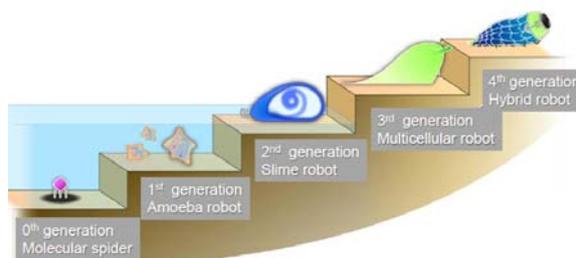


Figure 2 Evolution of Molecular Robots

【Key Words】

Molecular Robotics: Methodology to integrate and program molecular devices as a system

【Term of Project】 FY2012-2016

【Budget Allocation】 1,038,800 Thousand Yen

【Homepage Address and Other Contact Information】

<http://molbot.org/shin-gaku/>