UNIVERSITÄT
DUISBURG
ESSEN

# Veranstaltungen
## Ingenieurwissenschaften

**Fakultät für Ingenieurwissenschaften**
**Abteilung Elektro- u. Informationstechnik**
**Fachgebiet Automatisierungstechnik und komplexe Systeme**

***Univ. Prof. Dr.-Ing. Steven X. Ding***

Vortrag über eine Dissertation

**Referent:**

**M. Sc. Liutao Zhou**

**Thema:**

**Enhancement of Fault Tolerance and Attack Resilience in Cyber-Physical Systems**

This dissertation investigates the enhancement of fault tolerance and attack resilience in cyber-physical systems within a unified control and detection framework. A systematic and integrated methodology for anomaly detection and accommodation, encompassing both physical faults and integrity cyberattacks, is developed.

Initially, the effects of physical faults and integrity cyberattacks are examined within an observer-based cyber-secure system configuration. Through leveraging the coprime factorization technique, it is revealed that both types of anomalies exhibit distinct characteristics in the closed-loop system response. Specifically, physical faults manifest as variations in the feedback term, while the attack-induced variations are restricted to the feedforward term. This analysis highlights the inadequacy of the output residual-based anomaly detection mechanisms, necessitating to incorporate the input residuals derived from the controller dynamics.

Based on the prior system analysis, a collaborative scheme is proposed to simultaneously detect both kinds of anomalies. Particularly, additive fault detection is accomplished by a standard observer-based fault detector. Moreover, to account for the coupling between anomalies caused by multiplicative faults, a novel performance-based fault detection scheme is presented. Depending on the fault detection results, the attack detectors at the monitoring and control center operate in a coordinated manner.

Subsequently, the synthesis of fault-tolerant and attack-resilient controllers is studied within the Youla parameterization paradigm. An optimal fault-tolerant controller is designed by solving an H-infinity model-matching problem. Furthermore, it is demonstrated that the conventional Youla parameterization-based stabilizing controller is incapable of mitigating integrity attacks in the input channel. In order to resolve this problem, independent design parameters are introduced to the control law. Both control-theoretic and cryptographic interpretations of the proposed control strategy are provided.

Finally, the effectiveness of the proposed approaches is verified on a networked robot control system.

**Zeit:** **Mittwoch, 16. Juli 2025, 11.00 Uhr**

**Ort:** **Bismarckstraße 81, 47057 Duisburg**
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