INNOVATION PARTNERSHIPS
UNIVERSITY OF MICHIGAN

Recursive-Least-Squares-Based Cumulative Retrospective Cost Adaptive Control

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Category
Software
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OVERVIEW

Discrete-time adaptive control algorithm using cumulative retrospective cost for improved performance

- Efficient for minimum and non minimum-phase systems with unknown disturbance spectra
- Applications in aerospace, robotics, and industrial automation

BACKGROUND

Direct adaptive control is crucial for systems requiring continuous performance adjustments due to changing conditions. Historically, many adaptive control methods assumed that the controlled systems were minimum-phase, passive or positive real. These conditions limit the application range and effectiveness of adaptive controllers, especially in the presence of nonminimum-phase behavior. For command following and disturbance rejection, traditional controllers relied on known spectra of commands and disturbances and required disturbances to be measured. Moreover, for effective disturbance rejection, many methods necessitated a match between disturbance and control input matrices, complicating control schemes. This necessitates more versatile adaptive control algorithms that can handle non minimum-phase systems with unknown disturbance characteristics.

INNOVATION

Researchers at the University of Michigan have developed a novel discrete-time adaptive control algorithm based on a cumulative retrospective cost function. Unlike previous methods relying on instantaneous retrospective costs, this approach leverages cumulative retrospective performance, enhancing transient response. The algorithm is effective for both minimum-phase and non minimum-phase systems, even when the spectrum of commands and disturbances is unknown, and disturbances are unmeasured. By using a recursive least-squares algorithm to minimize the cumulative cost, the new adaptive controller provides improved performance and robustness. Real-world applications include advanced aerospace systems, robotics, industrial automation, and any field requiring adaptive control in dynamic and unpredictable environments. This innovation allows significant advancements in adaptive control applicability and effectiveness, overcoming historical constraints and expanding potential use cases.

ADDITIONAL INFORMATION

REFERENCES:

Hoagg, Jesse & Bernstein, D.S.. (2010). Cumulative retrospective cost adaptive control with RLS-based optimization. Proceedings of the 2010 American Control Conference, ACC 2010. 4016 - 4021. 10.1109/ACC.2010.5530434