Innovation of Robots with Bionic Design

Fumihito Arai

Biorobotics Laboratory, Dept. of Micro-Nano Mechanical Science & Engineering, Nagoya University,
and
Institute of Innovation for Future Society, Nagoya University, Nagoya, JAPAN

Abstract

Design selected by nature is based on evolution and we can get an idea how to design the robot. There are a lot of different kinds of robot design inspired by nature. Design policy of the robot is important for innovation in robotic technologies. In this talk, bionic design approach for the robots is introduced to improve performance of the robot as well as to add new functions to the robot. Especially, it is a big challenge to realize a milli, micro, and nano-scaled robot, and bionic design is attracting big attention. In this talk, several examples of miniature sized robots will be introduced. To realize miniature sized robots, energy supply is one of the key issues. We developed a new self-propelled micro-swimmer by the glucose biofuel cell and electroosmotic propulsion. It is driven by self-electroosmotic propulsion (EOP) generated by biofuel cell (BFC) with biofuels (glucose and O_2). Another important application of robot with bionic design is a patient simulator. We have developed Bionic Humanoid, which is an elaborate human model equipped with sensors and actuators to serve as a substitute for and test animals. Bionic Humanoid uses artificial materials to precisely recreate the structure of the human and to mimic physical property of the human. MEMS and 3D printing technologies are used to fabricate as well as to evaluate Bionic Humanoid. Bionic Humanoid is equipped with bionic sensors to monitor and quantify the force applied by the operator. Bionic sensor is designed so that the sensor-embedded model recreates the structure of the human and mimics physical property of the human. The Bionic Humanoid can be used, for example, to quantify the requirements of medical doctors, assess surgical skills, replicate physical constraints for the development of a medical device, and provide young surgeons with training opportunities. Recent progress of Bionic Humanoid will be introduced and discussed for future medical innovation. In summary, bionic design is quite important for innovation of robot.

Short Bio

Fumihito Arai is a Professor of Department of Micro-Nano Mechanical Science & Engineering at Nagoya University, Japan. He also serves as a Deputy Director of Institute of Nano-Life-Systems at Nagoya University. He received Master of Engineering degree from Tokyo Univ. of Science in 1988. He received Dr. of Engineering from Nagoya University in 1993. Since 1994, he was Assistant Professor of Nagoya University. Since 2005, he was Professor of Tohoku University. Since 2010, he has been Professor of Nagoya University. He was the Vice-President for Technical Activities, IEEE Nanotechnology Council (2002, 2003). He was AdCom Member of IEEE Robotics and Automation Society (RAS) (2009-2011, 2012-2014), and he serves as AdCom Member of RAS again since 2019. He was the Vice President for Technical Activities, IEEE RAS (2014-2015, 2016-2017). He was Editor in Chief of Advanced Robotics (2012-2017). His research fields are Micro-nano Robotics and Bio-Robotics. He received 88 awards on his research activities, for example, Early Academic Career Award in Robotics and Automation from IEEE Robotics and Automation Society in 2000, Best Conference Paper Award at ICRA2012. He is the author of 399 journal papers. He is a member of IEEE.