Seminars for Ph.D. Students
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Seminar 1 (June 13 Tuesday)

Decentralized routing control strategies for data-communication networks

Abstract:

An important problem in the operation of data-communication networks is the routing of messages. Typically, a data-communication network contains many nodes which are connected through a number of links. The routing problem consists of finding a way to direct messages from one node to another, through such links, until they reach their desired destination. In this talk, first, two approaches to solve this problem will be presented. In both approaches, the model used to describe the network dynamics is one which can incorporate arbitrary, different, time-varying processing delays at different nodes. The first of these two approaches is motivated by the solution to a related optimal control problem. The proposed controllers are completely decentralized in the sense that all necessary on-line computations are done locally at each node. Furthermore, the information needed for these computations is related only to the queue lengths at the present node and the adjacent downstream nodes. Both cases when the controls can be continuously changed and when the controls are updated at discrete time instants are considered. In the latter case the controls at different nodes may be updated at different time instants (i.e., the network is not necessarily synchronous). The second approach is based on a linear programming optimization problem, which can be solved off-line. The proposed controller in this approach too is decentralized in the sense that all on-line computations can be done locally at the individual nodes without any information transfer from the other nodes. It is shown that both controllers enjoy many desirable properties, such that loop avoidance, queue clearence in finite time, and guaranteed throughput. They also have certain robustness properties. After presenting these two approaches, an overlapping decomposition approach of networks is presented to allow local routing controller design.

Seminar 2 (June 14 Wednesday)

Robust flow controller design for data-communication networks

Abstract:

Flow control is needed in data-communication networks in order to avoid congestion. The rate of data packets sent from the sources is regulated by flow controllers. The challenge in the design of flow controllers is the existence time-delays, which are multiple (i.e., a different delay from each source to each destination), uncertain, and time-varying, in general. In this talk, first, a rate-based flow controller design approach will be presented for the case of a single bottleneck-node. The controller obtained by this approach has some guaranteed robustness against uncertainties and

variations in the time-delays. Furthermore, asymptotic tracking of a desired queue length at the bottleneck-node is also achieved and a weighted fairness condition is also satisfied. Lower bounds for stability margins for uncertainties in the time-delays and for the rate of change of the time-delays are also derived and a number of simulations are presented to demonstrate the time-domain performance of the controller. Trade offs between robustness and time-domain performance are also discussed. The possible extensions of this controller design approach to the case of networks with multiple botlleneck-nodes are then presented. The controllers obtained in this case are decentralized in the sense that each controller for each bottleneck-node can be implemented locally at that node. These controllers are also robust to time-varying uncertain multiple time-delays in different channels and they satisfy tracking and weighted fairness requirements. Lower bounds on the actual stability margins in this case are also derived and a number of simulations are also included.