Automating Quality Analysis: Toward a New Paradigm in Ink and Toner Assessment

Ronald Rezachek, Katun Corporation, Minneapolis, Minnesota, USA

Abstract

As a major distributor of parts and consumables for ink and toner based imaging systems, assessment of source materials is a priority in vendor selection, qualification and on-going quality control. The sheer volume of prints necessary for comprehensive analysis is prohibitive when it comes to manual measurement or visual inspection.

In order to provide the best quality products and to improve our internal tracking and communication, we have updated our inspection process to include automation of image quality measurement.

Working with a test equipment supplier, we have integrated a flatbed scanner-based system into our process that we use in conjunction with specialized color and density measurement equipment to provide a wide range of image quality measurements for both toner and ink based prints.

This move toward automated, instrumented analysis has improved the efficiency and repeatability of our inspections, and has enabled us to comply with industry-standard measurement methodology. In addition, the new system has allowed us to increase our throughput while providing us with a wider range of analytical data specific to each printing technology.

This paper will detail several of our assessment methods for both toner and ink-based prints, and will discuss the benefits we have achieved as a result of implementing these new processes into our workflow.

Introduction

We are using a flatbed scanner-based system to automate image quality measurement for our toner-based products. By replacing our manual methods, we have increased throughput and efficiency and we have expanded the number of measurements we make per print.

Toner

Previous Inspection Process

For our main measurements we used a handheld MacBeth densitometer for density measurement and a brightimeter for measuring background or fogging, both manual processes.

New and Additional Assessment Methods

The main measurements we look at with toner samples are the image density and the background level. We also measure resolution, tone reproduction, and character consistency.

Typically we compare all measurement results against the OEM to determine our performance level. In addition, by archiving our results, we can better track our performance over time.

Toner Test Target

The test target we use most commonly combines many print quality features in a single document. Figure 1 shows a small reproduction of the target.

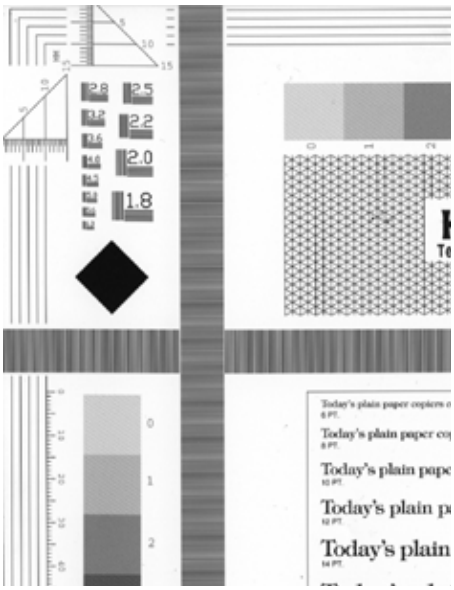

Figure 1. Toner test target image

Density

Since scanners are not densitometers, measuring density with a scanner requires a translation curve. By determining the transfer function between the gray values returned by the scanner and the corresponding density values, a transfer curve can be built and integrated into the software for seamless analysis and reporting of estimated densities. Since all of our manual measurements have relied on a MacBeth densitometer, we did try to match the MacBeth density scale as much as possible with the transfer curve we apply to the scanner output.

For our density measurements we measure gray averages and use an integrated transfer curve to automatically translate the gray averages to density equivalent values from within the image analysis software.[1,2]

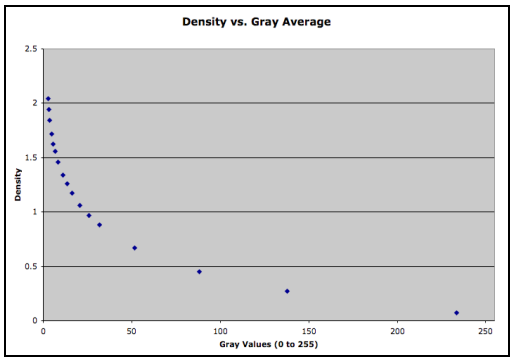

Figure 2. Example of a density transfer curve

Solid Area Density

We scan the image at 200dpi and measure solid area density in four locations per page. The differences in the values indicate the level of uniformity.

Tone Reproduction

The tone reproduction step wedge is repeated in four different locations per page. The density of each patch is measured in each location on a low resolution scan (200dpi), and the average values are reported.

Figure 3. Tone Reproduction

Resolution

To measure resolution, we measure both horizontal and vertical patterns. We are using two different measurement methods. Using bands analysis, the pattern is split up into “light bands” and “dark bands”. The average width of the dark bands and the average width of the white bands are measured and recorded and are divided to get a ratio.

The other method is to calculate the Contrast Transfer Function (CTF) on the 4.0 pattern. This requires the translation of data into density space.

CTF=Dmax(line)-Dmin(white)/Dmax(line)+Dmin(white)*100 (1)

Background

For measuring background we are using a region of interest (ROI) in the center of our test target that is about one inch square. We scan the area at 1600dpi. After setting the threshold in the center of the gray scale range (a value of 128), we measure the area of the background spots and report the background area as a ratio of the total ROI area.

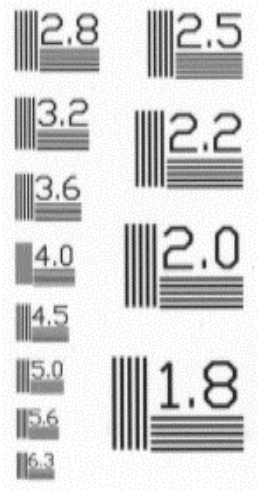

Figure 4a. Resolution targets

Figure 4b. Resolution target 4.0 scanned at 1600dpi

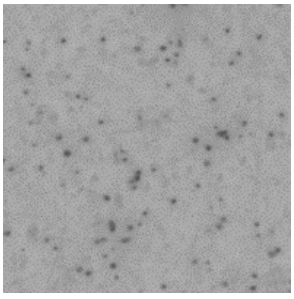

Figure 5. Background

Character Consistency

To increase efficiency by decreasing the amount of high resolution scanning required on the document, we only look at one character, the 8 point lower case letter "f" and only the positive character. We scan the character at 1600dpi. We measure character perimeter length, area and darkness. We also look for breaks in the character.

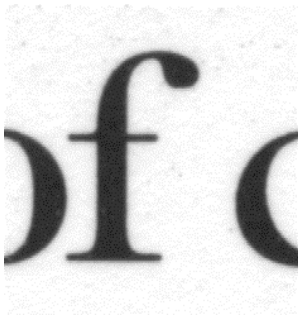

Figure 6. Character example

OCR

In able to fully automate the measurement process, we are using optical character recognition (OCR) to identify the type of sample, which then automatically selects which measurement set to run, and then assigns a file name to the recorded data.

We have a label printer that we use to print the pertinent information relating to the test; test conditions, machine used, date, test environment, type of test, sample number, machine count...etc. We scan this area at 400dpi and the ImageXpert software automatically decodes this information.

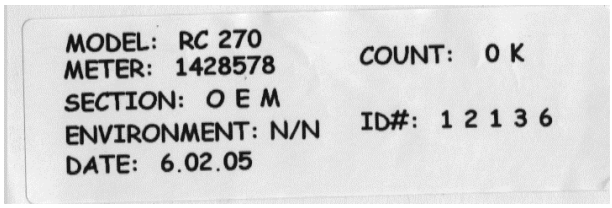

Figure 7a: Label for OCR

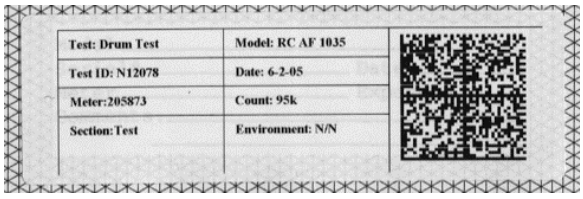

Figure 7b. Data matrix barcode example

We are in the process of developing a new labeling system that will use two-dimensional Data Matrix bar codes to identify the samples and record all pertinent information about the samples in a more space-conscious manner. The scanner-based system can automatically decode these barcodes and use the information to choose the relevant tests and to label and annotate data files. Not only is the 2-D data matrix pattern smaller, but decoding the barcode is more robust than relying on OCR which is more highly dependent on the quality of the training set for any given font.

Ink Jet

Previous Inspection Process

Historically, most of the assessment of ink jet print quality has been visual, although we have also applied some manual density measurements.

New and Additional Assessment Methods

We are developing tests for automating ink jet analysis. We will be including some of the standard characteristics of that technology such as color density, inter-color bleed, and some checks to make sure all nozzles are functioning.

Internal Standards

We have had standard testing procedures that we have used for many years in terms of sampling rates and image quality attributes. Since image quality is so dependent on the paper, we also have standardized the paper we use in our testing. We use paper that would most likely be used in the customer's setting, 20#, 84 brightness, standard bond paper. That paper is used for the copy runs, as well as the samples that are measured.

Typically, depending on the printer, the print modes used for the print testing are chosen to match the print modes most likely used by the customer. These print modes are then used for the OEM baseline testing (benchmarking) and the product testing.

By standardizing our print quality testing procedures and by using instrumented analysis, we are improving our inspection consistency and beginning to archive comparative data which will allow us to better track product performance.

Benefits

Using an automated system has provided us with many immediate benefits.

For example, we are able to take more density measurements per sample than we used to because of the automation of the measurement process. It is just as efficient to measure several patches and this decreases the impact of noise on our results making our conclusions more robust.

The use of the IX system has increased our efficiency in that it has reduced the amount of man-hours required to measure samples, especially on longer run tests. Because the system is automated, our throughput has increased as well. Now a whole stack of samples can be placed into the automatic document feeder on the scanner before the technicians leave for the day and the scanned results will be ready for analysis the following morning.

The use of an automated system will also make it easier for us to comply with industry standards, because the required measurement procedures and techniques can be implemented into the scanning program once, and provide consistent measurement results, as opposed to the variability inherent in use of manual test equipment.

In addition, it reduces the amount of training required for technicians needing to run the standardized testing and it makes it easier to implement any changes needed in the measurement process to comply with changes made to those standards.

In terms of consistency and repeatability, the fact that we use an automated system has greatly increased our ability to record more accurate and repeatable results.

Future Development

Standards

We are working on setting up ASTM F 2036-04 right now. The standard requires measurement of background in four locations on a specific target as well as image density over the page.

Color Toner

Assessment of color toner is a new and growing area for us. We have not yet implemented the scanner system although we will certainly be integrating it for color toner inspection once we identify the measurements that are critical to our process. We are currently using two different X-Rite Spectrodensitometers for assessment of color toner output.

Ink Jet

In addition, we will be working to integrate automated ink jet testing as our product line grows.

References

1. Yair Kipman, et al.,Scanner-Based Image Quality Measurement System for Automated Analysis of EP Output, Proc. SPIE Vol. 5294, p. 102-113. (2003).
2. Birger Streckel, et al., Objective Print Quality Measurements Using a Scanner and a Digital Camera,, Proc. DPP; pg. 145. (2003).

Author Biography

Ron has worked as a Senior Technical Analyst at Katun for the past 5 years. His work in the R&D Lab focuses on analysis of photoreceptors, drums unit cartridges, imaging unit cartridges, and charge components. Prior to joining Katun, he was employed by Unisys as a large-scale computer technician for 2 years, followed by 10 years at Ricoh Corporation where he serviced digital and connected products. Ron's formal education is in electronics, and his current interests include the application of image quality analysis and Six-Sigma quality techniques.