Feasibility Study on Image-based Faulty Nozzle Detection Method for Digital Textile Printing

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ABSTRACT

Digital textile printing (DTP) is a production method in which ink droplets are ejected from an inkjet head to print on a fabric. In recent years, the resolution of the DTP head has been increased, the nozzles have become smaller, fabric defects due to nozzle clogging have become easier to occur, and the production speed has also become faster, making it difficult for the human operator to confirm this in real time. In addition, real-time monitoring technology of defective nozzles is needed to break the existing time-based maintenance and implement condition-based maintenance. In this study, we propose a method to identify defective nozzle position by acquiring an image of printed fabric in real time and verify method at prototype level and to examine feasibility. Based on the multi-pass type 1.8m-wide production equipment using a 1200 dpi head module, the specifications and technical difficulties required for acquiring and analyzing the image are described in detail. It is hoped that these technologies will enable condition-based maintenance and further improve operational efficiency of manufacturing.

1. INTRODUCTION

Digital textile printing (DTP) is a production method in which ink droplets are printed on a fabric by color in an inkjet head. However, purge and wiping are often carried out because contamination of the nozzle, solidification of the ink, solidification of the ink, pretreatment dust, fiber fabric, etc., are easily contaminated or clogged. As a result, production is interrupted periodically, and if not detected, the fabric is discarded.

As the resolution increases and the production speed increases, it is difficult to detect with the naked eye. In 2005, Konica Minolta used a laser in the Nessanger series to directly detect nozzle clogging by detecting ink ejection. However, when the ink dust is generated near the nozzle, the light source receiving part is contaminated and it is difficult to read, which is expensive.

In this paper, we propose a method to obtain the image of the fabric output with the designed standard pattern and indirectly analyze it to find the clogged nozzle position of the 1200dpi head. The feasibility check for the proposed method and a schematic diagram of the verification device are proposed together.

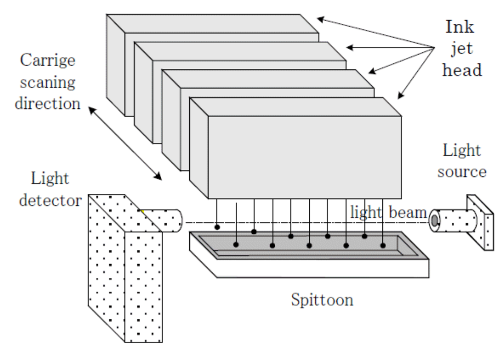

Figure 1. Laser based nozzle clogging detection

2. SAMPLES AND TEST METHOD

In this study, the multi-pass DTP system is applied to the conveyor belt by attaching the fabric wrapped on the roll about 1.8m wide and 6000m long. After supplying the fabric about 350mm, the DTP head is moved in the lateral direction and printing is called 1 pass and it is repeated. In this study, we propose a method to detect by 1 pass unit by attaching a camera to DTP head, and feasibility check and verification method are devised.

As shown in Figure 2, a device simulating a unit process corresponding to 1 pass was envisaged. In the mass production facility, the supplied fabric is stopped and the camera attached to the DTP head moves in the lateral direction, whereas in the 1 pass simulation device, the camera moves in the lateral direction by 1 pass instead of the camera to make relative movement.

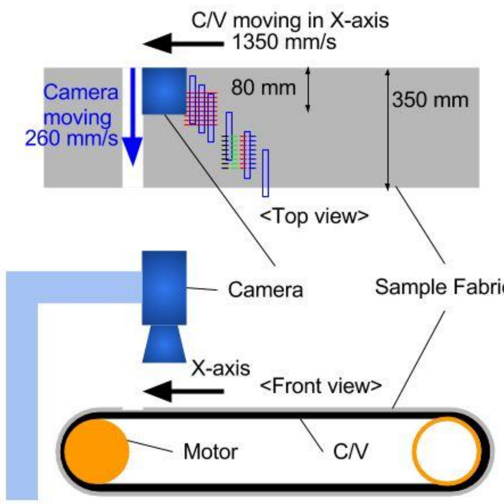

Figure 2. Sample and test apparatus

3. FEASIBILITY STUDY

It is difficult to analyze any printed image due to the blurring of the printed ink drops and the roughness of the fibers. Therefore, as shown in Figure 3, we have devised a method of creating a standard pattern with sufficient spacing, except adjacent nozzles. Such a standard pattern can be tested using not only the beginning of the fabric but also the fabric or the seam region of the image so that the clogging of the nozzle of the head can be detected even during mass production.

In order to measure a large area within a short time, a line-scan type camera was selected. It is a 16k line scan camera with a pixel size of about 5um which is the best among the commercially available cameras. Then, the area that can be shot at a time is only 80mm, so it is necessary to add or move the camera in order to shoot all 1800mm wide fabrics. Or sophisticated image processing device techniques can be developed to reduce costs.

The first thing to do before analyzing the image is to acquire the image of the printed fabric in real time during mass production. Figure 3 shows an image of a sample fabric. Because of the roughness of the fabric and thin thread, the dyeing becomes uneven, and it can be seen that it blurs.

Black, red, and blue are good for monochrome cameras, but it is difficult to get a clear image of yellow, so a color camera needs to be used. The left side of Figure 4 is the image obtained with the color camera. Although it is not possible to distinguish easily between the contrast and the printed color of the oblique lines produced by regularly woven fabrics, it is possible to obtain clearly distinguished processed images through simple image preprocessing as shown in the right figure.

Fabric printing is done within 1 ~ 2 sec. Therefore, detection of defective nozzle requires high-speed shooting, data transmission, and detection within 1 ~ 2 sec. Considering the line scan rate of about 140 kHz and the head moving speed of 1350 mm / s, image blurring is expected due to image shift of about 2 μm in the frame grabber. Therefore, when designing a standard pattern, it is necessary to correct the position of the image by inserting reference points and to make the pattern matching flexible. That is, it is necessary to preprocess the noise of the pattern and make the detection algorithm flexible. A machine learning algorithm that detects the abnormalities by learning the images continuously acquired during mass production will be needed rather than artificially setting the criteria.

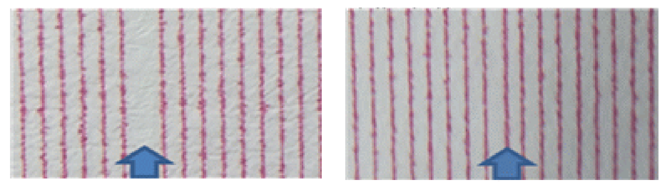

Figure 3. Nozzle clogging at left and nozzle deflection at right

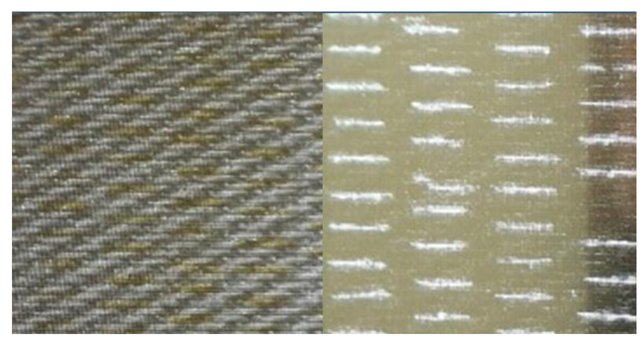

Figure 4. image processing before at left and after at right

4. CONCLUSION

In this study, we propose a method to acquire and analyze the image of fabric printed with standard pattern in order to detect the clogging of nozzle of DTP head in real time. As a result, it is possible to obtain a useful image by general commercial camera and simple image analysis, and it is confirmed that the position of defective nozzle can be sufficiently detected through the analysis.

If this can be used, the production facilities can be unmanned, and if the discharge amount of adjacent nozzles can be individually controlled, it is expected that the quality can be maintained without stopping production

ACKNOWLEDGEMENT

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