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Frame Scanning vs. Ribbons Scanning

Different Technologies Very Different Results

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It is important to first understand that economical film scanning occurs in batch. The entire reel is scanned using pre-defined settings in an automated film advance mode. Scanning at rates from 100 to over 500 images per minute. While it is possible on some older machines and on reader printers to manually advance one frame at a time, adjust the settings, crop, rotate, adjust density and lamp, capture the image then advance to the next frame, this is a very time consuming and expensive process that yields at most 5 frames per minute. It is extremely rare to find an application where this antiquated process would still apply. Some companies may apply this technique for adhoc requests or for rescanning. The two production scan processes currently in place are *frame scanning* and *ribbon scanning.* Both technologies are available to scan each type of microform (microfilm, microfiche and aperture card)

Frame scanning technology has been in place since the first film scanners were created by Sunrise, Mekel and later by Wicks and Wilson and Nextscan. Frame scanners write data one frame at a time. In all cases there is a feedback to the CCD array (Camera) which tells it when to start scanning and when to stop. This defines the frame to the capture system. In the early days there was a separate optical sensor that was manually set by the operator. The operator visually defined a position on the film where the system would detect peaks in the histogram (see figure 1). Peaks in the histogram represented the black space between the frames on the film. These peaks were then used to fire the CCD array to capture the image. Later improvements allowed the operator to set the camera to fire a certain distance before the peak and stay on a certain distance after the peak. This separate optical sensor was placed upstream in the scan path about 0.5 to 1 inch in front of the CCD array. As the technology in frame scanners advanced, the separate sensor was removed and the CCD array did the detection at the software level. The operator, using a representative scan section of the film, analyzed the histogram to adjust the settings for the entire reel. These settings told the scanner when to start writing data and when to stop. At this point in time it was not economical or technically feasible to store the entire data stream. Since the data stream is not stored, frame scanners must process the images as they are scanned including any binarization, cropping, skew, mirror rotation, etc. This impacts accuracy and speed as this requires CPU cycles. It is not uncommon to slow a frame scanner by 66% by increasing the sharpening or switching to grayscale output.

Ribbon Scanning was first available in 2007. Ribbons scanning stores a single uncompressed grayscale data stream of the entire reel. Detection of frames and all image processing is performed as a separate auditing step on a completely separate machine. Not only does this allow the scanner to run at fully rated speed, but it allows the operator to correct for errors in frame detection. All ribbon scanners can also run as frame scanners.

Ribbon scanning technology is available as an optional upgrade to each of the manufacturers units created in the last 4 years. Reference the following documents for a more in depth discussion on ribbon scanning

http://www.pimage.com/Ribbon_File_Scanning.pdf
http://www.nextscan.com/pdfs/NextStar_White_Paper.pdf
http://www.thecrowleycompany.com/downloads/pdf/sell-sheets/MekelQuantum-SellSheet.pdf
http://www.wwl.co.uk/documents/VirtualScanstation.pdf

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Challenge - Missed Frames: The biggest risk with a frame scanner is if something on the reel is missed completely. Since a frame scanner only displays the frames that it actually writes to disk and since they can display on the screen at up to 500 images per minute, there would be no way for an operator running the scanner to recognize a missed frame. Typically frame and even ribbon scanning is run in unattended mode where the operator loads the roll, adjusts the lamp, starts the scan process, then works on another task for the next 20min to hour it takes to scan the reel. If a frame is missed on a frame scanner the only way to detect it would be if every frame was numbered on the film or if the operator compared the images to the original film using a reader printer. Rarely is film tagged with a sequential number on every frame and comparing images to film on a reader printer is exhausting and not economically possible. If the film is blipped (see Film Blip in Figure 1) frame scanners can be very accurate at detecting each frame by setting the detect band to detect on the blip, however it is not uncommon for a roll of film to have one or more frames where the blip was not present and in this case a frame scanner would miss the frame entirely. If the film is in good condition with consistent document types and no filming errors, a frame scanner should detect all of the frames accurately, there is just no guarantee unless someone was to review every frame of every reel prior to or subsequent to scanning. Figure 1 below shows the basics of film detection. It also shows an example of a good roll of film with consistent document types and sizes, consistent frame density and a leading edge blip. Notice that the film blip is technically not at the leading edge.

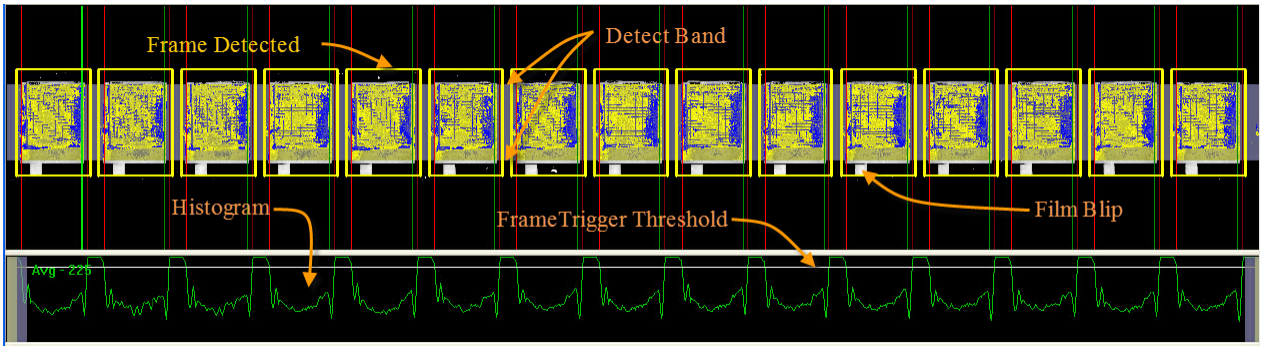

Figure 1

There are over 50 settings that affect frame detection. It is not automatic and it takes an operator with very advanced skills and lots of experience to set a frame scanner up for challenging film. Simple and consistent film, like the film described in Figure 1, can be setup relatively easily. On challenging film where frames overlap, positive and negative frames are present, photostats, engineering drawings and small receipts are intermixed in the reel, the setup can be very time consuming and in some cases even impossible. One of the major challenges comes when setting up a project or are reel. The operator has no idea what subsequent reels will contain, nor do they even know if the film will change mid-span. It is not uncommon for an agency to film open books in a two up format followed by engineering drawings, then finish off the reel with a box full of miscellaneous loose pages, receipts and inverted photostats. No single frame detection setting will capture all of these items when filmed on the same reel. A reel like this on a frame scanner would need to be scanned in three sections with three different settings.

Figures 2a shows how a frame scanner could entirely miss an image if it is two dark to trigger the frame detect threshold. It also shows how excessive skew can cause image crop and how frames too close together can cause them to be combined. These can all be easily recognized and corrected in the auditing process of a ribbon scanner as shown in figure 2b.

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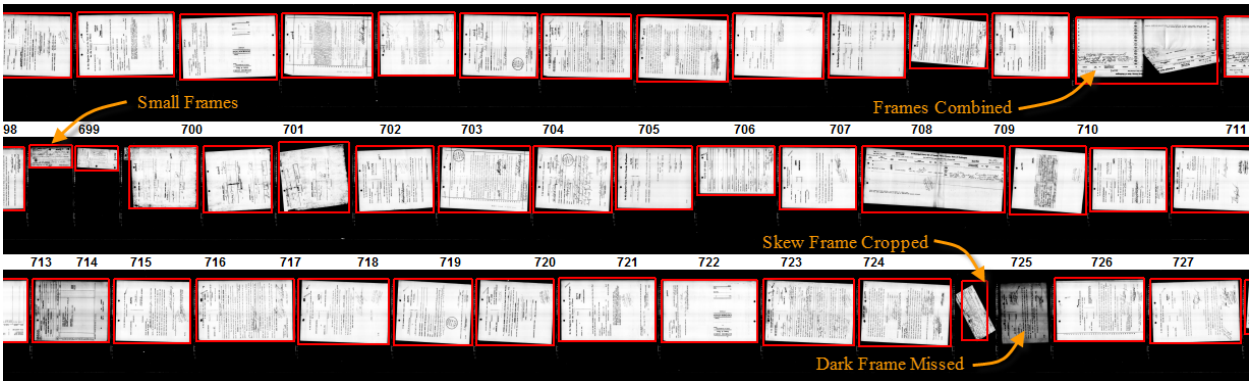

Figure 2a

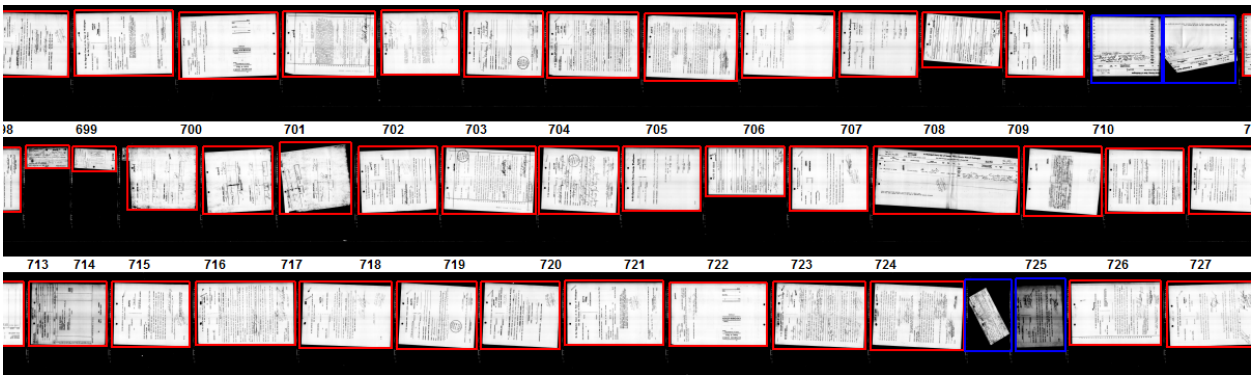

Figure 2b

Challenge - Cropped Frames: The second challenge with a frame scanner is not that it misses a frame but that it crops a frame. Since a full data stream is not present, the frame must be rescanned from the original roll. This requires the operator to reload the film, advance the roll to the particular frame then rescan and overwrite the individual frames. While it is possible to do this, if there are a number of cropped frames or the reel is very poor quality it can take longer to correct individual frames than it took to scan the reel in batch mode in the first place. Figure 3 shows how a frame scanner could improperly detect frames and as a result crop data, requiring rescanning. Each yellow box would output an image bound by that box, so all of the frames on the right half would need to be caught in QC and rescanned.

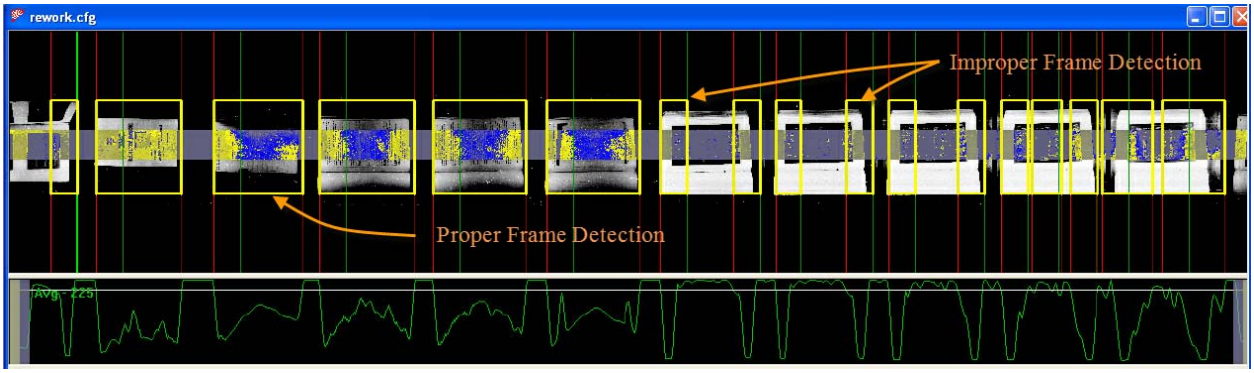

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Figure 3

Figure 4 shows how a frame with multiple polarity is improperly recognized by the frame detection algorithm. It is common to have a photostat (black with white text) taped into a book with white pages and writing on the frame around the photostat (white with black text) all on a roll of film with a black inter-frame gap. This can result in the text written on the white book pages to be cropped off.

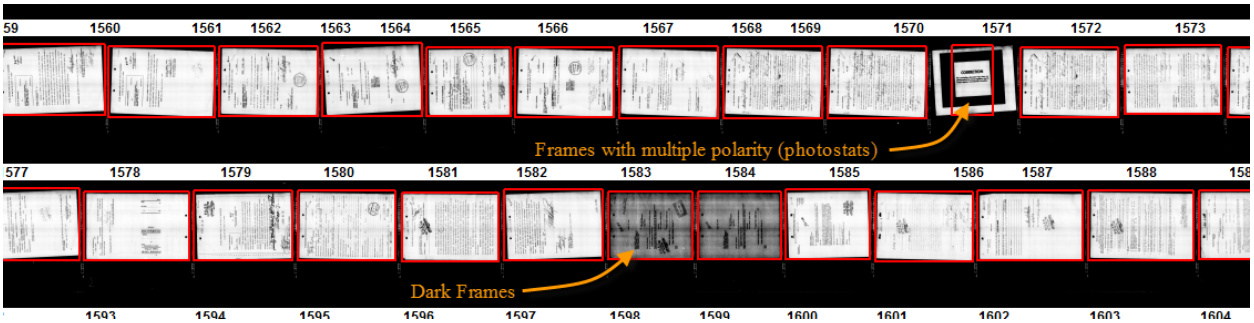

Figure 4

Challenge - Binarization: The third challenge is correcting for improper binarization. Binarization is the process of generating a monochrome (1bit image) from a grayscale image (12bit, 8bit or 4bit). Think of photocopying your driver's license. The text is generally legible but the photograph is a black blob. This is the result of improper bianarization. In order to capture the photograph you have to switch the copier into halftone or photo mode. True photo mode uses gray ink. Scanners have the same problem with binarization. Each scanner has software to create monochrome imagery from the grayscale data stream. Some do it better than others and all of them will have problems with specific types of documents. The accuracy of the conversion to monochrome largely depends on the skill and experience of the operator, the tools they have at their disposal and the budget they have to implement those tools.

Some frame scanners allow the operator to store both a grayscale and a monochrome versions however it significantly impacts frame throughput. In this case an operator could review every image and re-create any monochrome image from the grayscale, however the tools for this are generally not very good and the binarization is not dynamic, it is more trial and error. The operator could also elect to deliver the grayscale image in lieu of the monochrome where poor quality frames are encountered. The process of re-binarizing images to create a single highly legible monochrome archive is very time consuming, it could easily double or tipple the project cost and as a result most agencies are moving towards full grayscale scanning.

With ribbon scanning, the auditing process affords a dynamic process for re-binarization, allowing for more efficient and cost effective correction for poor quality originals or filming. (see the following video for a live demonstration of the auditing process Ribbon File Auditing) The two biggest challenges with binarization is inconsistent frame density between frames, like a blue or dark green form with faded text adjacent to a white page with high contrast black text or inconsistent density within a frame like the bottom pink copy of a multipart form having faint typed data where someone has written on the copy with black marker. Light date stamps, seals and signatures on pages with high contrast printed text can also be very challenging. If the operator increases the threshold so that the signature can be read, all of the text on the form will bleed together and become illegible. The best solution in these cases are to deliver these frames in grayscale.

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Conclusion: In conclusion, conversion service bureaus have struggled for many years with how to guarantee high quality data capture from microform. Prior to ribbon scanning it required many checks and innovative techniques to effectively simulate ribbon scanning by not cropping images and storing backup grayscale imagery. This required many hours of review and correction and some rescanning. Even with these techniques in place a frame could still be missed entirely and nobody would know. There are many image archives in existence today that were scanned from film with a frame scanner and are missing frames. Ribbon scanning eliminated this risk and provided the necessary, efficient tools to review and correct for errors in frame detection. It also afforded the operators the tools to dynamically adjust for skew, rotation, mirror, polarity and binarization. If an agency has any concern over the quality of their film, they should fully understand the advantageous of ribbon scanning over frame scanning and take that into account, particularly if they are considering a lower priced solution on a frame scanner that is using old technology.