Development of the 23”x29.5” Sheet-fed Inkjet Press KM-1

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Abstract

To materialize the "digital print," we have been developing a new digital printing system with our inkjet technology. We adopted so called "single pass printing system" for the system. It has a page-wide print head array and can print ink droplets on a rapid-delivered paper. We developed a variety of technologies such as a new print head, a new ink, a new image compensation technique, and so on, for the system. We integrated 1,800 printing nozzles into 600 npi density that can eject small droplets in higher frequency. We developed a new ink formulation that can show performances necessary for the single pass printing. We also developed a new technique that can compensate streaky image defects. Combined these new technologies, we achieved to develop a new digital printing system that can print a high-resolution and high-quality image quickly.

Introduction

Tablet computers have been receiving plenty of attention and spreading throughout the world recently. As a result, the importance of paper as the information transmission media has decreased. A conventional mass-produced paper print has decreased greatly. On the contrary, "digital print," a newly developed printing method by means of digital printing system, has many advantages such as easy-print without printing plates, quick delivery, flexible high-mix low-volume production, and is expected to grow rapidly.

To meet such situation, we started a development of new digital printer by utilizing inkjet technology. Its concept was “a machine that fits to the existing offset printing environment.” We aimed that customers of the offset-printing system could build a digital printing system by utilizing their existing peripheral equipments.

We adopted so called "single pass printing system" for the system with a page-wide print head array [1]. We integrated 1,800 printing nozzles into 600 npi density that can eject small droplets in higher frequency [2]. We developed a new ink formulation that can show performances necessary for the single pass printing. We also developed a new technique that can compensate streaky image defects. Combined these new technologies, we achieved to develop a new digital printing system that can print a high-resolution and high-quality image quickly up to B2-size (23”x29.5”) sheet.

We will present results and findings during the development as well as the outline of the system and the product-concept.

Equipment outline

***Figure 1**. Sheet-fed Inkjet Press KM-1*

KM-1 is roughly divided into a paper-feeder, a main body, a paper deliverer, and an ink supply unit. It also has a blower rack, UV lamp power supply unit, a chiller, and a data-server as incidental equipment.

To meet a wide variety of paper, size and thickness, its paper conveyance system has been designed to change paper-feeding pathways by just pressing a button. To carry out double-sided printing automatically, a reverse feeding system was arranged under the printing unit. The page-wide print head array, UV-LED lights, and an imaging inline sensor have been arranged alongside of the paper-feeding cylinder.

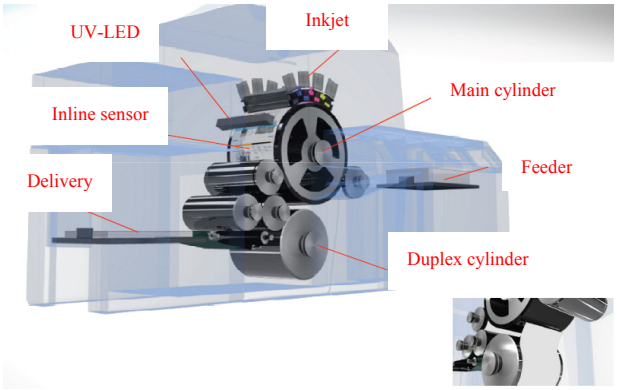


***Figure 2**. KM-1 compact Duplex system*

Table1: KM-1 specifications.

	Specifications
Printing type	Single pass inkjet printing
Transportation	Gripper transportation
Speed	Simplex: 3,300 sheet/hour Duplex: 1,650 sheet/hour
Number of colors	4 colors (Y,M,C,K)
Number of heads	2 Heads/module 8 Module/color (Total 64 heads/color)
Resolutions	1,200 dpi x 1,200 dpi
Maximum print media size	585 x 750 mm
Media thickness	Simplex: 0.06 - 0.6 mm Duplex: 0.06 - 0.45 mm
Media type	Coated paper Non-coated paper Embossed paper etc
Ink	UV-curable ink
RIP	Full variable

Achievement technology

System

One of the technical challenges of KM-1 was to attain printing speed compatible to the conventional offset-printing system. We focused our resources on three points, data transfer, RIP, and image processing hardware, and developed technologies for high-speed printing as below.

1. To connect the controller unit to the printing unit, we needed several meters of wiring in KM-1. We adopted "V-by-one" technology, which could transmit data to a comparatively long distance, for the high-speed data transfer.
2. To process image data to printing data quickly, we optimized and customized the RIP controller.
3. To arrange full variable printing data quickly, we developed image processing hardware by using FPGA.

As a result, KM-1 enabled printing of the paper of B-2 size by the full variable at 3,300 sheets per hour.

Ink Technology

We adopted UV-curable ink technology for KM-1. Merits of the UV-curable ink are:

1. Less head clogging can happen because of its less volatility. It can make jetting performance of the system stable.
2. It can forward the printed media immediately to the next process because of its quick-drying property.
3. It can print on a wide variety of media, absorbable or unabsorbable, without pretreatment because of its self-fixing property.
4. It can suppress the "curl" printed on a plain paper.

We developed a new and unique ink formulation to attain these merits. It was also designed to meet the emitting spectrum of UV-LED light source. It was also designed to secure the color reproducibility of the "Japan Color 2011." Combined these features, we succeeded to develop a new ink that satisfied robustness, image quality, and quick-drying necessary for the "digital print."

Head technology

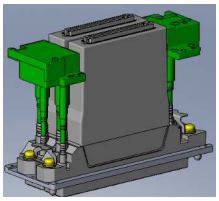
We developed a new print head and a print head module, and a print head array for KM-1.

1. We developed a new print head, KM1800i, by integrating 1,800 printing nozzles into 600 npi density in the HA structure [2]. The print head can drive up to 41 kHz in two-drop driving mode at 600 dpi resolution.
2. We developed a new head module by assembling two new heads staggered. Two new print head were united into the module precisely in a micron order.
3. Eight modules were set to make a print-head array for each color. The array enabled to print an image up to 575-milimeter width.
4. The module can be replaced easily by users when damaged. KM-1 can calibrate the arrangement of the replaced module automatically by reading printed image with an in-line imaging sensor.

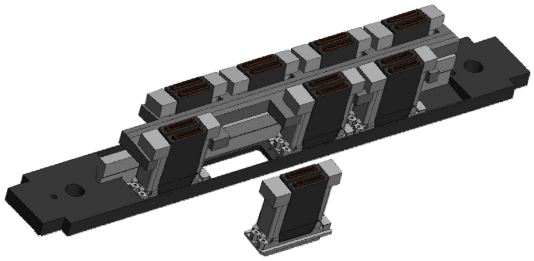
Table2: KM1800i specifications.

	Specifications
Number of nozzles	1,800 nozzles
Resolutions	600 npi (Nozzle pitch 40.3 μm)
Actuator	Piezoelectric shear mode; HA structure
Frequency	41 kHz (2-Drop driving mode)
Internal Heater	Available

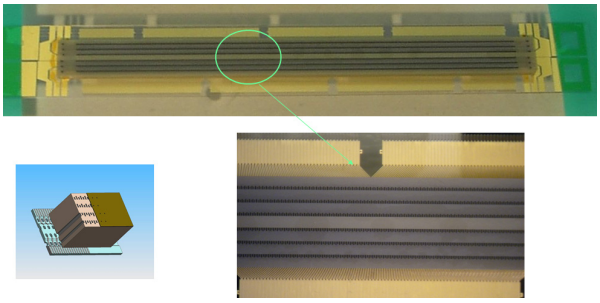
(1)Print head



(2)Head module



(3)Print-head array



(4)Head chip

***Figure 3**. Inkjet heads & Module*

Nozzle error (misfiring) correction

It is said that misfiring is unavoidable in inkjet print head, especially in a largely nozzle-integrated one. Such misfiring will yield streaky image defects especially in the single pass printing system. To deal with this issue, we adopted two techniques. First we adopted UV-curable ink in which we formulated monomers that have high boiling points. That makes the ink less volatile and much stable against the issue. Second we developed an online feed-backing that can compensate the streaky image defects.

The system will add a color bar at the back end of the image. The imaging sensor, which has been installed at a posterior position of the LED lights, will inspect the color bar after the image will be cured by the LEDs. When the sensor detects streaky defects (misfiring), the printing will be interrupted and a new chart that will pinpoint the nozzle position of the defects will be printed. The imaging sensor will inspect the image and will identify the position of the missing nozzles. The setting of droplet volume of surrounding nozzles of the missing nozzle will be increased to make the defects less noticeable then. The waste paper, therefore, will be limited to just four sheets.

We also developed a new technique that will speed up the compensation. The imaging sensor captures the image in the resolution below half to the printing resolution (1,200 dpi) first. The resolution of the captured image is restored in the controller then, and the positions of the missing nozzle are identified precisely.

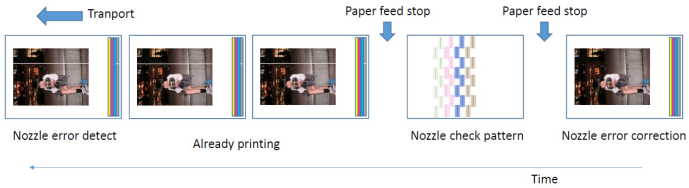


***Figure 4**. Nozzle error correction*

Conclusion

We have been developing a new digital printing system KM-1 with our inkjet technology; e.g. mechatronics, software, image processing, ink, and head technologies.

In addition the printer adopts many new technologies that is not reported here. We improved and installed many new technologies to KM-1 after the announcement at DRUPA 2012 and, thereby, high definition and high reliability printing have been achieved as a sheet-fed inkjet machine of B-2 size sheet paper. We are planning to test it in the market, and will improve to fulfil the market's demand.

References

[1] Applications of Page Wide Piezo Inkjet Printing to Commercial and Industrial Market, Y. Zhou and C. Rensch, Proceedings of DPP2001: International Conference on Digital Production Printing and Industrial Applications, p. 50 - 53, 2001.

[2] New Developments of Shear-Mode Piezo Inkjet Heads for Industrial Printing Applications, H. Watanabe, T. Okuno, S. Kawaguchi, H. Takamatsu, M. Ueda, Proceedings of Nip 27 and Digital Fabrication 2011, p. 282 - 285, 2011.

Author Biography

Mitsuru Obata received his Bs. degree in 1986 and Ms. degree in 1988 from Nagaoka University of Technology. He joined Konica Corporation in 1988. He belongs to the R&D Group Inkjet Business Unit, and engaged in the development of process for Inkjet printer.