Dr. Chih-Ming Ho, UCLA

Control of Complex Systems: FSC.X Technology Enabled Personalized Medicine

Abstract: A complex system is composed of a large number of interacting building blocks/elements which self organize, generating emerging properties that are usually not directly linked to those of the individual building elements. Biological cells, turbulent flows, internet and financial activities are all examples of complex systems.

In each living cell, the interactions among the bio molecules, proteins and nucleic acids intrinsically serve as the foundation of the extensive networks of signal and regulatory pathways. Emergent cellular functionalities are derived from the self-organization of these pathways and can not be easily related to individual bio-molecular interactions. As such, the sheer magnitude of pathway processes and pathway crosstalk presents significant challenges to their straightforward manipulation to direct cellular phenotypic and genotypic outcomes.

Frequently, we intend to control complex systems toward a desired state, with a key example being the application of pharmacological agents to treat diseased cells in medicine. Rather than laboriously mapping out the detailed cascade of signaling pathways, our approach has employed a feedback system control (FSC.X) scheme to bypass the challenges associated with simultaneously considering/manipulating multiple cellular regulatory pathways in cellular complex systems. In addition, we have harnessed these control schemes to rationally design combinatorial drug therapy modalities to stimulate these cellular pathways with improved efficacy and low toxicity. This imposes another challenge which pertains to the large parameter space. For example, N drugs with C concentrations each would result in C^N potential search trials. With the feedback system optimization approach, we have demonstrated that only tens of searches instead of C^N cases are needed to identify the optimized drug cocktail. We also have demonstrated that FSC.X is a generic platform technology, which can be effectively applied in wide classes of systems with large parameter space, e.g. eradications of cancers, inhibition of viral infections and maintenance of human embryonic stem cells.

With the capabilities of rapidly searching and discovering of the optimized combinatorial drugs by FSC.X technique and handling minute amount of patient sample by microfluidic system, it will be possible to determine the best drug-dose combination for a specific patient. In this case, we will be able to prescribe the personalized drug for a patient, not just according to the type of the disease being diagnosed.

Bio: Dr. Chih-Ming Ho (http://ho.seas.ucla.edu/) received his Ph.D. from The Johns Hopkins University and holds the Ben Rich-Lockheed Martin Professor in the UCLA School of Engineering. He served as the UCLA Associate Vice Chancellor for Research from 2001-2005.

Dr. Ho specializes in microfluidics, bio system technologies and turbulence. He is ranked by ISI as one of the top 250 most cited researchers worldwide in the entire engineering category. In 1997, Dr. Ho was inducted as a member of the National Academy of Engineering. In the next year, he was elected as an Academician of Academia Sinica. Dr. Ho holds ten honorary professorships. He has delivered 19 named distinguished lectures and presented over 150

plenary/keynote talks in international conferences. Dr. Ho was elected Fellow of the American Physical Society as well as American Institute of Aeronautics and Astronautics.