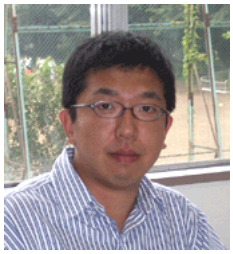
【Grant-in-Aid for Young Scientists(S)】
Science and Engineering (Engineering Ⅰ)



Title of Project : Construction and Function Emergence of Cellular Build up Wet Nano Robotics

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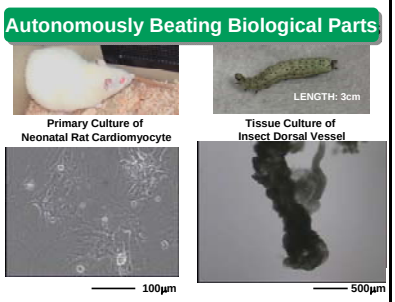
Research Area : Micromachine, Bioatuator, Intelligent Mechanical System, BioMEMS

Keyword : Bioactuator, Wet Robotics, Insect cell

【Purpose and Background of the Research】

In recent years, there have been many studies on downsizing and integration of not only semiconductor devices but also mechanical systems and chemical systems, such as micro electro mechanical systems (MEMS) and micro total analyticalsystems (μTAS). Those systems and devices are driven by conventional technology i.e. a magnetic field, electricity and air pressure. The strategy to miniaturize such conventional systems as these is called a "top-down approach." However, the driving systems and the sensors in the micro systems to be treated by the top-down approach generally need a large-scale external system and have many problems regarding energy conversion efficiency and sensitivity. Here we propose an environmentally robust hybrid (biotic–abiotic) robotic system that uses insect heart cells, called "Cellular Build Up Wet Nano Robotics". Our group has already presented a hybrid actuator using rat heart muscle cells, but it is difficult to keep rat heart muscle cells contracting spontaneously without maintaining the culture conditions carefully. Insect cells, by contrast, are robust over a range of culture conditions (temperature, osmotic pressure and pH) compared to mammalian cells. Therefore, a hybrid wet robotic system using not mammalian cells but insect cells can be driven without precise environmental control.



【Research Methods】

In this study, we propose to utilize insect cells and tissues as a mechanical component and we demonstrate the example of a micro bioactuator and mechanical systems driven by biological components. This driving occurs autonomously at room temperature for a long time without maintenance.

【Expected Research Achievements and Scientific Significance】

Expected experimental results suggest the possibility of constructing an environmentally robust hybrid wet robotic system with living cells and open up a new science and technology, biorobotic approach and industrial application.

【Publications Relevant to the Project】

- "Long-term and room temperature operable bio-actuator powered by insect dorsal vessel tissue", Y. Akiyama, K. Iwabuchi, Y. Furukawa, and K. Morishima, *Lab on a Chip*, Vol. 9, Issue 1, 140–144, (2009)
- "Fabrication of a Controllable Bio-Micropump Driven by Skeletal Muscle Cells", T. Kogure, Y. Akiyama, T. Hoshino, and K. Morishima, *Proceedings of the 15th International Conference on Solid-State Sensors, Actuators and Microsystems*, 124-127, (2009)
- "Autonomous Beating and Fluid Pumping Gel by Cardiomyocytes Drug Stimulation" K. Imagawa, H. Horiguchi, K. Ikeda, Y. Akiyama, T. Hoshino, S. Maruo and K. Morishima, *Proceedings of the 15th International Conference on Solid-State Sensors, Actuators and Microsystems*, 769-772, (2009)
- "Culture of Insect Cells Contracting Spontaneously toward an Environmentally Robust Hybrid Robotic System", Y. Akiyama, K. Iwabuchi, Y. Furukawa, and K. Morishima, *Journal of Biotechnology*, 133, 261–266, (2008).
- "Minituarized Mechano-Bionic Systems with Muscle Powered Bioactuator", K. Morishima, Y. Akiyama, H. Horiguchi, T. Ishisaka, and H. Sato *Proceedings of The second IEEE/RAS-EMBS International Conference on Biomedical Robotics and Biomechatronics 2008*, pp. 408-413, (2008)
- "Biological Contractile Regulation of Micropillar Actuator Driven by Insect Dorsal Vessel Tissue", Y. Akiyama, K. Iwabuchi, Y. Furukawa, and K. Morishima, *Proceedings of The second IEEE/RAS-EMBS International Conference on Biomedical Robotics and Biomechatronics 2008*, pp. 501-505, (2008)

【Term of Project】 FY2009-2013
【Budget Allocation】 86,700 Thousand Yen
【Homepage Address and Other Contact Information】
http://www.tuat.ac.jp/~biomems/