Model-Free Feedforward Control of Inkjet Printhead[1]

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1 Introduction

Inkjet printers are non-impact printers which print text and images by spraying tiny droplets of liquid ink onto paper. Besides the well known small inkjet printers for home and office, there is a market for professional inkjet printers. Inkjet printers are used to form conductive traces for circuits, and color filters in LCD and plasma displays. That makes the printing quality is an important issue. Currently, most inkjet printers use either thermal inkjet or piezoelectric inkjet technology. Most commercial and industrial inkjet printers use a piezoelectric material in an ink-filled chamber behind each nozzle instead of a heating element. When a voltage is applied, the piezoelectric material changes shape or size, which generates a pressure pulse in the fluid forcing a droplet of ink from the nozzle. In my project the piezoelectric inkjet printer is considered.

2 Problem Statement

After a drop is jetted, the fluid-mechanics within an ink channel are not at rest immediately: apparently traveling pressure waves are still present. These are referred to as residual vibrations. These residual vibrations result in changing the speed of the subsequent drops. That is due to the fact that the initial meniscus positions of the subsequent drops are different than the initial meniscus position of the first drop. Usually the fixed actuation pulse is designed under the assumption that all the drops have the same initial meniscus position. To guarantee consistent drop properties, one has to wait for these residual vibrations to be sufficiently damped out to fulfill this assumption. Cross-talk is the phenomenon that one ink channel cannot be actuated without affecting the fluid-mechanics of the neighboring channels. The cross-talk happens due to the fact that the pressure waves within one channel influence other channels. Residual vibrations and cross-talk result in ink drops with different speed and volume which affect the printing quality. The main goal is to improve the printing quality of the printhead that is achieved by keeping both the speed and volume of the ink-drop constant.

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3 Model-Free Optimization

Since there are no online measurements for the system variables, a feedforward controller is the only appropriate solution. Optimization of process performance has received attention recently because it represents the natural choice for reducing production costs, improving product quality, and meeting safety requirements and environmental regulations. Process optimization is typically based on a process model that is used by a numerical procedure for computing the optimal solution. In practical situations, however, an accurate process model can rarely be found with affordable effort. Uncertainty results primarily from trying to fit a model of limited complexity to a complex process system [1] and [2]. In this paper, we propose a new input pulse, that consists of two pulses an actuation pulse and quenching pulse. The actuation part is used to formulate and jet the drop while the quenching part is used to dampen the residual vibrations. A lot of efforts have been done to produce a good model for the ink channel [3] and [4], however this model is still incomplete and fails to predict the meniscus position of the drops. In our approach the optimization is carried out on the real set-up instead of using a printhead model. A high speed camera is used to obtain the time history of the drops traveling from the nozzle plate to the paper. An image processing technique is developed to obtain the actual speed of each drop. An optimization technique is used to get the optimal actuation pulse parameters by minimizing the error between the actual drop-speed and a desired reference drop-speed.

References

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