CPS Medium: Collaborative Research: CyberMech, a Novel Run-Time Substrate for Cyber-Mechanical Systems

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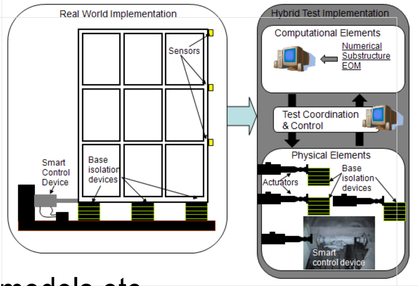
Introduction

- Hybrid Testing: Physical components & numerical model
- **R**eal-**T**ime **H**ybrid **S**imulation of structural components

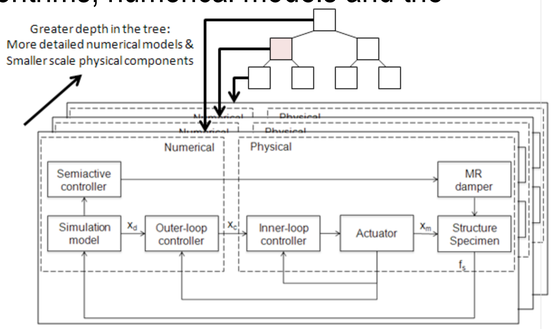


Challenges

- Complex interaction b/w sensors, actuators, controllers & models etc.
- Configurable, adaptive concurrency platform for parallel execution
- Real-times constraints: Multiple time-scale dynamics
- Asynchronous, on-the-fly adjustments to data flow and control flow
- Co-design of physical components, control algorithms, numerical models and the computational platform they run on

Target Application Domains

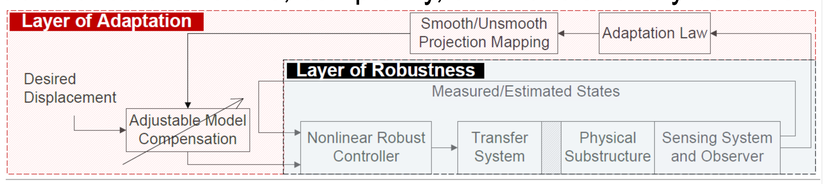
- RTHS with multi-scale models
- Tele-operation and interactive control of cyber-mechanical systems



Nonlinear Self-tuning Robust Control System (SRCSys)

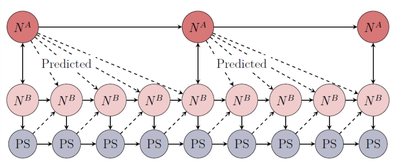
A multi-layer nonlinear control system is designed to accommodate extensive performance variations in the physical sub. due to structural failure, complexity, and nonstationary behavior.

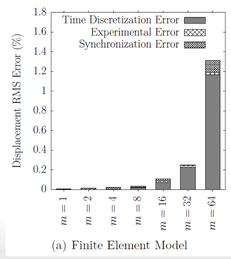
Multi-layer Self-tuning Robust Control System



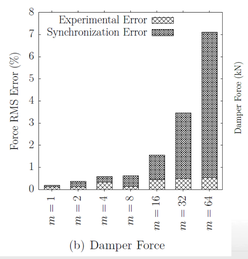
Asynchronous multi-scale models

- MTS with RTHS is asynchronous
- Need stable predictors for compatibility

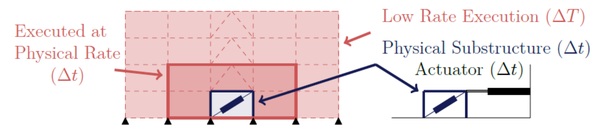


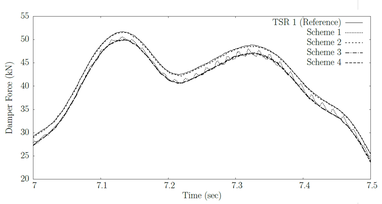


(a) Finite Element Model



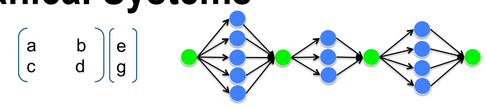
(b) Damper Force



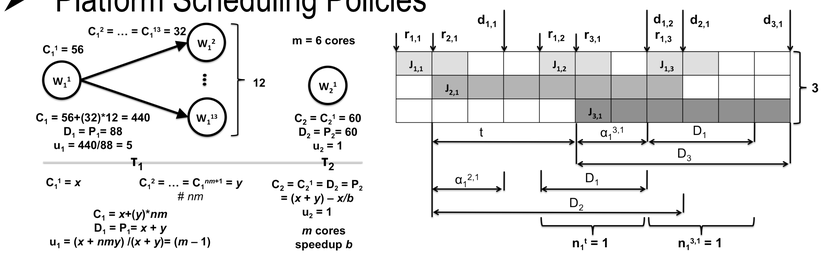


A Concurrency Platform for Cyber-Mechanical Systems

- Cyber-Physical Real-Time Parallel Task Model

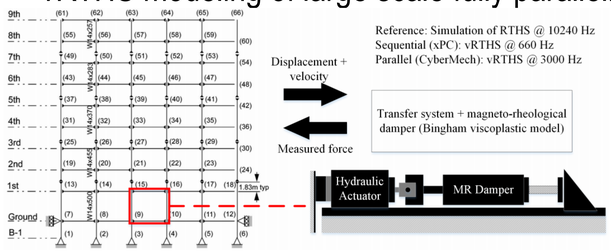


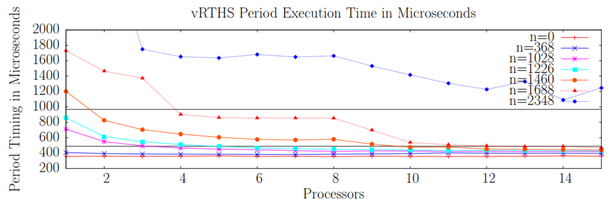
- Platform Scheduling Policies



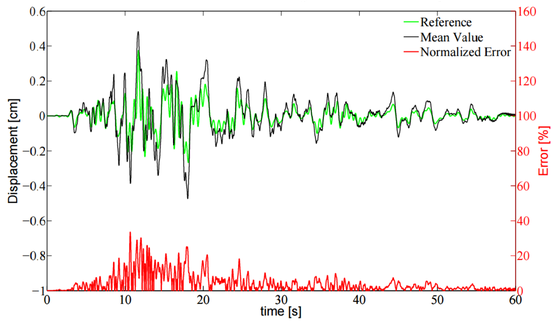
Empirical Evaluation

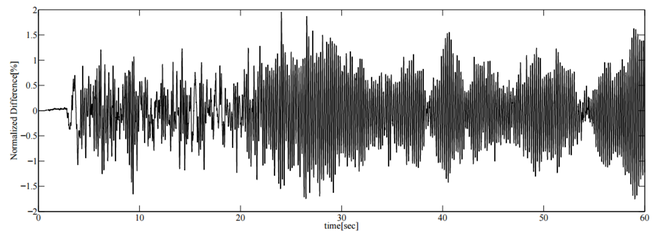
- vRTHS modeling of large scale fully parallelized RTHS



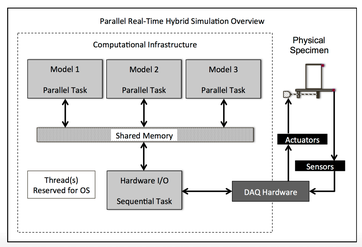


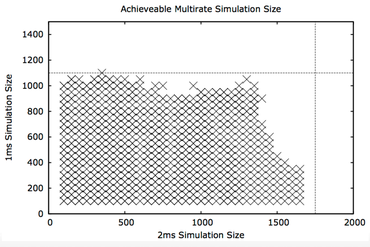
- Robust RTHS on CyberMech platform – reproducible experimentation





- Robust RTHS on CyberMech platform – integrated thread-safe multi-rate behavior





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