Modeling, Analysis and Control of Print Registration in Roll-to-Roll Printing Presses

Article

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Abstract

Print registration in roll-to-roll (R2R) printing process is investigated in this dissertation. Print registration is the process of aligning multiple images that are printed in consecutive print units. The quality of the print output depends on the proper alignment of these images. A new mathematical model for print registration is developed by considering the effect of key process variables, such as web tension and transport velocity, print cylinder angular position and velocity, and the compensator roller position. Sources of machine induced disturbances and their effect on print registration are also investigated and machine design recommendations to mitigate these disturbances are given. Propagation of disturbances between print units due to web transport is investigated. The interaction, or the disturbance propagation behavior, between print units is studied by developing a new interaction metric called the Perron Root based Interaction Metric (PRIM). The new interaction metric, for large-scale interconnected systems employing decentralized controllers, is developed using tools from the Perron-Frobenius theory. A systematic procedure to minimize interaction is given by designing pre-filters for decentralized control systems. The disturbance propagation behavior with two registration control strategies is compared using the PRIM and it is found that a compensator based registration control (CRC) has smaller magnitude of disturbance propagation when compared to a print cylinder angular position based registration control (PARC). It is also found that a simple, decentralized, memoryless, state feedback controllers stabilizes print units with CRC. Results from a number of model simulations and experiments are provided to support the recommendations and conclusions.

Link to the article