Interaction Analysis of Control Systems Employed in Roll-to-Roll Printing

Article

Authors

Aravind Seshadri and Prabhakar R. Pagilla

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Abstract

Roll-to-roll (R2R) machines have been extensively used to manufacture a wide variety of consumer products, such as paper, plastics, textile, etc. R2R machines facilitate continuous processing of materials with minimal stoppage time and provide significant improvement in productivity over batch manufacturing. With recent advances in technology it is now possible to manufacture flexible electronics, flexible digital displays, solar films, etc., using R2R processing. R2R processing of flexible electronics requires better understanding of machine and process dynamics to achieve tight tolerances required in their manufacturing. One of the conventional R2R processes that is critical to enable R2R processing of flexible electronics is printing. In this paper, machine and process dynamics for R2R printing are studied in detail. Specifically two control configurations, depending on the type of control input, are analyzed; a compensator based registration control strategy (CRC) typically used with mechanical line shafts (MLS) and a print cylinder angular position based registration control (PARC) strategy used typically with electronic line shafts (ELS), are compared. A comparison of these strategies is given based on a dynamic model for the print section, which includes governing equations for strain in the material, print cylinder velocities, and registration error (a metric that quantifies print quality). An interaction metric is used to analyze interaction of key process variables between print units. Model simulations are conducted for different scenarios to evaluate the strategies. Results of the model simulations are presented and discussed.

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