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Bounded-Error Estimator Using State Augmentation in the Presence of Missing Data

Background

Rapid advancement in technology have resulted in increasingly complex systems. Since there are certain crucial system states that cannot be directly measured or observed through system outputs, state estimators (also known as state observers) are designed to tackle this problem. Currently, a great deal of state estimators relies heavily on the accuracy of sensor measurements. However, as systems such as autonomous vehicles, power grids, and smart buildings become integrated and distributed, significant missing data or communication delays across the sensor networks may be inevitable. Without effective estimator design to address these issues, these data losses may deteriorate the estimator performance and cause the resulting closed-loop system to become unstable.

Invention Description

Researchers at Arizona State University have developed a new bounded-error estimator that achieves equalized recovery for discrete-time time-varying affine systems subject to missing data. By augmenting the system state estimate with a Luenberger-like observer error, the equalized recovery estimator design problem is formulated as a semi-infinite optimization problem, and leverages robust optimization tools for solving. Due to the design freedom introduced by the Luenberger-like observer, the eigenvalues of the augmented system can be placed at desired locations, which results in a preferred intermediate level in the equalized recovery problem compared to existing approaches. The equalized recovery estimator is capable of handling missing data patterns expressed as fixed-length language specifications. Simulations involving an adaptive cruise control system demonstrate the equalized recovery performance of the estimator.

Potential Applications

- Autonomous systems
- Cyber-physical systems
- Power grids
- Smart buildings

Benefits and Advantages

- Reframes the equalized recovery estimator problem to allow efficient optimization with off-the-shelf software

Related Publication

Laboratory Homepage of Professor Sze Zheng Yong