論文 / 著書情報
Article / Book Information

題目(和文)	画像転写ベルト系の振動抑制のためのモデル化と制御
Title(English)	Modeling and Control for Vibration Attenuation in Image Transfer Belt System
著者(和文)	YuJie
Author(English)	Jie Yu
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	Mechanical and Control Engineering 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of (Philosophy)
学生氏名： Student's Name	YU JIE	指導教員（主）： Academic Advisor(main)	山浦 弘 教授
		指導教員（副）： Academic Advisor(sub)	

要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This thesis mainly deals with modeling study of image transfer belt system and optimal H_2, optimal H_∞, mixed H_2/H_∞ control along with their applications for the established image transfer belt system model. The remainder of the thesis is organized as follows.

Chapter 2
In this chapter, a simplified mechanical model, called four-rollers-belt (FRB) system with and without the tensioner part is studied to figure out the effect from tensioner on belt variation. Meanwhile, to ascertain the applicability of this simplified model, the multi-rollers-belt system which originated from the real equipment is set as comparison and studied along with the FRB system. Also in order to explain the necessity of active control method, limitation on passive control method by flywheel under system uncertainty disturbance is presented. Numerical simulation results are given in this chapter to prove the proposed model and inefficiency of the previous control method.

Chapter 3
An optimal state feedback controller based on H_2 norm is proposed for the model established in chapter 2. The control design procedure is explained in detail including how to solve stabilization problem for open-loop system, and minimization problem on H_2 norm of transfer function from loading disturbance on system outputs. Several combinations of outputs including speed of different driven rollers, and tensioner displacement are selected to find out the optimal constrain for attenuation on belt vibration. Also to testify the effectiveness of proposed controller, several numerical simulations are exhibited and compared in this chapter too.

Chapter 4
An optimal output feedback controller based on H_∞ norm is designed in this chapter to stabilize image transfer belt system and endow strong robustness on belt variation. Procedure to obtain the desired controller is conducted and a mathematical model for real loading disturbance is proposed. Numerical simulation results including comparison between conventional PID speed controller and optimal H_∞ controller, system performance with and without uncertainty by the proposed controller are conducted to exhibit the effectiveness of this design.

Chapter 5
An optimal output feedback controller based on mixed H_2/H_∞ norm is investigated in this chapter to take advantage from both of these two norms. The control architecture is explained with how to pick up constraints on outputs. Various selections and combinations between outputs with different constraints and optimization settings are studied thoroughly in numerical simulations, in order to figure out the most promising design for system. And results ascertain the efficiency of this mixed norm control design.

Chapter 6
In the end, the conclusions of this thesis are summarized in this chapter.

The conclusions obtained in the above mentioned study are briefly summarized as following:

1. Effect from tensioner part on belt variation cannot be ignored based on simulation results. Moreover it is one of the main reasons leading to belt vibration when loading disturbance entering the system.

2. The proposed mechanical model for image transfer belt system is applicable in control design compared to the complicated one that is similar to real equipment based on numerical comparison results.

3. Passive control method by flywheel is ascertained its effectiveness on the proposed model. However it cannot maintain the desired capability with system uncertainty, which leads to requirement of active control related to system robustness.

4. Effectiveness of state feedback optimal H_2 control method is ascertained compared to open-loop system response to impulse loading disturbance. It is shown that different additional regulated output led various control performances on belt displacements. Attenuation along with drive roller speed leads to better result on stretching displacement, while constrain on tension roller speed obtains much more improvement on absolute displacement. This kind of state feedback requires large amount of calculations for controller.

5. Validity of proposed output feedback optimal H_∞ controller is proven by simulation results of response to a simulated real loading disturbance signal, along with performance of open-loop system, and closed-loop system with conventional PID speed controller. Robustness of the closed-loop system endowed by proposed controller is certified by calculating results reacted to loading disturbance along with system uncertainty

6. Usefulness of mixed H_2/H_∞ objectives controller is clarified by impulse response of closed-loop system numerically. Various control performances according to different selections of regulated outputs and constrains are uncovered. It is shown that condition with bounds of belt displacement on H_∞ norm with bounds of drive roller speed on H_2 norm achieves the most satisfying control results.