CIRST

Intelligent Infrastructure Systems Laboratory

Cyber-Physical Instrument for Real-time Hybrid Structural Testing (an MRI Development Project)

Graduate Students:
Ge (Gaby) Ou, Amin Maghareh, Xiuyu Gao, Nestor Castaneda

PI: Dr. Shirley J. Dyke

National Science Foundation Grant No. CNS-1028668 (MRI)

BOWEN LABORATORY

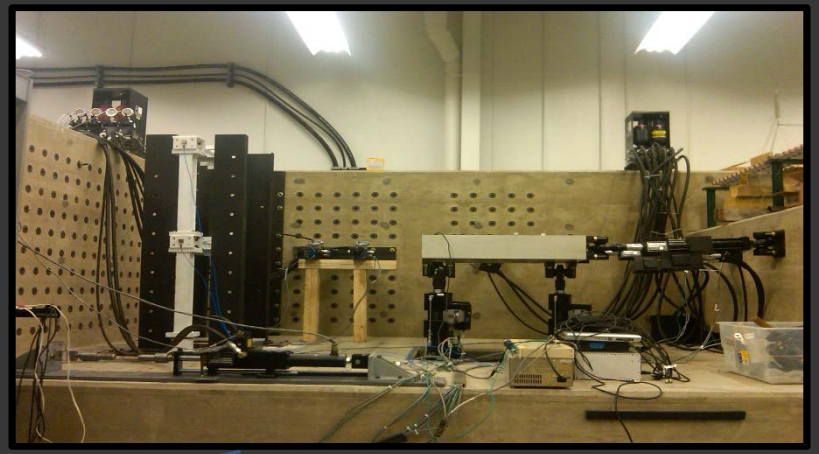
PURDUE UNIVERSITY

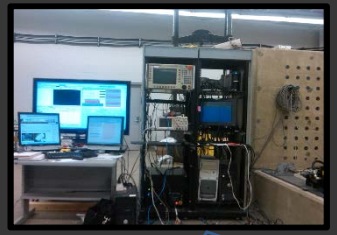
Research Objectives

High-fidelity performance validation is critical for the acceptance of new structural monitoring and control systems. However, testing of numerous possible scenarios of such systems is not always feasible due to the expense and time involved. Real-time hybrid simulation (RTHS) techniques use a testing procedure where known structural components are represented with numerical models, and specimens of elements that are not well understood are physically tested. These methods provide the opportunity to test numerous configurations with a single experiment.

Framework Hardware Development

Modularized moment resisting frame specimen equipped with advanced vibration mitigation damping systems

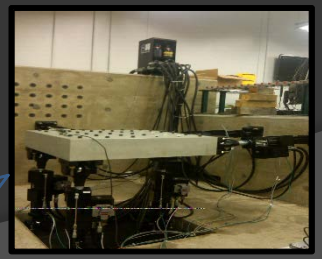




High performance programmable DSP system plus high precision servo - hydraulic motion control system.

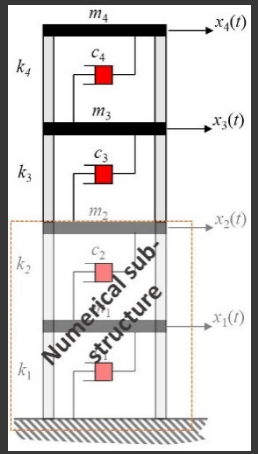
Reinforced concrete reaction station that allows reconfigurable multi - axis dynamic testing setup.

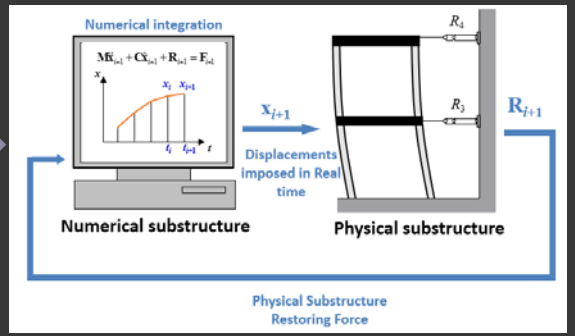
Six DOF shake table. All hydraulic, mechanical and electrical parts assembled and calibrated on site.

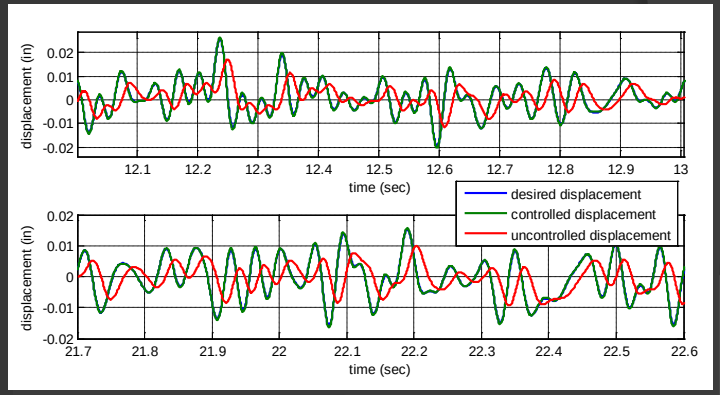


Robust Integrated Actuator Control

To implement desired displacement on experimental substructure RIAC control algorithm is developed based on H_∞ loop shaping control together with Kalman filter for noise reduction.







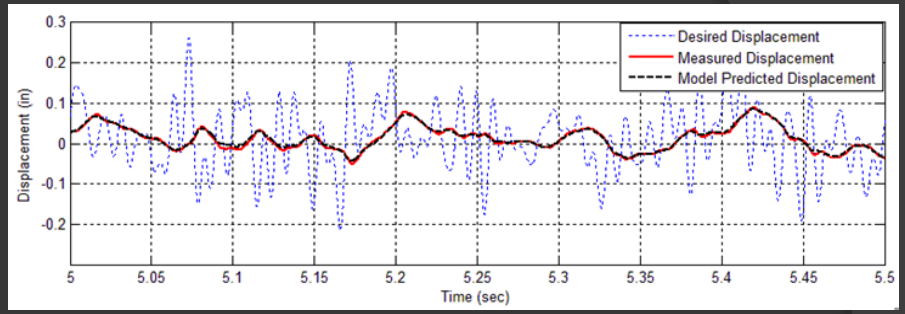
Parametric Identification of Servo-hydraulic Actuator in RTHS

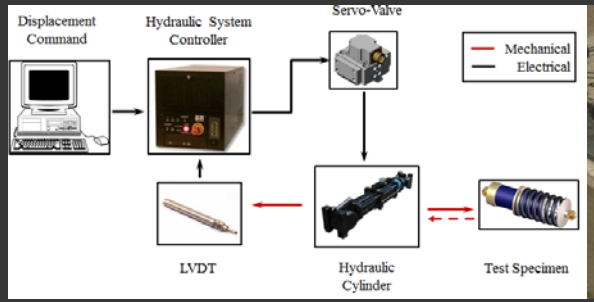
The servo-hydraulic actuator serves as an interface between the numerical and physical substructure. Actuator dynamics need to be compensated to perform RTHS.

Parametric model enables fast controller design under various physical substructure through RTHS simulation.

Genetic algorithm is used to extract component operation parameters from experimental data.

The predicted response from the parametric model matches the experimental results and performs well in RTHS applications





Cyber-Physical Instrument for Real-time Hybrid Structural Testing (MRI)

This project focuses on the development of an instrument to integrate physical and simulated components of an RTHS. The goal is to integrate these under a common reusable middleware architecture for flexible and reconfigurable use.

Sponsor(s): National Science Foundation
Grant No. CNS-1028668 (MRI)
Faculty Investigator(s): Dr. Shirley Dyke
Graduate Student(s): Xiuyu Gao, Nestor Castaneda, Ge (Gaby) Ou, Amin Maghareh