Workshop on "Glocal Control"

Date: September 7, 2010

Time: 13:10 -- 17:20

Place: Room 414, Pacifico Yokohama, Yokohama, Japan

Registration: free of charge

Organizers: Shinji Hara and Koji Tsumura (The University of Tokyo)

The workshop is supported by Grant-in-Aid for Scientific Research (A) of the Ministry of Education, Culture, Sports, Science and Technology, Japan, No. 21246067, and it will be held in conjunction with MSC2010 sponsored by IEEE Control System Society.

Program:

13:10: Opening: "Idea of Glocal Control"
by Shinji Hara (The University of Tokyo)

13:30: "Model reduction of large-scale dynamical systems"
by Thanos Antoulas (Rice University)

14:10: "Wind Integration -- By All Means Available"
by Kameshwar Poolla (University of California, Berkeley)

14:50 - 15:20: coffee break

15:20: "Simple examples of multi-agent dynamical systems: local location control which guarantee global behavior"
by Boris Polyak (Institute for Control Science, Moscow)

16:00: "The PageRank Computation in Google, Consensus of Multi-Agent Systems and Glocal Control"
by Roberto Tempo (Politecnico di Torino)

16:40: "Robust Stability for LTI Systems with Generalized Frequency Variables"
by Shinji Hara (The University of Tokyo)

==================== ABSTRACTS ======================

"Idea of Glocal Control" by Shinji Hara

The word "Glocal" is the combination of "Global" and "Local," and "Glocal Control" is a new research direction in control aiming at realization of global functions by just local actions.

The background and goal of the research direction are as follows: Recently, systems to be treated in various fields of engineering including control have became large, hierarchical, and complex, and more high level control such as adaptation against changes of environments for open systems is required. The typical example include analysis and control of meteorological phenomena and bio systems.

One of the distinguished features in such large scale dynamical systems is that our available actions of measurement and control are restricted locally although our main purpose is to achieve the desired global behaviors. This motivates us to develop a new research direction so called "Glocal Control," which means that the global purpose is achieved by only local actions of measurement and control together with prediction of global behaviors. The main goal is to develop a new control theory which can treat such large scale, complex, and hierarchical dynamical systems uniformly and provide systematic ways for designing decentralized cooperative control systems to realize desired global states.

"Model reduction of large-scale dynamical systems" by Thanos Antoulas

In many applications one is faced with the task of simulating or controlling complex dynamical systems. Such applications include for instance, air quality management, VLSI chips and interconnects, neural models, micro-fluidic chips, earthquake prevention in high-rise buildings etc. In all these cases complexity manifests itself as the number of first order differential equations which arise. For the above examples, depending on the level of modeling detail required, complexity may range anywhere from a few thousand to a few million first order equations, and above. Simulating (designing) systems of such complexity becomes a challenging problem, irrespective of the computational resources available.

Model reduction (system approximation) amounts to distilling a simpler substitute model for a large-scale complex model, while preserving the input-output behavior of the complex model as accurately as possible.

In this talk we will give an overview of the area as well as some recent results. The results will be illustrated in terms of examples from various application areas.

"Wind Integration -- By All Means Available" by Kameshwar Poolla

There is an increasing interest in renewable energy production both from economic security and environmental perspectives. The State of California has set a target of 30 % penetration from all renewable sources by 2020. Wind energy will play a key role in realizing such aggressive targets. At today's modest (? 1%) penetration levels, wind energy is integrated into the grid by legislative fiat. At deep penetration levels called for, integration of utility-scale wind production into the electricity grid poses serious engineering and market challenges. These are due to the variability, intermittency, and uncontrollability of wind power. In this talk we investigate ways to use a portfolio of available means to achieve deep penetration of wind generation in the current grid. This portfolio includes co-located storage, fast-acting local production, optimized contracts, and novel market instruments.

We introduce a linear programming formulation that enables us to study sensitivities and conduct parametric studies. We argue that co-located storage has a marginal economic utility of ? 17 MW-hours-per-day for each MW-hour of storage. Our studies suggest that it will become necessary to waste some produced wind energy (when production is lower than ? 30% of nameplate capacity) to permit reliable servicing of electricity contracts. This is due to the difficulty associated with forecasting produced power at low wind levels. Finally, we suggest the use of risk-limiting contracts to achieve firming of wind-power. In these auditable contracts, the producer receives a short reprieve which enables them to offer power predictably by avoiding ramp times. We conclude by discussing how variability risk should be shared among participants in an electricity network while respecting security constraints.

"Simple examples of multi-agent dynamical systems: local location control which guarantee global behavior" by Boris Polyak

We consider very simple model of N agents in Rn, each agent communicating with two neighbors. Neither total number N of agents nor any "centralized" information is available to an individual agent. Linear algorithms of control are presented which guarantee that the agents will be located equidistantly on a straight line, defined by boundary points. Various extensions of the model are discussed.

"The PageRank Computation in Google, Consensus of Multi-Agent Systems and Glocal Control" by Roberto Tempo

In this lecture, we study the PageRank computation for the Google search engine. In particular, we introduce this problem discussing the so-called random surfer model and the teleportation matrix. Subsequently, we present new distributed randomized algorithms (of as Vegas type) for an efficient PageRank computation, and show their main features related to the theory of positive matrices. We also study relations between the PageRank computation and consensus of multi-agent systems. We describe extensions of these results to aggregation problems, which include some examples of aggregation of control journals. Finally, we discuss connections between these problems and the emerging research area of glocal control.

"Robust Stability for LTI Systems with Generalized Frequency Variables"

by Shinji Hara

A class of homogeneous large-scale systems with decentralized information structures such as multi-agent dynamical systems can be represented by a linear system with a generalized frequency variable. This talk is concerned with D-stability and robust stability conditions for such systems.

We first provide a motivating example which shows why we need to investigate the D-stability conditions, and then we derive a unified D-stability condition, which is confirmed by a numerical example. The second topic is on robust stability toward a efficient treatment of heterogeneous large-scale networked systems, where we consider three different types of multiplicative perturbations and derive necessary and sufficient conditions for the robust stability. The one of the result is applied to the cyclic gene regulatory network where each gene has multiplicative dynamic perturbation. We show that robust stability of the uncertain gene regulatory network can be effectively determined from the graphical test derived from our robustness condition.