Using Digital Data to Automate Skilled Tasks in Digital Printing

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Abstract

In recent years, digital workflows and digital printing presses have become quite common. We can expect a focus on two kinds of research and development as we enter the next stage. The first is automating the printing process, which until now has required the skills of a highly experienced operator, and the other is finding ways to assure high-quality printing using digital printing automation. In order to solve the problems involved in achieving these goals, Dainippon Screen has developed two printing support systems. One is a system that measures the image on printed sheets during printing in real time, and that can be used to control the ink fountain keys automatically, as well as to monitor the dampening water. The other is a system that controls the ink fountain keys during printing based on a single shot of the entire image on a printed sheet.

I will explain these systems in greater detail.

Introduction

P2QM is a total digital workflow, designed by Dainippon Screen, based on international ICC and CIP3 standards that covers all the aspects of color management from prepress through printing (Figure 1). This workflow employs two printing support systems. The inline printing support system (TrueFit Advance) measures the density of the color patches in a color bar on a printed sheet, and controls the volume of ink and amount of dampening water automatically. The digital color console (ColorMission) uses the results of an image of the entire printed sheet to control the adjustment of ink levels during printing. It does not require the use of color bars.

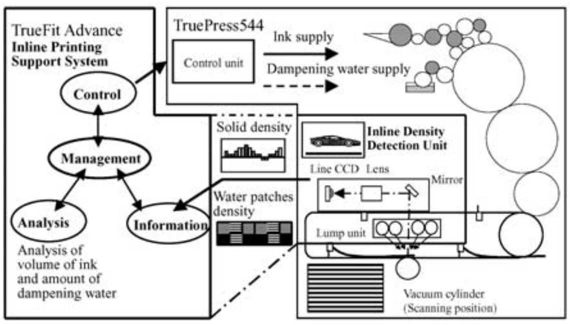

Figure 1. Automated Skilled Tasks in the P2QM Workflow

Inline Printing Support System

The inline printing support system uses the density measurements gathered from the color bar by the inline density detection unit to estimate the current ink and water balance and is designed to control the ink volume and the amount of dampening water appropriately (Figure 2).

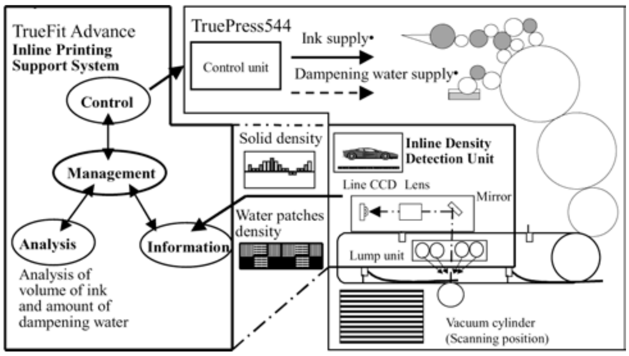

Figure 2. The Inline Printing Support System(TrueFit Advance)

This system has the following three advantages:

1. Automatic control of the volume of ink in response to changes in the printing environment.
2. Ink presets that bring the ink density up smoothly to reduce the number of waste sheets between jobs.
3. Ink and dampening water levels are controlled simultaneously with the aid of a special algorithm and monitor patch that use the ink density to determine the amount of dampening water.

Inline Density Detection Unit

The inline density detection unit is positioned at the paper delivery end of Dainippon Screen's TruePress 544 (a digital offset printing press). A color bar is printed at the end of the printed sheet; the sheet is hooked by a claw, which is attached to the delivery chain, and is transported from the delivery cylinder to the delivery table. Just before the claw releases the sheet, the sheet passes through the image capture area, where a CCD line sensor synchronously scans the color bar.

Ink Control Algorithm

Until now, ink density control systems have required that a printed page be pulled off the press, its ink density measured, the results compared to an accepted reference standard, and that information used either on or off line to control the ink volume. Unfortunately, if a printed sheet was pulled while the ink density was changing, the ink fountain key adjustments made could alter the ink density in a way that the operator had not intended.

The inline density detection unit, on the other hand, monitors the ink density in real time, so that adjustments are made to the ink fountain keys with the appropriate timing. This enables extremely precise ink volume control.

The ink control algorithm controls the ink volume through a variety of phases. These phases are defined by the deviation of the ink density from the target density.

The Algorithm Process

1. Beginning of printing: The system uses the first set of sheets in a job to roughly adjust the ink presets and control the ink volume.
2. Transition: To reach stabilized status as quickly as possible, the system avoids overshooting the desired levels by adjusting the control vectors.
3. Stabilized status: The system is in stand by mode.
4. End processing: To prepare the ink presets for the next job, printing is carried out at ink volume levels that are slightly lower than the target density levels. In situations where the response of the measurement points (printed sheets), and control points (ink fountain rollers), to ink control is slow, phase control makes high-precision adjustment possible.

Monitoring Dampening Water

As you can see in Figure 3, the color bar includes solid patches and multi-lines patches at different resolutions. With these patches, the density of fine multi-lines is as low as that of coarse multi-lines when the amount of dampening water is high and is higher than that of coarse multi-lines when the amount of dampening water is low.

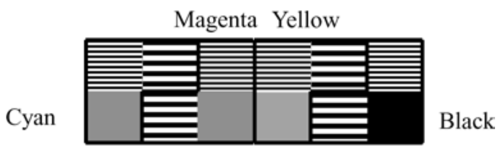

Figure 3. Water Volume Detection Patches

The water volume estimation algorithm uses the density of the solid patch, as well as the densities of the fine and coarse multi-line patches to calculate the Yule-Nielsen factors for the patches containing fine and coarse multi-lines. When the line surface area is 50%, the Yule-Nielsen factor is approximated. The differences between the Yule-Nielsen factors increase linearly with the amount of water.

In tests to determine how well the water volume detection system works with coated paper, it took about 50 sheets from the time the water level at the TruePress 544 was changed, before ink and water adjustment reached stabilized status.

The inline printing support system also features an ink and water control function that maintains ideal conditions as set by the operator.

The Digital Color Console

The digital color console captures an image of the entire printed sheet using a digital camera and performs color management for the printing press using the information gathered (Figure 4).

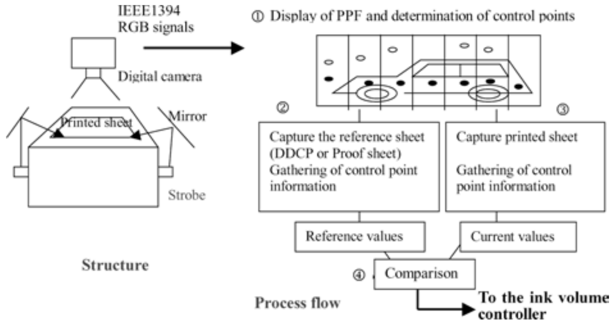

Figure 4. Digital Color Console Process (ColorMission)

The Process Flow

1. The CIP3 PPF (Print Preview File) corresponding to the printed sheet is displayed, and the control points for each ink fountain key zone are selected. The control points can be sampled automatically.
2. The image of a reference sheet is captured, the RGB and density values required for control are gathered, and reference values are determined.
3. Image capture is applied to printed sheets that are pulled from the printing press as it operates, and the control point information is gathered (using the same methods as were used with the original reference sheet) for use as the current values.
4. The current and reference values are compared, the necessary signals to control the ink volume are generated, and the ink volume is controlled using the controller.

The illustration of the car is demarcated by vertical lines that indicate the ink fountain key zones. Each zone contains a black circle and a white circle. The black circles indicate representative color control points, while the white circles indicate gray control points. Those colors within the entire document or ink fountain key zone that contribute most to the visual impression of the image are known as representative colors. It is important to manage these representative colors properly. The image analysis algorithm can select candidates for the representative color in each zone automatically; this algorithm preferentially selects those colors that have a relatively small edge and occupy a large surface area. The gray control points are used to control the shades of gray, which are also considered extremely important in printing.

In tests of ink control using the digital color console, the goal was to achieve consistent color despite changes in the daily standard density of the same printing press, and the eight points that were measured represent the variance in color from the reference values. The effects of the ink control are apparent starting with the second feedback loop, and it is obvious that the values are approaching the reference values as the iterations increase.

Conclusion and Future Topics

Highly accurate real-time color readings like those described above can be used as printing press controls for quality stabilization or for printed product testing. They are well suited for use with high-precision scanners, digital control systems, color analysis devices, test plates, and other technologies that have been fostered by Dainippon Screen.

In the future, the integration of printing support systems such as those introduced here will continue, and automated, consistently high-quality printing production can be expected as a result.

Biography

Takaharu Yamamoto received his master degree in the Precision Machinery Engineering from Osaka University in 1985. That same year, he began working at the R&D Department of Dainippon Screen Mfg. Co., Ltd., where he was primarily engaged in developing flatbed scanning output devices (Imagesetters and Platesetters). He has since joined the Digital Printing Technology Department, where he continues to work on developing color management systems that will increase the operating efficiency of printing presses.