UCLA Engineering

HENRY SAMUELI SCHOOL OF ENGINEERING AND APPLIED SCIENCE

BIOENGINEERING

PRESENTS

A cargo-sorting DNA robot

THURSDAY, MAY 11, 2017
12:00 – 1:00 PM
2101 ENGINEERING V

Lulu Qian, Ph.D.

Caltech

Assistant Professor, Department of Bioengineering

ABSTRACT:

Rationally designed molecular robots that perform mechanical tasks at the nanometer scale allow for embedded control within complex biochemical environments. There are two critical challenges in the design and synthesis of molecular robots: modularity and simple algorithms. Here we show three modular building blocks for a DNA robot that performs cargo sorting at the molecular level. A simple algorithm encoding recognition between cargos and their destinations allows for a simple robot design: the robot is just a single-stranded DNA with one leg and two foot domains for walking, and one arm and hand domain for picking up and dropping off cargos. We demonstrate that the robot explores a two-dimensional testing ground on the surface of DNA origami, picks up two types of cargos that are initially mixed together and delivers them to specified destinations, until all molecules are sorted into distinct piles. The robot is designed to perform a random walk without any energy supply, and thus a single robot can repeatedly sort multiple cargos. We also demonstrate that DNA origami provides localization that is similar to cellular compartmentalization in biology and allows two distinct cargo-sorting tasks to take place simultaneously in one test tube. In principle, the system can be scaled up to multiple types of cargos with arbitrary initial distributions, and to perform many instances of distinct tasks in parallel, using exactly the same robot design. The building blocks could also be used for diverse functions other than cargo sorting.

BIOGRAPHY:

Dr. Lulu Qian is an Assistant Professor of Bioengineering at Caltech. She received her bachelor's degree in Biomedical Engineering from Southeast University in China, and her Ph.D. in Biochemistry and Molecular Biology from Shanghai Jiao Tong University. She then worked as a postdoctoral scholar at Caltech, and as a visiting fellow at Harvard University. Her interests lie in engineering molecular systems with intelligent behavior. Specifically, she is interested in exploring the principles of molecular machines in nature with the end goal of creating synthetic molecular machines that approach the complexity and sophistication of life itself. To this end, she works on designing and constructing nucleic-acid systems from scratch that exhibit programmable behaviors from the basic level — such as recognizing molecular events from the environment, processing information, making decisions, and taking actions — to the advanced level, such as learning and evolving. She is a recipient of the Burroughs Wellcome Fund Career Award at the Scientific Interface, the Okawa Foundation Research Award, and the National Science Foundation Faculty Early Career Development Award.