Efficient and Accurate Microfilm Conversion

Edge Scanning vs. Ribbon Scanning

The most critically important topic often overlooked when considering scanning microfilm is, how effective is the scanner at detecting individual frames of data. The two common detection techniques used today by microfilm scanner manufacturers are Edge Detection and Ribbon Scanning. Edge Detection uses last century's components and technology whereas Ribbon Scanning defines the state-of-the-art way to capture microfilm in the current digital age.

Before making the decision to acquire a microfilm scanner, you must determine which type of scanner is best suited for your scanning conversion task. Understanding the different types of frame detection that different microfilm scanners use should be the key indicator to determine your final selection. This is, by far, the most important decision that you will make in selecting a microfilm scanner. Making a correct decision at this point is going to dramatically affect the capture accuracy and overall conversion efficiency of your conversion process.

Most entry-level film and fiche scanners are designed only for on-demand use. They employ what is commonly known in the industry as "edge detection." Edge Detection Scanners use Area Scan Cameras. Area Scan Cameras contain a matrix of pixels that capture an entire image of a defined area that is directly in front of it. Area Scan Cameras are best suited to only capture stationary objects. This requires that each individual microfilm image be stopped accurately in unobstructed view of the Area Scan Camera. Additionally, if the desired target area is not properly aligned and positioned precisely in front of the limitations of the Area Scan Camera, portions or the entirety of the desired capture area will be missed.

Edge Scanning technology utilizing Area Scan Cameras also use software to detect the gap between frames, in an attempt to discriminate between the end of one frame and the beginning of the next frame. Unfortunately, when using this process there is no way for the user to know if every image was captured or which images may have been missed, partially or totally, without checking and comparing each microfilm image to the individual files that were outputted as a result of the scanning process. This totally defeats the original purpose in using an Edge Detection Scanner as an "automatic" film scanner. It would be faster and more accurate to manually scan and output each image. However, if on-demand scanning is determined to be best for your requirements, NMS Imaging also offers award-winning desktop microfilm scanners from ST Imaging.

The alternative and only practical way to "automatically" scan microfilm is to use a scanner that employs a Line Scanner. Line Scan cameras contain a single row of pixels that can capture data at very high speeds. As an object (film image) moves past the Line Scan Camera it captures every single column of pixels and then, using software in the background, it reconstructs the image line-by-line. Line Scan Cameras are capable of very high-speeds because the microform is scanned while in full motion. Unlike Area Scan Cameras, a Line Scan Camera can expose a new image while the previous image is still transferring its data. This process of scanning microfilm with a Line Scan Camera is commonly known as "Ribbon Scanning". The end product of this process is one Gray Scale Ribbon that accurately represents the entire roll of microfilm, individual microfiche or individual aperture card.

It is important to understand the order in which the conversion process is accomplished using Edge Detection Scanning vs. Line Scanning. With an Edge Detection Scanner, the first thing that the scanner does is attempt to properly and accurately "frame" the image, or target data. Then the Area Camera captures what is in front of it. It then is saved in the designated file format. In the end, if the framing proved to be inaccurate, the missing or poor-quality image must be located and rescanned. It is simply illogical to attempt to frame first, capture second and then rescan problematic or missing images.

In the uncommon world of scanning "perfect film", where the film images are the same size and orientation with perfect spacing and blip marks from beginning to end, you could have about a 90% chance of you getting accurate results from any manufacturer's scanner that uses edge detection, but you will still likely have up to 10% rescans before you can verify that you have fully digitized a roll or fiche. If your film is similar to most collections in the world (different sizes, different reduction ratios, different spacing, skewed, too light, too dark, etc.), there is 0% chance you will get 100% accurate results from any scanner using edge detection, and you will likely have to manually rescan every image before you fully digitize that microform.

Are all High-Speed Line Scanners the Same?

Just because a high-speed microfilm scanner uses a Line Scanner doesn't mean that images can't be missed. Only true "Ribbon Scanning" ensures that every pixel is scanned and retained. There is only one manufacturer of high-speed line scanners that uses true Ribbon Scanning. Ribbon Scanning technology is a digital scanning technique that applies line scanning technology to capture all of the data for an entire roll of microfilm, from top to bottom, beginning to end. Ribbon Scanning cannot miss a single pixel, let alone an entire frame. Ribbon Scanning even includes all the spaces between the frames, with quality control being performed by a human operator AFTER the film is initially captured. When you ribbon scan microfilm, it allows you to guarantee that every roll or sheet that is digitized is captured 100% completely, and that there are no skipped frames, improperly cropped pages, etc. in the final images. True Ribbon Scanning produces files that are composed of data in RAW format, grayscale and uncompressed. Anything compressed in NOT a Ribbon File.

Some manufacturers that use "Strip Scanning" lead consumers to believe that they also perform "Ribbon Scanning" when in actuality they capture "Strips" of digital images and use post-processing to reassemble those strips to create a "Ribbon". When Strip Scanning, the files produced are compressed from inception (hence eroded in their image quality). Clearly, manufacturers of Strip Scanners understand the benefits of using True Ribbon Scanning and attempt to make the same veiled claim. However, Strip Scanning with post processing is not the same as True Ribbon Scanning.

Some manufacturers of high-speed microfilm line scanners that don't Ribbon Scan attempt to output images "on the fly" as the film or fiche passes through the machine. This only gives the scanner a single opportunity to perform its frame detection (the process during which the machine recognizes individual frames on a section of film and segments them into separate image files) as well as other necessary computer-intensive tasks such as de-skewing / cropping, sharpening, etc. If there is a change in density of the film (the difference between the lightest and darkest images), an image may be cut in half by a misfiring frame detection process or even skipped entirely. "Fixing" these types of mistakes requires the identification of a skipped frame (no easy task on a roll containing thousands of images), finding it on the physical roll (even harder), rescanning it properly, and manually inserting / replacing the rescans in the original batch of images – a very time-consuming and expensive proposition, which is why most conversion projects cut corners and don't do it.

By capturing each roll of microfilm or fiche as a contiguous "Ribbon", even the empty spaces between the frames on the film are captured in addition to the frames themselves. Frame detection can be performed as many times as required in order to perfectly capture every frame on the roll. Frame boundaries can even be redrawn by the operator by simply dragging them with a mouse. Scanner operators should spend the majority of their time QAing and tweaking images BEFORE they're output (not after), so there are no mistakes to correct in the final images.

NMS Imaging represents high-speed microfilm Line Scanners manufactured by nextScan. nextScan offers a family of different line scanners suitable for scanning various film formats. nextScan scanners are available with scanning speeds from 150ppm to 2,400ppm. All nextScan scanners use Ribbon Scanning technology. The task of microfilm conversion is too important and costly to rely on inaccurate and unreliable technologies. Regardless if your film is perfect or imperfect, the only way to guarantee 100% reliable and accurate conversion every time is to use Ribbon Scanning technology to create a full digital duplicate of each microform.

Because the cost of Area Camera components used in Edge Detection microfilm scanners are much less costly than Line Scan Cameras components, Edge Scanner are less expensive to manufacture and sell. The initial purchase price of a microfilm scanner that uses Edge Detection will always be less expensive than that of a microfilm scanner that uses a Line Scan Camera. However, the most expensive component of all microfilm conversion projects is the labor cost. When comparing the laborious process of using an Edge Detection Scanner that is slower and less accurate than a Line Scanner, using a high-speed Microfilm Line Scanner with Ribbon Scanning technology will prove to be far less expensive over the total cost of the project.

Lighting Systems – LED vs. LED with Strobe

All manufacturers of high-speed microfilm scanners tout that they use an LED Light Line to provide reliability and consistency of light quality. While this is true for all manufacturers of these scanners, all LED Lighting Systems are not equal.

nextScan is unique in that they incorporate the use of a Strobe with their LED Light Line to "freeze" every column of pixels being captured. The benefits of their lighting system, trademarked as LuminTec® is detailed in the following white paper as part of this primer on Efficient and Accurate Microfilm Conversion.

LuminTec® LED Light Line Illumination System for High Performance Scanners

Introduction

This white paper details nextScan's LED illumination system called LuminTec®, which effectively increases the real resolution by nearly two times in the scanning direction without increasing image file size.

During the scanning process for high-speed scanners, the source image is moving during the time that each scan line is being captured. This movement causes a blurring of adjacent scan lines and results in less than optimum image resolution. This reduction in image resolution can be as much as $^1/_2$ in the scanning axis because the source image is moving and therefore exposes two scan lines during the capture time of one. See Figure 1 and 2.

Scan Direction →

LuminTec®

Figure 1

Scan Direction →

Non-LuminTec® Illumination System

Figure 2

In Figure 1, notice that blurring does not occur with LuminTec Lighting because the pixel columns are frozen by the Strobe. In Figure 2, the fence blurs horizontally because the pixel column is moving during capture, which degrades the overall image. With LuminTec® the effects of the scanning movement are eliminated.

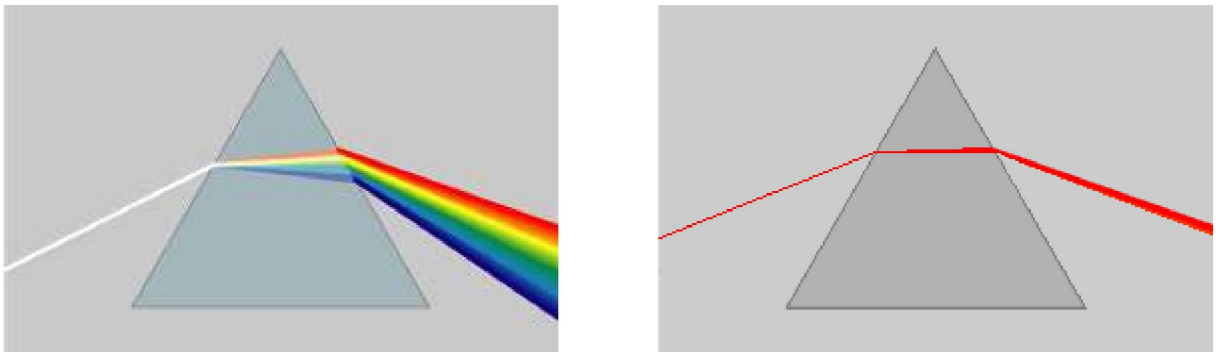
Strobe Solution

This movement and resultant blurring were resolved in the capture process by having a strobe light synchronized to the shutter of a camera to provide sufficient light for a very short exposure interval to "freeze" the moving object. Similarly, we can "Freeze" each scan line and increase our resolution by a factor of nearly two, by using the strobe effect. Only nextScan supplements the capture process with the use of a strobe.

Enter the LED

Enter the modern high-power LED. LED's can have the ability to be turned on and off in sub-microsecond intervals, which can effectively "strobe" each scan line freezing its motion. Additionally, they can be driven at 10 times their normal power levels for short intervals, as long as the average power consumption does not exceed their rating. The LED's have no infrared emissions, and as a result do not cause the sensor to have pixel-to-pixel bleeding due to heating of the photo sites.

Additionally, the LED light produced by LuminTec® is nearly monochromatic, meaning it contains only a single color. This helps the lens resolution because color correction deficiencies of the lens will not matter. Think of a prism and how it breaks up white light into the colors of the rainbow. This same effect happens in all lenses that have to deal with "white" light, which contains all visible colors. This spreading of the colors contained in white light causes individual pixels to be blurry. In the example below, a single pixel of white light enters the prism and is spread into its component colors which may cover several pixels. This



is especially true of microfilm media with its high reduction ratio and small pixel spot size.

nextScan use of high-quality optics and LuminTec® Lighting makes our lens perform better

The End Benefit

In the end, the nextScan LuminTec® Light Line yields the following benefits:

- Almost 2X the resolution in the scanning direction
- No Infrared emissions to blind the camera
- 100,000 hours Mean Time Between Failure (MTBF) vs. 2000 hours for incandescent systems
- 1/10 the power consumption and thus heat generation of incandescent illumination systems, resulting in higher MTBF of the scanner as a whole.

Feeds & Speeds – How Fast Is This Scanner

This is one of the most confusing and potentially disingenuous specifications for users to try to sort through. Let's first look at microfilm Line Scanners. Surprisingly enough, manufacturers of true High-Speed Microfilm Line Scanners appear to have agreed to rate their scanners based on a common measurable denominator. A claim of **XX**/ipm (images per minute) or **XX**ppm (pages per minute), assumes scanning 16mm roll film, 24X reduction ratio, scanned at 200dpi.

However, if your conversion doesn't fit this description for rated speed, all bets are off. If you scan 35mm microfilm, your scanning speeds are going to be dramatically decreased; the area of 35mm microfilm is over twice the area of 16mm microfilm, so it stands to reason that the time to capture over twice as many pixels will diminish by more than 50%. If you elect to scan at 300dpi instead of 200dpi, your speed just diminished by more than an additional 50%. What if you want to scan 35mm microfilm at 300dpi? Correct, your true speed just fell off the cliff. This why manufacturers like nextScan offer microfilm scanners with variable rated speeds that the user can select. Of course, buying a faster rated scanner is at an additional cost. However, unlike other manufacturers of high-speed microfilm scanners, nextScan gives the client the option to buy speed upgrades at any future time on most of their scanners.

When we examine claimed rated speeds for on-demand small desktop Edge Detection Scanners, it is anybody's guess as to what the basis is for the speed claims. There is no standard that is used, so the rated speeds that are advertised by all manufacturers are simply "theoretical". Some manufacturers claim an impractical speed of, "50 Pages per Minute" or "100 Images per Minute". When you analyze what they are claiming, simply think about what has to happen in that sixty second timeframe:

- The roll of film is loaded on the scanner
- The drive motor advances the film until the software detects a change between the density of the film leader and the density of what it perceives to be the first image and then stops the film.
- The scanner activates the Area Scan Camera to capture the area under the camera
- The scanned image is saved
- The drive motor then advances the film until the software detects another change between the density of the first image and the density of what it perceives to be the next image and stops the film.
- The process continues

Is it believable that this can happen fifty or one hundred times in sixty seconds? Maybe in a laboratory environment, with perfect microfilm that contains images that could have originally been check size documents (or postage stamp size), filmed in duo-duplex mode (two channels, one above the other so that two images are scanned at once), it may have been demonstrated once. None of the above is real world! Most conversions contain letter or legal-size documents, or larger, and the microfilm quality is less than desirable.

If you want to know what the true conversion speed of your microfilm will be, ask your vendor to scan your sample film and give you a written speed estimated based on your microfilm. Vendors can make any claims on a brochure; make them back them up!

External Storage Devices

Scanning of microfilm produces files that can be enormous in size. When using a line scanner, the original microfilm will be converted to one gray scale file that contains every pixel that was represented on the entire roll of film or microfiche. While this ensures that nothing visible on the original microform will be missed, the total number of pixels captured can be significantly large.

This is a topic that many vendors chose not to discuss with prospective clients because they do not have an elegant solution. However, this is a key component to any efficient high-speed microfilm conversion system that must be considered. nextScan offers External Storage Devices, marketed as a Ribbon Storage Device (RSD). The RSD is configured either as a Stand-Alone Tower or a Rack Mount Device in either an 8TB, 16TB or 36TB configuration. Multiple RSDs can be used for future additional total storage requirements.

An RSD is not just a collection of Hard Drives in an enclosure. The RSD consists of multiple high-speed drives in a RAID configuration; usually RAID 5. The RSD has its own Operating System, a SQL Database and multiple Intel Processors. The nextScan Scanner is connected to the RSD via an Ethernet connection. The RSD manages the workflow of the conversion process. It controls access to the Ribbons, State of the Ribbons in the process and Exporting of the Ribbons to their final file format. Ribbons can be output multiple times to different file formats, if required. Additionally, Ribbons can be maintained on the RSD to provide disaster recovery or archival storage. Many other vendors simply sell a large USB hard drive for external storage that has none of the same capabilities as an RSD.

When the scanning capture process is running, the "Ribbons" are simultaneously being written to the RSD. As soon as a Ribbon is finished being written to the RSD, it is available to any of the (5) PC Workstations that can be attached to the RSD. The (5) PC Workstation Software Licenses are included in the sale price of any nextScan scanner with RSD. An unlimited number of Workstation Software Licenses can be used at an additional cost for Software Licenses. Use of an RSD completes the components required to have a true high-speed microfilm conversion system. In this configuration, the most expensive hardware component (the scanner) can be kept running non-stop while the Auditing, QC and Exporting can be done at inexpensive workstations. One operator can load film on the scanner and then perform Auditing and QC while the scanner completes its task. In fact, multiple high speed nextScan Microfilm Scanners and easily be operated simultaneously by one operator.

When estimating the total cost of an in-house microfilm conversion, all of the above issues and configurations must be considered. All too often, clients simply compare the initial acquisition cost of one scanner to another and draw erroneous conclusions.

Please contact your NMS Imaging Account Executive for your free in-house evaluation of your needs and receive a no cost, no obligation analysis and quotation. We are the experts when in comes to Efficient and Accurate Microfilm Conversion.

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