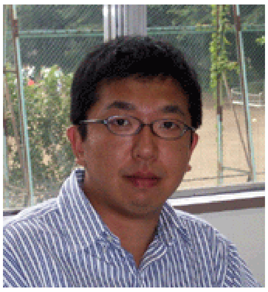
Toward Cellular Build Up Wet Robotics



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Abstract

While previous works on cell-based devices for integrated chemical systems have focused on exploiting biochemical functions of cells, we demonstrated the direct utilization of on-board cells as microactuators converting chemical energy into mechanical energy and an environmentally robust hybrid (biotic–abiotic) robotic system that uses living components, called "Cellular Build Up Wet Nano Robotics". The concept of biomicroactuators was demonstrated by using cardiomyocytes to drive hydrogel microstructures. Arrays of hydrogel micropillars made by the replica molding method and modified for cell attachment comprised a supporting scaffold for cardiomyocytes. The demonstrated capabilities should enable fundamental changes in the concept of actuators and cell-hybridized instrumentation. Our group has also presented a bioactuator using rat heart muscle cells and a number of muscle-powered wet robotic components, but it is difficult to keep rat heart muscle cells contracting spontaneously without maintaining the culture conditions carefully. By contrast, insect cells are much robust over a range of culture conditions (temperature, osmotic pressure and pH) compared to mammalian cells. Therefore, insect cells are more practical use of a hybrid wet robotic system, and they can be driven without precise environmental control. From this point of view, to utilize robust biological components as a functional systems and self assembly process and their emergent functionality, and to build up such a soft and wet machines will lead us an innovative fundamental change and produce a new principle and design to future man-made systems. We demonstrate the example of a micro bioactuator and mechanical systems driven by biochemical energy. This novel muscle-powered bioactuator successfully show autonomous beating at room temperature for a long time without maintenance. Experimental results suggest the possibility of constructing an environmentally robust hybrid wet robotic system with living components and open up a new science and technology, biorobotic approach, medical, environmental monitoring, agriculture and industrial application.

Biography

Dr. Keisuke Morishima is a Professor, Department of Mechanical Engineering, Osaka University, JAPAN; he graduated from Nagoya University where he received his PhD in Engineering in 1998. In 1997, he was JSPS Postdoctoral Research Fellow. From 1998 to 2001, he was a Postdoctoral Research Associate, Department of Chemistry, Stanford University, USA. He joined Kanagawa Academy of Science and Technology as a Research Scientist in 2001. In 2004, he was a Visiting Research Fellow at Lund Institute of Technology, Sweden. In 2005, he joined Department of Mechanical Systems Engineering, Tokyo University of Agriculture and Technology as an Associate Professor. In 2007, he joined Department of Bio-Mechanics and Intelligent Systems, Tokyo University of Agriculture and Technology, Japan. In 2011, he moved to Department of Mechanical Engineering, Osaka University as a Professor. He is mainly engaging in the research fields of Micro-Nano Robotics and its application to the micro-nanomanipulation, bio automation, BioMEMS, MicroTAS, microactuators, medical applications, living machine, soft & wet nano robotics, regenerative medicine. In recent years, he received 2009 Best Paper Award, The Robotics Society of Japan, 2009 The Young Scientists' Prize, The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, 2006 Young Scientist Award, Ando Foundation.

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