Monday, October 21st, 2013, 4:30 P.M.
Room No. 109, DASAN bldg. 1st Floor
(Host: Prof. Yang, Sung / Language: English)

Gangnam Style in Microbiorobotics :Biologically Inspired Microscale Robotic System

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Bacterial chemotaxis is the most widely studied to understand the cell's response to a stress environment. It's controlled by more than 40 genes in over 14 operons that produce proteins for the structural components of the flagella, the flagellar motor, transmembrane receptors, and signal transduction. The signal transduction pathway of Escherichia coli are closely related and provide a model for signal ransduction in other species. Inspired of bacteria, more importantly, we can develop a new class of robotics. Recently, as the field of engineered microscale robotics matures, a need for control of miniaturized systems has emerged. One approach is utilization of a live organism as an actuator. First, we will discuss the practical integration of bacterial flagellar motors to actuate microrobots for engineering works in microfluidic environments. The ability to integrate multiple levels of functionality with a control hierarchy will be highlighted to show the realization of bacteria-powered microrobots for single cell manipulation. We will also talk about bacteria-inspired robotic microswimmers with active propulsion. An external rotating magnetic field is generated by a set of electromagnetic coils in an approximate Helmoltz configuration. The magnetic field induces rotation in a flagella conjugated magnetic bead. The flagella act as both a fluidic actuator for device propulsion and as a coupler for a polystyrene bead, which is used in place of a targeted localized drug and therapy delivery system, such as a drug filled vesicle. Lastly, *Tetrahymena pyriformis GL* (*T. pyriformis*) will be introduced to show control of eukaryotes for microbiorobotics. By magnetizing ingested ferromagnetic nanoparticles (magnetite, Fe_3O_4), the swimming direction of individual cell becomes controllable using external time varying magnetic fields. Since endogenous motility of a cell and the artificial magnetotaxis are combined into one system, the motion of the artificial magnetotatic *T. pyriformis* is able to be finely controlled. Also, "Point to point" feedback control was performed in real time with a vision tracking system and two sets of electromagnets, showing controllability of single cell. For improved control of a position and orientation of a cell, a feasible path is planned by randomized roadmap tree (RRT) which is one of the fast path planning schemes. Combining the feedback control and the path planning scheme enables *T. pyriformis* to move to the target with the desired direction, which might be a basic movement for novel medical therapeutics.

Biosketch

Dr. MinJun Kim is presently an associate professor at Drexel University with a joint appointment in both the Department of Mechanical Engineering & Mechanics and the School of Biomedical Engineering, Science & Health System. He received his B.S. and M.S. degrees in Mechanical Engineering from Yonsei University in Korea and Texas A&M University, respectively. Dr. Kim completed his Ph.D. degree in Engineering at Brown University, where he held the prestigious Simon Ostrach Fellowship. Following his graduate studies, Dr. Kim was a research fellow at the Rowland Institute in Harvard University. For the past several years, Dr. Kim has been exploring biological transport phenomena including cellular/molecular mechanics and engineering in novel nano/microscale architectures to produce new types of nanobiotechology, such as nanopore technology and nano/micro robotics. His notable awards include the National Science Foundation CAREER Award (2008), Louis & Bessie Stein Fellowship (2008), Drexel Career Development Award (2008), Human Frontier Science Program Young Investigator Award (2009), Army Research Office Young Investigator Award (2010), Alexander von Humboldt Fellowship (2012), KOFST Brain Pool Fellowship (2013), and Bionic Engineering Outstanding Contribution Award (2013).