Analysis and Minimization of Interaction in Decentralized Control Systems With Application to Roll-to-Roll Manufacturing

Article

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Abstract

Analysis and minimization of interaction in multivariable systems employing decentralized controllers with application to roll-to-roll manufacturing systems are considered in this paper. A new interaction metric based on the Perron-Frobenius theory of nonnegative matrices is presented. This new metric may be used to quantify interaction in a large-scale interconnected system, establish constraints on closed-loop system stability, and provide a systematic design procedure for constructing decentralized pre-filters, which minimize interaction. The new interaction metric is applied to a roll-to-roll (R2R) manufacturing system, which utilizes decentralized control systems. R2R manufacturing is a continuous process in which flexible materials are transported on rollers through processing machinery where operations, such as printing, coating, lamination, etc., are performed to obtain finished products. Based on the Perron root interaction metric (PRIM), a comprehensive experimental study to analyze and minimize interaction on a large experimental R2R platform is presented. A representative sample of experimental results which demonstrate the applicability of PRIM is presented and discussed.

Link to the article