EAGER: Resilient Control Systems with respect to Instrumentation Attacks: Theory and Testbed Verification

PI: Liang Zhang (liang.zhang@uconn.edu)
Dept. of Electrical and Computer Engineering

Key challenges:

- The operation of the physical plant of a CPS is typically governed by closed-loop control.
- A major part of any control system is its instrumentation, i.e., sensors and actuators.
- The control system performance may be compromised by attacks on its sensors and actuators.
- Sensors may project erroneous information to the controller and the actuators may receive undesirable commands, possibly leading to a catastrophe.

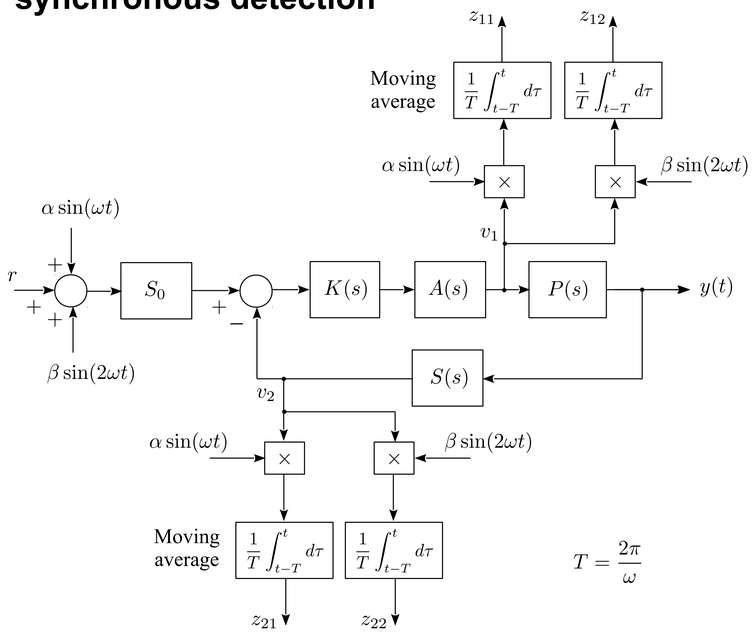
Scientific impact:

- This research is intended to introduce a new paradigm in the area of CPS − attack-resilient control systems.
- This includes methods for system vulnerability analysis, controller optimization, synchronous detection-based sensor/actuator health assessment, resilient controller design for attack identification and mitigation, and knowledge fusion for resilient control in MIMO systems.
- By providing a theory and analytical tools for design and analysis of such systems, the research will enhance the field of CPS from the point of view of resiliency.

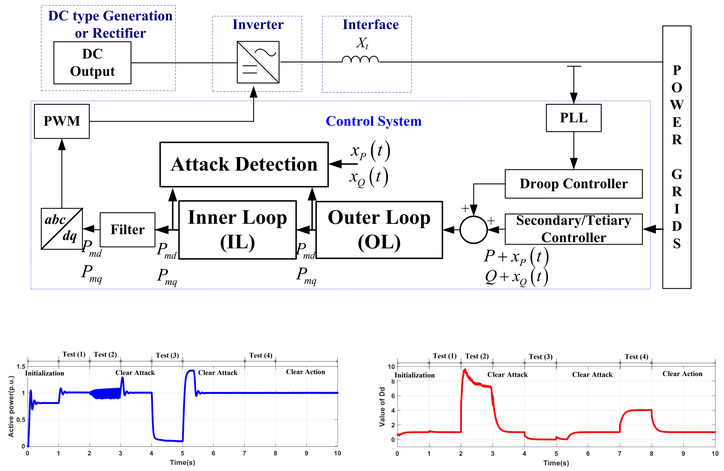
Approach and results-to-date:

- *Vulnerability analysis*: Develop analytical metrics for quantitative evaluation of the system vulnerability w.r.t. instrumentation attacks on the sensor and/or the actuator.
- *Controller design optimization*: Develop rigorous methods for selecting controller structure and parameters, which minimize the performance degradation caused by a given set of instrumentation attacks.
- *Resilient control*: Develop methods for design and analysis of resilient control systems, which degrade gracefully under attacks on their sensors and actuators.

Identification of deception attacks using synchronous detection

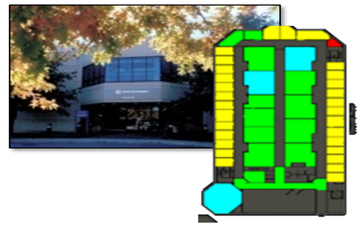


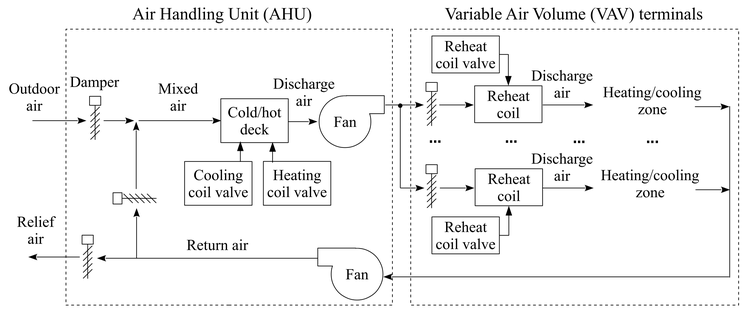
Application of synchronous detection in microgrid inverter control



Planned testbed verification: High Performance Building Testbed at UTRC

(Summer 2019)





Broader impacts:

- The broader impact of this work is in its effect on cyber-security of critical infrastructure systems, such as power, telecommunications, transportation, buildings, gas, oil, and water.
- The results will provide operators and engineers of these infrastructures with a set of rigorous engineering tools for resilient system monitoring and control.
- The collaboration with UTRC through testbed verification will lead to effective dissemination of research results among practitioners and acceleration of technology transfer.
- The project will contribute to the workforce training in resilient CPS through university and industrial curriculum developments, innovations, and outreach activities.

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Liang Zhang, PhD
Associate Professor
Dept. of Elect and Comp Engr
Liang.zhang@uconn.edu