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Information Management

White Paper

Focusing more on the forest, and less on the trees

Why total system image quality is more important than any single component of your next document scanner

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Evaluating total system image quality in an ADF document scanner

When choosing a document scanner, there are compelling reasons to focus on how total image quality impacts your business needs, not necessarily individual components or a specific component technology.

In today's 'go paperless' age, document scanners have become more popular than ever. That popularity means many more choices for information management hardware in the marketplace, and a tougher choice than even a few years ago.

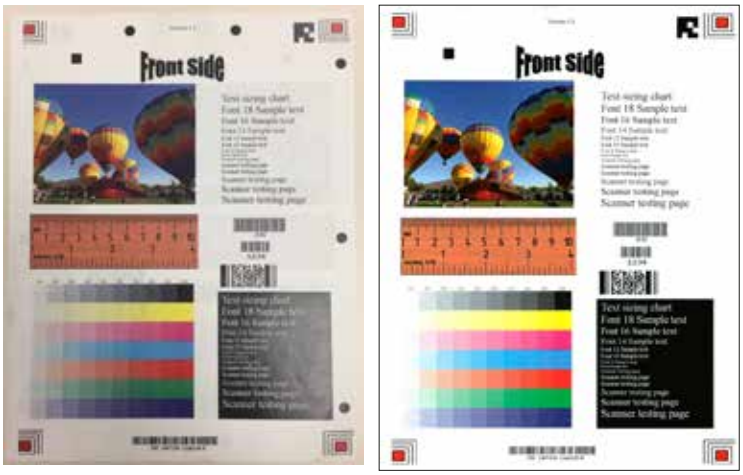
However, with so many scanners on the market — each leveraging various (and often proprietary) technology — there seems to be a focus on individual system components. But the ability to meet your business scanner needs, and deliver the best image quality, relies more on the total systems package and how they interact, rather than any one component choice.

First off, you want the best possible raw image to put into image processing. Which means imager type becomes a factor. There are several factors to consider when comparing these, and while Charge-Coupled Devices (CCD) were traditionally the easy choice, the arguments putting them ahead of Contact Image Sensors (CIS) no longer hold up.

High color gamut

This refers to how much of the full color spectrum can be reproduced — which translates to how many colors as well as how accurately the color reproduction is throughout the spectrum. Most scanner designs end up delivering their output images in SRGB color space – which looks good on a monitor, but inherently has a small color gamut. Both CCD and CIS systems are capable of rendering plenty of color gamut and neither has an outright advantage in terms of color fidelity. This is also a factor of illumination.

More often than not, manufacturers end up tuning their color gamma curves to eliminate the appearance of yellow or slightly blue tinged papers and the net effect is that some colors are lost forever regardless of the imager chosen. Optics and Illumination also play a critical role in determining what color gamut will get captured and then it comes down to how the software treats the raw image in terms of color look-up tables and color-space conversion. Bottom line? **Unless you're in the market for a very high-end fine-arts photographic scanner, and not one that handles a wide variety of everyday documents and photos, both CCD and CIS systems can deliver what's needed for optimum color.**



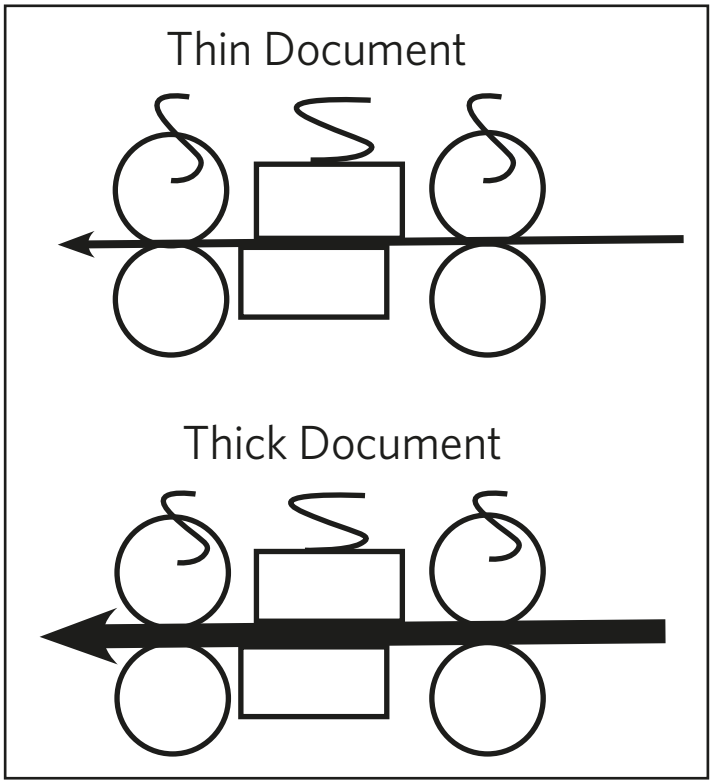
The color gamut of CIS systems allows faithful reproduction of colorful documents. Left: Digital photograph of test target. Right: Output image from CIS-based scanner. Image processing software is often used to produce images that are more pleasing than the originals, with increased saturation of colors, darker black tones, and lighter white tones.

Fast readout times

For many years, CCDs were the devices of choice because they made it easier to move data at high readout times. That technology curve has long since been conquered in terms of speeds needed for typical document scanners and, in fact, there are CIS assemblies available today that can scan over 400 ppm at 300 dpi.

Ability to scan documents of varying thicknesses

Most effective scanner systems that employ CIS imagers today also make use of versatile mounting schemes that are able to float one of the CIS assemblies in relation to the opposing imager. The net effect of this is a system that maintains the paper plane well within the needed focal range while still allowing extra thick or poor condition documents to pass through. This 'floating' or flexible image gap approach is made possible by the extremely light package-weights afforded by a CIS module in contrast to the weight and size of a CCD lens reduction camera system. In fact, several of the most recent competitive scanners that employ CIS technology can accept plastic ID cards of 1.2 mm thickness or more.



A flexible image gap in CIS systems allows thin and thick documents to maintain the paper plane as they pass by the imager. Springs attached to one set of transport components accommodates documents of varying thickness.

Additionally, with CIS technology the magnification from the document to the sensor is 1:1 and provides excellent, as well as consistent, X magnification along the entire length of the document. In the past, many CIS systems did not employ a floating mount system and this led to them having a reputation of not being able to handle severely wrinkled, folded or torn documents. Well-implemented CIS/paper-path systems no longer face these limitations and the X magnification results show near zero deviation from true 1:1 reproduction. Magnification accuracy in the Y direction (or "down the page in the direction the document is fed through the scanner") is not a factor of which imager type is selected, but rather how the paper drive system and paper path designs maintain the sheet's movement at a constant velocity while it is being imaged.

Another factor to consider is that CCD lens reduction systems lose sharpness as you move to the edges of the document due to optical falloff typical in their lenses. A SELFOC CIS lens delivers consistent sharpness or focus across its entire length with no change in the resolution or sharpness of an image as you go from edge to edge. The optical falloff in a CCD lens reduction system can also impact the dynamic range and signal-to-noise ratio performance at the edges of the image due to lower light levels passing through the lens the further you move away from its central axis (center of the page). Most CCD systems manage this well but the effects can definitely be noticed as you get out to 75 or 90% of the document width.

When it comes to scratches, dust and dirt, it was formerly thought that, because the CIS touches the paper, CIS imagers would scratch easier or create more dust. With regard to scratching, the CIS module floats scanned pages through, so there's very light contact pressure on the glass which means it's not any more scratch- or error-prone than its CCD counterparts. With regard to dust and dirt, some contact with the glass may actually offer an advantage because, if there is debris present, scanning acts like a snow plow, often pushing any dust and dirt collected out of the way.

CIS scanners produce high quality output images of documents containing text. Left: Digital photograph of test target, 8 pt text. Right: Output image from CIS-based scanner. Focus and sharpness remain consistent across the entire width of the image in CIS scanners.

Multiple-chip construction

A CIS module consists of several smaller chips which are seamed together along the full-page width. For example, a typical 600-dpi optical resolution CIS module for an A4 scanner usually consists of approximately 13 smaller chips that are seamed together. Manufacturing process improvements in the accuracy of this seaming have improved to the point where it takes a very deliberate test target to show where these physical seam points are at and this effect is not problematic to real images.

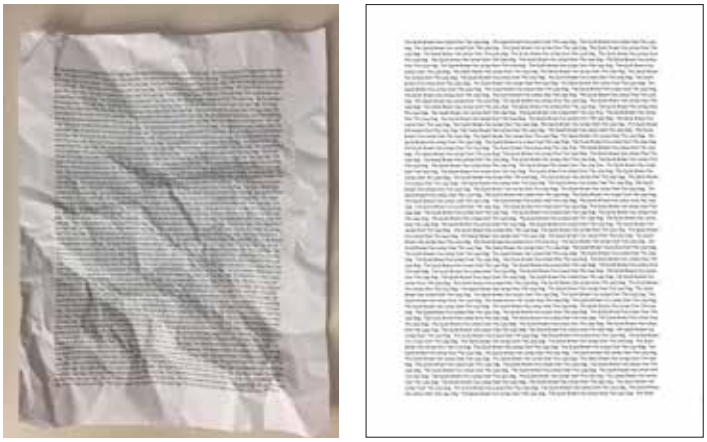
Larger focal depth/higher signal-to-noise ratio

Because of the lens reduction used in a CCD camera, versus the SELFOC lens type used on a CIS, CCD cameras have a larger depth of field and this difference still exists today. However, what's changed is **that improvements in SELFOC lens capabilities have expanded the depth of field in CIS systems to a point where this is no longer a liability**. Depths of field of 0.25 mm or greater are available and, when most papers being scanned measure less than 0.1 mm, this just isn't the concern it once was. Additionally, electrical charge generation from the CMOS sensor chips within CIS modules has also significantly improved, leading to better signal-to-noise performance overall.

Another factor that used to be a concern for CIS imagers is that their different elements would require more frequent calibration in order to keep their signal levels consistent over time. That drawback has been effectively eliminated through the use of mini-cal routines that can be done prior to every scan batch to maintain excellent consistency across all the individual chip elements. These routines are employed automatically in software without any intervention by the customer and, with more powerful processing power, today's scanners can do this without penalty to scanner throughput performance.

Again, there's more to the story than the imager. Today's scanners leverage a number of other components that level the playing field by compensating for any perceived shortcomings. There are also several factors that may directly impact your business application for your scanned documents. For example, an architectural or engineering firm may have different needs and tolerances than a medical facility. With that in mind, the other factors to consider when choosing an ADF scanner include:

- **Illumination:** single vs dual sources, and where they are in relation to the paper; LED white vs RGB
- **Paper feeder:** how does the paper move through the machine, and how will that impact different paper shapes, sizes, and quality of original documents
- **Scanner mechanics:** motor selection, control practices (micro stepping, frequency matching for vibration, etc.), belt-tensioning and roller nip-force control
- **Image processing:** delivering the best image and data contained within it is as much about how the image is processed and how data is extracted, as how good the starting image was. Scanner functionality to also consider which will affect the overall quality of the images processed include:
  - > OCR and barcode reading
  - > Background color smoothing
  - > Streak detection and removal
  - > Binarization
  - > Color dropout
  - > Deskew and cropping
  - > Image uniformity



Illumination system and transport design of CIS scanners handle poor quality input documents with ease. Left: Digital photograph of crumpled test target, 8 pt text, showing wrinkles and shadows. Right: Output image of same document from CIS-based scanner with dual LED illumination. The flexible image gap keeps the document flat to the glass while scanning, and within the needed focal plane.

Where CIS is today

Typically, a CIS will deliver equivalent Image Quality and throughput performance at a mere fraction of the power it takes for a comparable CCD Lens Reduction system. It takes a good deal more illumination in a CCD system that has to transmit light through a lens and onto a much smaller pixel site. This power savings can be a significant portion of the total power usage for a typical desktop scanner. The size difference is also a big reason most manufacturers will consider CIS an advantage, especially as customers demand more compact, higher-performance desktop scanners.

Conclusion

While it may have been an issue ten years ago or more, today, creating the optimum image quality for customers is no longer defined by the type of imager. CIS technology has come a long way in regard to solid reliability and craftsmanship, scanning speed, signal-to-noise ratio, imaging uniformity, geometric accuracy, color fidelity and registration, and resolution capabilities. And with LED illumination replacing the fluorescent tubes of previous generations, resulting image quality is on par, if not ahead.

These advances in technologies, now available on scanners of all sizes and capacities, can provide the highest quality images, most reliable performance, and an overall better value to customers than ever before. So when selecting a scanning solution to meet your budget and document scanning needs, look for an information management provider that will deliver the best data capture for your business — one providing industry-leading scanners, software, and services to support your capture needs for years to come.

Want to learn more?
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