Model Reference Adaptive Control of Web Guide

Article

Authors

Aravind Seshadri

Publication Information

OSU Theses

Abstract

The term web is used to describe materials which are typically manufactured in a roll-to-roll manner. A wide variety of materials such as textile, paper, plastics, composites and metals are manufactured in rolled form because roll-to-roll manufacture of materials is convenient for transport and storage, saves time and reduces costs. As the web is transported in the processing machinery, inherent machine misalignment and process induced disturbance cause lateral fluctuations. These lateral fluctuations, if not controlled, can result in inferior quality of the finished product. The primary focus of this research is on the development and implementation of adaptive control strategies for controlling the lateral fluctuations (lateral control or lateral guiding) in a web processing line. New performance measures which can better assist machine operators in diagnosing lateral behavior were also investigated. A novel model reference adaptive controller, which is referred to as the ``Guide Adaptive Controller'' (GAC), was developed for web guiding applications. The GAC was implemented on an experimental web line and the performance of the controller was compared with an existing industrial controller. The adaptive control strategy resulted in better performance compared to an industrial controller especially when used with difference web materials with opacity and gage variations. Compared to the existing industrial controller, the adaptive controller does not require re-tuning when the operating conditions change because the GAC adapts to process variations and attenuates disturbances. Additionally, the same adaptive controller can be used with different guide mechanisms. Two simplified approximations of GAC were also developed and implemented on an experimental web line in order to observe the adaptive behavior of the controllers. Based on these observations a systematic procedure for industrial implementation of the adaptive control strategy was developed. Extensive experimental results on commercial guides with different operating conditions and disturbances indicate that GAC can provide improved guiding performance when compared to an existing industrial controller. Therefore, GAC has a high potential to successfully replace existing guide controllers. A novel performance metric which provides a better characterization of the guiding performance when compared to existing metrics was developed. The developed metric is based on histograms. Commonly observed histograms were studied and their occurrence in web guiding applications were analyzed. The performance metric can be used as a diagnostic

tool in the web processing industry to monitor the occurrence of different machine and process induced disturbances, and also to compare controllers.

Link to the Article