【Grant-in-Aid for Scientific Research(S)】
Integrated Science and Innovative Science (Comprehensive fields)

Title of Project：Development of Molecular Robotics based on DNA Nanoengineering

Satoshi Murata
(Tohoku University, Graduate School of Engineering, Professor)

Research Area：Comprehensive fields

Keyword：Autonomous Decentralized Systems, DNA Nanoengineering, Molecular robotics

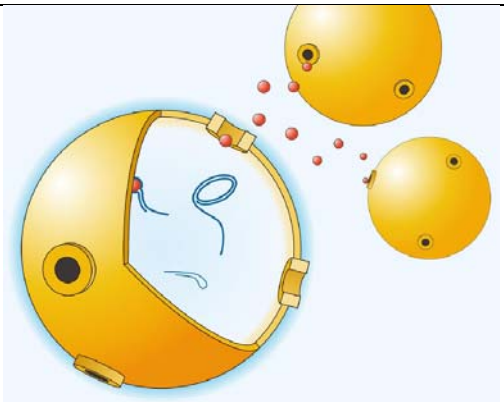
【Purpose and Background of the Research】

The new field called "DNA Nanoengineering" is focused on designing various molecular devices out of synthesized DNA. It emerged at the intersection of computer science, biochemistry, material science, and engineering. As the result of recent efforts, DNA has established as an important building block for the bottom-up self-assembly in nanotechnology, with various nanostructures and nanodevices. Recent progress indicates that the field is now heading beyond structural elements and towards complex systems that integrate sensing, information processing, and actuation, all realized within DNA-based devices. This project aims at developing fundamental methodology to integrate those DNA devices to build functional systems, in other words, the "Molecular Robots."

【Research Methods】

There are several approaches to realize molecular robots. The approach we have adopted is to mimic the structure of living organisms, namely the cellular structure. The key technology we use is the special method to grow DNA nanostructure on a surface of templates such as micro-sized gel bead, called "substrate-assisted self-assembly." This method enables us to build capsules made of DNA with known base sequences. These capsules not only can contain various DNA molecular devices, but also integrated with various channel devices which functions as interface for the molecular robot like channel proteins on the lipid bilayer.

In our project, we focus on development of the following four technologies. (1) Construction of DNA compartment to store molecular devices (2) Construction and implementation of interface device that enables molecular input /output through the compartment (3) Method to control reactions in the molecular robot and also molecular communication between molecular robots (4) Rule design for the swarm of molecular robots to emerge cooperative behavior through the interaction by the communication.



【Expected Research Achievements and Scientific Significance】

This project is expected to be a breakthrough that extends the robotics to the world at the molecular scale. Technologies developed here can be used as fundamental tools for varieties of artificial molecular machines, therefore, it will make a large impact for both academic and industrial fields. For instance, a super-drug delivery system in which a group of molecular robots beats the diseased part like the immune system will be one of the future applications of the molecular robotics.

【Publications Relevant to the Project】

・Hamada S, Murata S, Substrate-assisted assembly of interconnected single duplex DNA nanostructures, *Angewandte Chemie (Int. Ed.).* **48**, 6820-6823, 2009
・Fujibayashi K, Hariadi R, Park SH, Winfree E, Murata S, Toward Reliable Algorithmic Self-Assembly of DNA Tiles: A Fixed-Width Cellular Automaton Pattern, *NanoLetters*, **8**-7, 1791-7, 2008

【Term of Project】 FY2010-2014

【Budget Allocation】 164,700 Thousand Yen

【Homepage Address and Other Contact Information】

URL http://www.molbot.mech.tohoku.ac.jp
EMAIL murata@molbot.mech.tohoku.ac.jp