

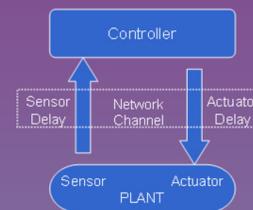
Shared Communications Network Control

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Introduction

- Networked Control Systems
Control systems in which controller and plant are connected via a communication network
- Advantages
 - Reduces cabling costs
 - Easily modifiable
- Disadvantages
 - network-induced time delays
 - transmission failures by congestion deteriorate system performance



Research Objectives

- Model and analysis control over a shared communications network applied to a simple inverted pendulum problem
- Congestion control algorithm can opt to discard data rather than queue it
 - Reduce delay at cost of data loss
 - Identify trade-off by restricting queue to maximum size

Methods

- Create model in MATLAB SIMULINK
- Vary background network traffic to observe system performance
- Vary background traffic
 - Determine optimal queue size to enhance system performance
 - Drop stale data to transmit recent data

Single Inverted Pendulum

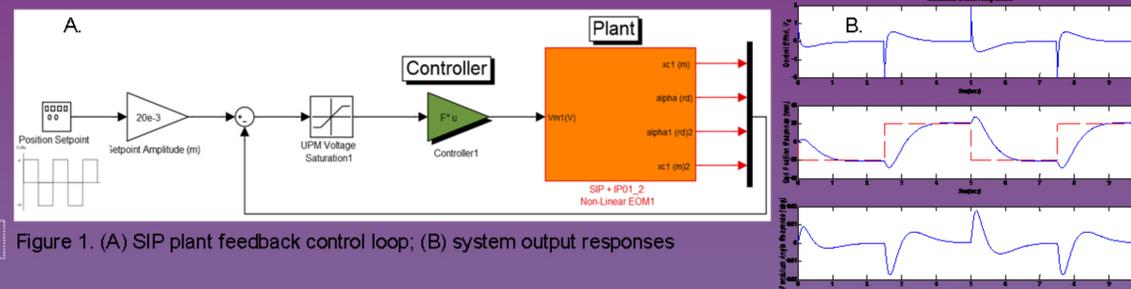


Figure 1. (A) SIP plant feedback control loop; (B) system output responses

Networked Control Model

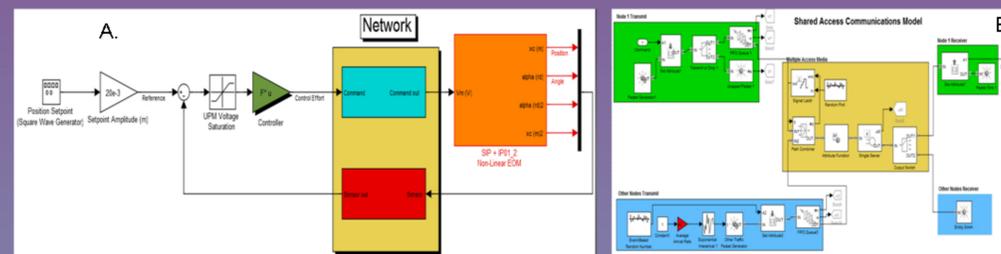


Figure 2. (A) SIP Plant feedback control loop with network; (B) network model.

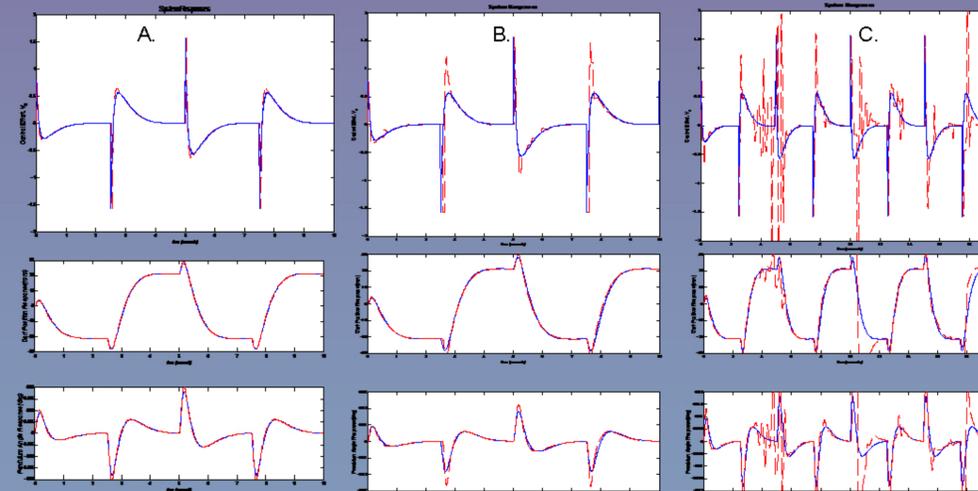


Figure 3. Network control system responses at various levels of background traffic (A) Low; (B) Moderate; (C) Very High.

Future Research

- Simulate large-scale networked physical systems
- Design controllers robust to variation in delay
- Create application specific algorithm for congestion control

Expected Results

- Increased network traffic degrades system performance
- Increasing delays are the consequence of queues in the switches
 - Determined optimal queue size for a certain network traffic arrival rate
 - Identified trade-off between packet (data) loss and delay caused by queue size

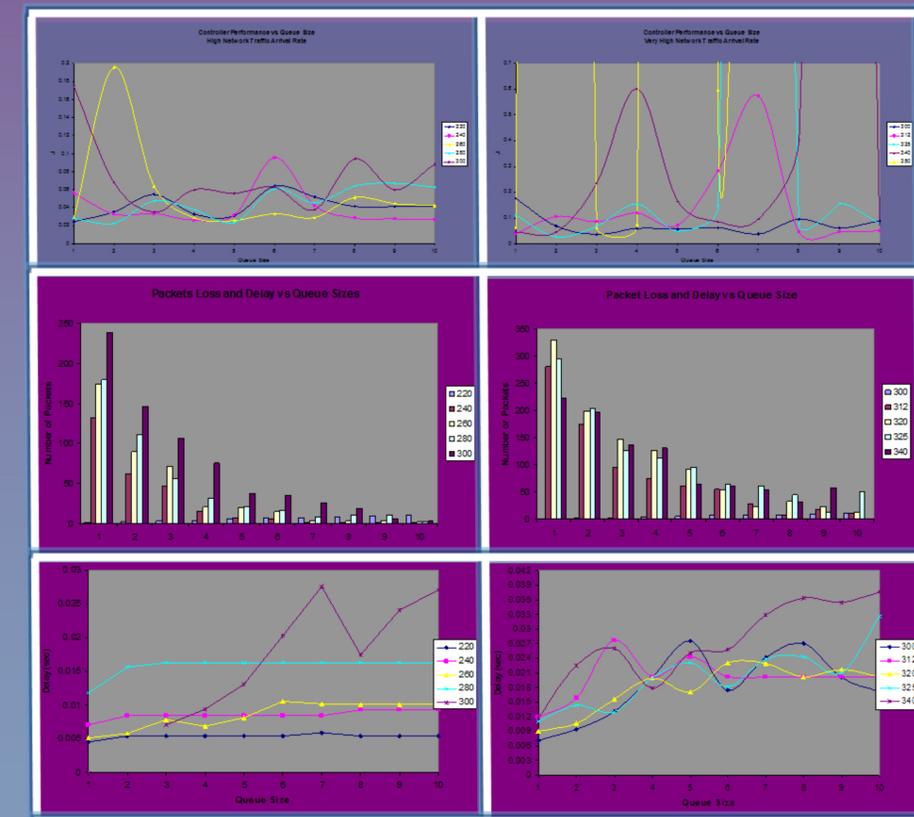


Figure 4. Trade-off between data loss and delay and its effect on controller performance.

References

- Nutaro, James, T. Kuruganti, and S. Djouadi. 2009. On the modeling of WAN for control system design. *2009 Winter Simulation Conference*.
- Lian, Feng-Li, J. Moyne, and D. Tilbury. Analysis and Modeling of Networked Control Systems: MIMO case with multiple time delays. *American Control Conference*