On-line Wide Format Printer Diagnostics

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Abstract

For years, wide format printer manufacturers have capitalized on the usefulness of on-board densitometers in closed loop process control. Image quality and repeatability have benefited from this on-going monitoring and adjustment process. Based on this success, many manufacturers are considering expanding the on-board and on-line options to include a variety of diagnostic capabilities for use during printer set-up, periodic performance verification, and troubleshooting during field service visits.

This paper will cover the use of several common imaging and instrumental modalities in on-board and on-line diagnostics for wide format printers.

Introduction

On-line diagnostics for wide format printers can range from simple laser units to measure media cockle and print registration to systems that use multiple cameras to capture images across the web and then use them to perform more elaborate image quality measurements.

Use of Lasers

Laser triangulation units can be mounted on the print head or on the cross bar. They can be used to measure height changes across or along the print. Topographical changes are most frequently seen when a high volume of ink is applied or when the environment is very humid. The humidity or high ink load can result in paper cockle or buckle. Cockle is characterized by a macroscopic dimpling of the media. It is a relatively low frequency variation and is measured easily by using a laser triangulation system.

Figure 1. Illustration of side view of cockled paper

As the paper is advanced through the printer, one or more lasers can be triggered to capture data points at specific locations at specific time intervals, or a laser can be mounted on a print head and data points can be captured while the print head shuttles back and forth. These grids of points and profiles can be translated into height information that can indicate the magnitude of the paper deformation objectively and repeatably. Multiple lasers can allow for comparative measurements between printed and non-printed areas for additional diagnostic information.

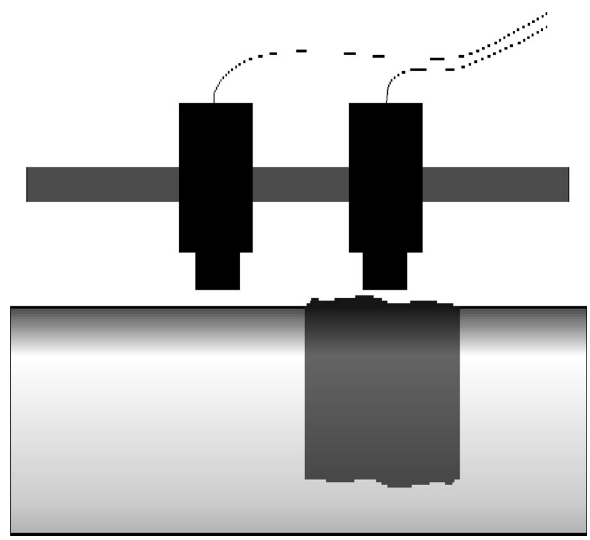

Figure 2. Lasers for comparative cockle measurement

Since paper cockle can be seen on both the top and bottom surfaces of the media, the laser could also be mounted on the underside if this is more acceptable for a particular printer configuration.

This type of measurement is most useful in assessing media compatibility, but it is not the only use for lasers on-board wide format printers. Lasers can also be used to identify the locations of the edges of media to synchronize start of print signals on each pass.

Use of Area Cameras

2-D CCD cameras can be used to image a variety of attributes from color registration to print head alignment and registration. In development, 2-D camera based systems can be used to measure other attributes such as bi-directional motion control, jet testing and dot morphology.

The following figure (figure 3) includes examples of several attributes that are commonly assessed on wide format prints that could be assessed on-line.

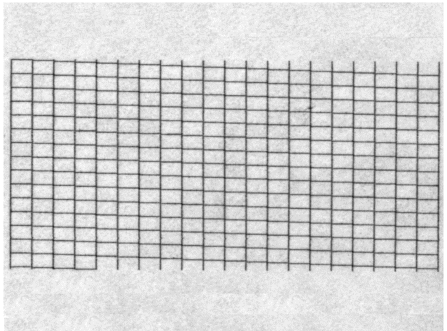

Figure 3a. Jet health test looking for missing, weak or mis-directed jets

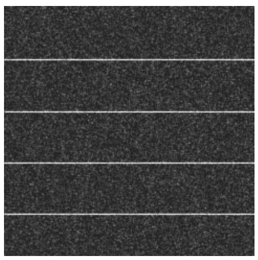

Figure 3b. Banding caused by a missing jet or non-optimized motion control

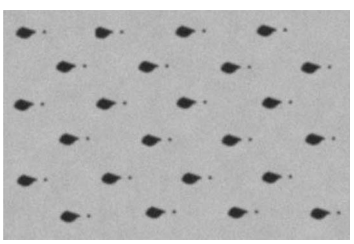

Figure 3c. Dot shape and satellite formation

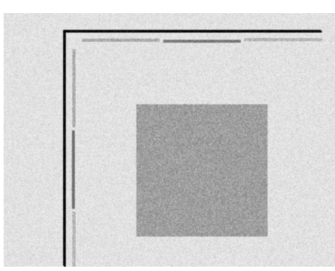

Figure 3d. Horizontal and vertical color registration

As the previous figure shows, 2-D cameras can be used to capture images for any measurement that can be performed in a finite location.

As in the case of the laser systems discussed in the previous section, multiple 2-D cameras could be mounted across a printer to improve system efficiency. Various attributes could be measured at different locations. Using a combination of cameras could be quite beneficial since it would allow printer performance assessments by using just a very small swath of printed attributes between jobs. This approach could minimize substrate waste and the time required for off-line analysis.

For example, macroscopic measurements such as solid area mottle and microscopic measurements such as dot shape and satellite assessments could be performed on images captured with different 2-D cameras located at different positions across the printer. In these examples, different cameras are necessary since different fields of view and different magnifications are required.

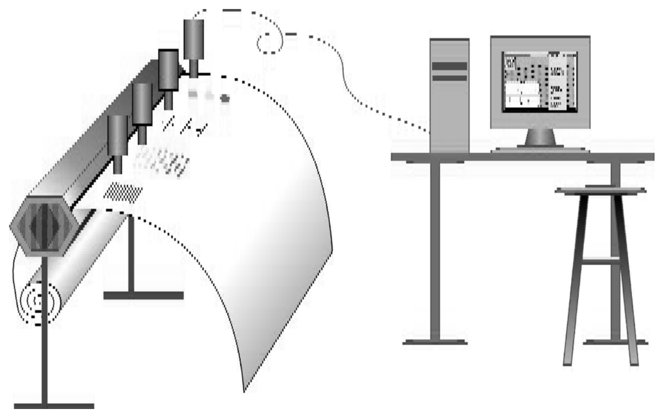

Figure 4. Multiple camera solution for on-line analysis

Another application for multiple 2-D cameras is multiple print head alignment. For printers that use multiple print heads across the web, print head alignment is critical to the output quality. A 2-D camera can be placed at each junction between print heads to measure alignment and give immediate feedback to the production engineer or the field service engineer.

Figure 5. Print head alignment

A more economical solution would be to use just one camera and position it at various locations across the web to image each of the junctions between print heads, one at a time.

Although 2-D cameras would be perfectly well suited for a flat bed printer, roll-to-roll printers or roll-to-basket printers might not have sufficient sample flatness (to ensure alignment with the CCD array) to produce good quality images. Focusing or illumination variations could affect image capture quality across the field of view, and could subsequently impact measurement results.

Use of Line Scan Cameras

1-D CCD cameras (also called line scan cameras) are relative newcomers in the field of image quality analysis instrumentation. 1-D cameras require motion control to build up 2-D images. Since wide format printers rely on encoders to control motion accurately, a 1-D CCD camera can be synchronized to the printer's encoder for image capture. Another option is to introduce an independent encoder for the line scan camera to avoid image contamination from any motion errors that the printer may have.

Line scan cameras can be used to capture images of attributes that require larger areas to measure properly. For example, dot placement accuracy usually requires the image capture and analysis of a large field of dots imaged at high magnification. Similarly, motion quality assessment requires image capture of a ladder chart or similar target where distances between adjacent marks are measured for both periodic and random variations. These line arrays are usually quite long in order to account for periodic motion errors.

Use of a 2-D camera would require a step and repeat image capture method followed in most cases by image stitching. This method is time consuming and frequently introduces errors of its own. The line scan camera captures one single image--no image stitching is required. This increases speed and decreases image capture errors as long as the motion is well synchronized and controlled.

Given the same multiple-print head alignment application as described in the 2-D camera section, a line scan camera could be used to image across the web using its own encoder and axis of travel. A single image could be captured of each junction and alignment could me measured automatically.

Line scan cameras only require one "line" of focus and of illumination so the systems are quite stable and are equally applicable to both flat bed and roll-based printer systems.

Next Steps

Lasers are already in common use in wide format printers for alignment and edge verification. For camera systems, mounting issues and camera weight and obtrusiveness have impacted the attractiveness of camera-based options. However, 2-D cameras are now available "on a chip" which has provided much smaller and less obtrusive options to the industry. While traditional 2-D and 1-D cameras might be included on-line for analysis and verification in some applications and environments, this miniaturization may increase the feasibility and use of on-board and on-line imaging-based analytical tools.

Conclusion

Multiple imaging modalities exist for image capture both on-board and in-line on wide format printers. Existing analytical software can be used for image quality analysis. Applications ranging from system verification during production to field service may benefit from this type of analysis. Many wide format printer manufacturers use visual assessment as the basis for printer verification and testing. The inclusion of quantitative, objective analytical systems and methods can augment traditional methods and enable clearer communication between vendors, field service engineers and customers.

Biography

Mr. Kipman is the founder and president of ImageXpert Inc., the industry leader in automated image quality inspection systems. Mr. Kipman founded ImageXpert in 1989. Over the past decade, Mr. Kipman has guided the company to the forefront of the image quality industry. ImageXpert now offers a diversified product line that addresses the needs of a wide range of markets including image quality and related fields. Mr. Kipman holds a M.S. in mechanical engineering, with a major in electro-optics from the University of Connecticut and a B.S. from the Technion Institute of Technology.