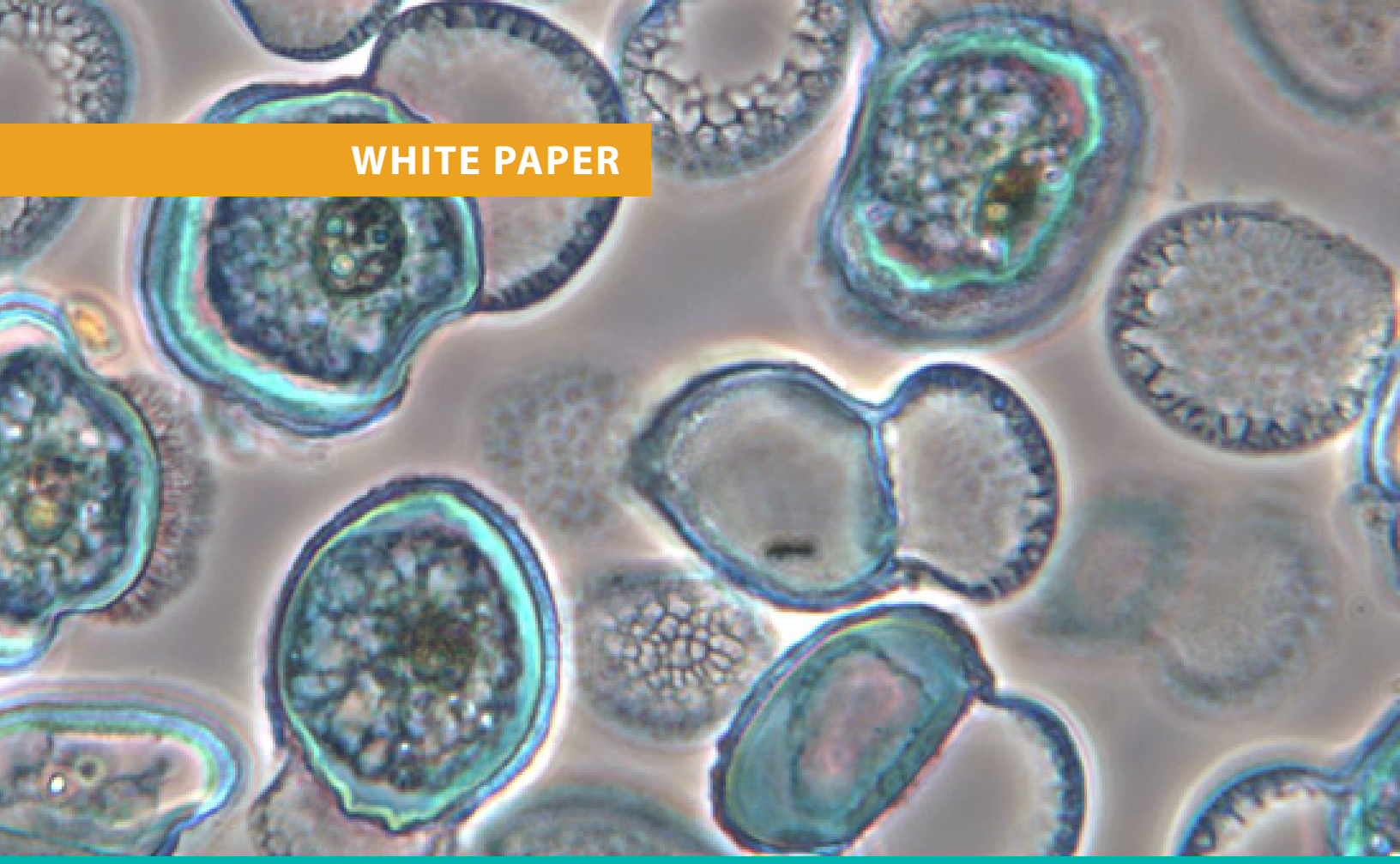
WHITE PAPER



SPOT IMAGING™
Take a closer look

WHAT TO CONSIDER WHEN IT IS TIME TO REPLACE YOUR DIGITAL MICROSCOPE CAMERA

What to consider when your digital microscope camera is out of date.

A high quality research or pathology microscope can last for decades; however, the same is not true for digital microscope cameras. Just like a computer or many other laboratory instruments, a microscope camera has electronic components, firmware and software that can become dated 3-4 years after purchase as new technology enters the market.

Microscope camera replacements can be postponed for a while but, generally speaking, they should be replaced with an updated system every 4-8 years, depending on the product. State-of-the-art replacement digital cameras are available at affordable prices therefore the most important consideration is how to improve and streamline your workflow.

Improving and streamlining your workflow relates to the following:

1. Speed and quality of image acquisition without the need for manual adjustments,
2. Intuitive nature and ease of use of the software,
3. Compatibility with projection on a larger screen for teaching or consults,
4. Compatibility with the Windows 10 operation system as your institution upgrades from Windows 7,
5. Use with a small form or laptop computer for space saving and work outside of the laboratory,
6. The ongoing and reliability of support, remote upgrades or on site assistance, provided by the camera provider.

This white paper will explore digital microscope cameras and purchasing considerations.

What to consider when purchasing a replacement digital microscope camera.	
Category	**Components**
Usability	• Ease of use • Short learning curve • Software specifically focused on streamlining pathology workflows
Image Quality	• Color • Fluorescence • Flat field • Resolution • Sensitivity
Live Preview and Speed of Acquisition	• Frame rate • Global shutter • Continuous auto-exposure with manual offset • Digital zoom and pan
Streamlined Pathology Workflow	• Barcode accession including cases • Parfocal image capture • Auto-calibration • Auto-archive • Auto-image flat field correction
Infrastructure Fit	• Microscope • 1080p and 4K UHD monitors • LIMS interface • IT operating system (OS) and other infrastructure, such as small form or laptop computers
Comprehensive Pathology Workflow	• Integrated pathology image management both grossing and microscopy
Support by network and imaging experts throughout the life cycle	• Evaluation • Specification • Installation • Training • Service and support

Staying with a Camera based on Older CCD Technology and Software Designed for the Research Market

At its introduction, cameras based on CCD technology (what we call the previous generation) took the industry from the inconvenience of running wet labs to process film to a revolutionary new digital workflow for still capture. This first generation of digital cameras got nearly any user an image; what one did with that image depended on how much time they had to manually manipulate the image file.

"…It is the ability to easily interface with the LIMS to allow a user to quickly and easily take a picture and have it be stored as a record. Every click, every second of time adds up – assuming all the functionality is there, ease of use is most important…"

Thomas J. Gniadek, M.D., Ph.D., NorthShore Medical Group

Sensors: A Brief Technical Note

Digital cameras contain a sensor, a solid-state device that captures the light required to form a digital image. Previous generation cameras use a sensor based on CCD (Charge-Coupled Devices) technology that requires specialized silicone and fabrication. Over time CMOS (Complementary Metal–Oxide–Semiconductor) streaming technology sensors were developed and are currently on their fourth generation, such as the Sony Pregius®.

Introduced in June 2009, scientific complementary metal-oxide-semiconductor (sCMOS) technology is based on CMOS image sensor design and fabrication techniques and offers several advantages over previous CMOS- and charge-coupled device (CCD)-based sensors for many applications. sCMOS sensors are used in fourth-generation cameras.

The big advance in sCMOS over CMOS is the addition of circuitry and Graphical Processor Units (GPUs) directly on the sensor that runs complex noise correction algorithms. This results in a new standard in speed and low noise making the cameras that incorporate these sensors fast and sensitive while reasonably priced. The sCMOS sensors allow live feed and computer control over images, automation of many image adjustment features and compatibility with the latest presentation devices.

Usability

Continuing to use a previous generation camera means you are already familiar with the system and its limitations. Software interfaces are typically imaging tool boxes designed for the larger bioresearch market and not specially designed for pathology production line applications. These types of software have a lot of bells and whistles that are rarely, if ever, used by a pathologist and the suboptimal flow can add minutes to each case, eventually adding up to hours each day.

Many microscope manufacturers still use the fixed-video format and CCD sensor technology (see Technical Note) and although buying into older outgoing technology may seem easier and work for the short term, in the long term it will be a roadblock to the adoption of new streamlined work practices.

Image Quality, Live Preview and Speed of Acquisition

For some applications, such as laparoscopy and arthroscopy, cameras with CCD or older CMOS sensors and a fixed-video format are the best design. But it limits automated computer control over:

- Image format,
- Digital zoom,
- Annotations,
- Measurements,
- Frame rates,
- Color balance,
- Color correction,
- Exposure and gain.

For a pathologist who reviews many slides daily this is not ideal, and a time sink. Non-automatic image correction requires post-acquisition manual adjustments adding minutes/image with a significant impact on work time. Lack of high-speed continuous auto-exposure and limited live frame rates also negatively impact the workflow adding more seconds per objective change. In addition, image fields of view are a fraction of the eyepiece field of view.

At A Glance: A Comparison of Older and Next Generation Digital Microscope Cameras with Accessories and Software

Previous Generation Digital Microscope Cameras	Next Generation Digital Microscope Cameras
CCD sensor	sCMOS sensor
Functional limitations	More functionality
Requires full size computer tower, control box, power supplies and cables	Uses standard small form computer or laptop with USB 2.0/3.0 ports
Does not support 4K UHD monitors	Support 1080p and 4K UHD monitors
Fixed-video format limits computer control over many image functions and requires manual image adjustment	Bidirectional data communication allows live functionality and image control eliminating manual adjustments
Slows workflow	Streamlines workflow
No case-wide barcode accession	Case-wide barcode accession
Generic bioresearch focused software tool box	Software specially designed for pathology workflows
No LIMS interface	LIMS interface
Requires separate cameras for brightfield and fluorescence	Cameras support both brightfield and fluorescence

Streamlined Pathology Workflow
If case barcode scanning processes are not available, such as in systems with older technology, information must be hand typed, wasting more time, creating stress, and potentially leading to typographical errors and misfiled images.

Infrastructure Fit
Cameras from this era required a lot of descrete support electronics that were integrated onto separate plug-in cards that in turn require full size tower computers, control boxes, power supplies and a myriad of cables to connect them all. Workspaces become cluttered and cost is added

These cameras also used CCD sensor which cannot simultaneously do both high resolution and high frame rates or live work. These low-resolution sensors do not support the latest 4K UHD monitors and presentation systems, thereby forcing the use of less interactive and less engaging multi-head

microscopes instead of projection for teaching and consults. The introduction of sCMOS and other proprietary technology that SPOT Imaging incorporates into their systems make high resolution live teaching and consults possible.

Older image management software lacks an image archive management system. Without a uniform central system for organizing and maintaining patient images, time is wasted retrieving images and can result in lost images, a disaster in a clinical setting. Other disadvantages include the lack of a LIMS interface to automatically port images into diagnostic reports, an important influencer of hospital satisfaction surveys.

CLIA certification must also be taken into account and may be impacted by the least expensive alternative for teleconferencing interfaces in lieu of high-resolution video feed. Commonly, teleconferencing interfaces use video compression on high-bandwidth live-image feeds resulting in garbled image detail. Continuously changing software revisions and interface features also must be considered. Lack of high-video frame rate and high-fidelity audio reduce communication clarity and the absence of hospital level security architecture can lead to breaches of the network's IT infrastructure and data.

SPOT Imaging Simplifies Digital Pathology with Sophistication

As an early adopter of sCMOS sensors, the next generation of imaging technology, SPOT Imaging continues to leverage their engineering expertise, knowledge of pathology workflows and the latest processing power to produce pathology-focused solutions within a shared software environment. Ease of use, streamlined workflows and the ability to easily share and save images are only some of the advantages of the digital cameras based on the latest sCMOS technology.

Usability
Higher sensitivity sCMOS sensors support brightfield and fluorescence imaging with one camera not only saving the purchase cost of a second camera but also adding the bonus of not needing to switch cameras, or learn and use two camera interfaces.

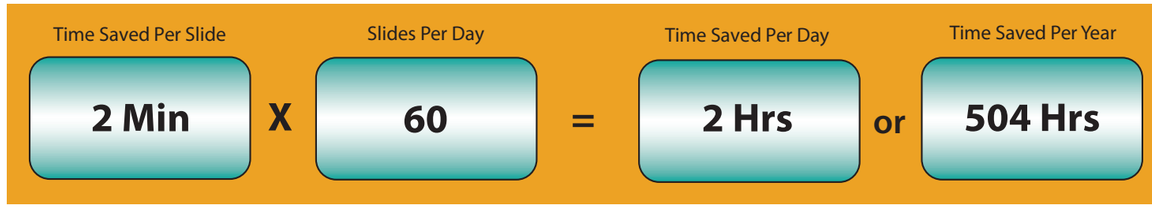


Figure 1 In studies SPOT Imaging found that using PathScope™ for routine microscope imaging saved an average of two minutes per slide.

SPOT Imaging's PathSuite™ software and hardware environments are designed for pathology workflows with optimized interfaces that present only the tools required at each stage of the imaging workflow, eliminating distracting extraneous features. Repetitive actions are automated as illustrated in Figure 1.

Image Quality, Live Preview and Speed of Acquisition
As chip makers push the boundaries, SPOT Imaging has implemented many customized technical advances. SPOT Imaging leverages the graphics processor to enable high resolution at full frame rate, live image zoom and pan, live ICC (International Color Consortium) color correction, and live annotations and measurements.

Auto-flat-field correction eliminates image corner darkening and post-acquisition image adjustment for color issues. Differential staining in live consultative sessions is supported as well as the capability to add notations to presentations.

The USB 3.0 port provides bidirectional data communication supporting continuous auto-exposure to speed up the imaging workflow and provide superior professional presentation.

Streamlined Pathology Workflow
The adjustable C-mount camera adapter provides focus parfocal with the user's eyepieces to reduce specimen refocusing for the camera acquisition; the new adapter's magnifications better match the eyepiece field of view capturing more of the specimen in images.

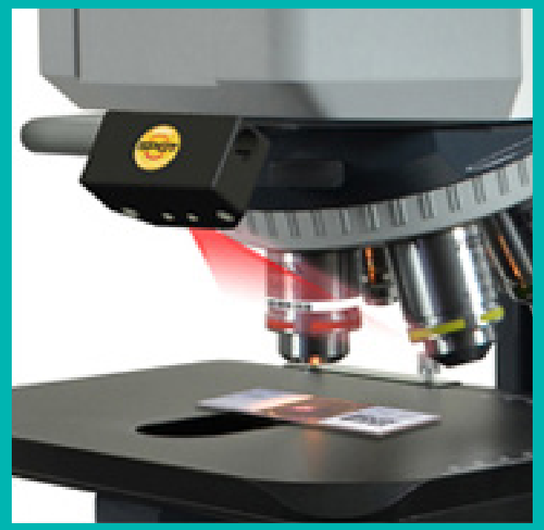
A case barcode reader eliminates typos and other human errors. A case-based image archive management system autosaves images with easy access supporting the complete case image archive.

Infrastructure Fit
SPOT Imaging cameras, accessories and software are designed to support current infrastructure and make life easier. They fit existing microscopes on a desk or a laboratory bench, grossing hoods and interface to LIMS systems.

The commonly used, built-in USB 2.0/3.0 ports allows the use of standard small form or laptop computers and eliminates the need for external power supplies and control boxes, ridding clutter and decreasing costs. New adjustable C-Mount camera adapters provide configurations to support virtually any microscope model allowing quick digital camera upgrades. The computer-optimized optical designs use precision manufactured optical and machined components.

The standard high resolution sCMOS sensors offer many benefits, including the support of 1080p HD and 4K UHD projection formats for teaching and consults. More fluid live modes for presentations result from higher data transfer rates and increased frame rate.

LIMS interfaces facilitate the inclusion of images in patient reports increasing patient satisfaction and hospital ratings.



Automatic Magnification Tracking

One-Click Image Capture

Figure 2 The PathScope microscope imaging system streamlines workflows allowing capture, accession, and sharing of high quality images. Barcode scanning enables auto-accessioning of the case data. The HistoSnap button allows image capture without looking up from the eyepieces. The microscope objective tracker saves the magnification used for later addition of accurate measurements. Image files are automatically saved to a file server or LIS.

The intuitive software interface was designed for pathology with icons focused on the most common pathology tasks. Sharing images securely with remote colleagues is as easy as selecting their name from the software. Integrated audio and annotation tools make it simple to collaborate and consult.

Support by network and imaging experts throughout the life cycle

Software is provided as a service to lower the initial acquisition cost per seat, ensure no cost updates including OS upgrades, and continuous access to the SPOT Help Desk Team, with dedicated technical support for digital pathology image capture. Unlike microscope providers who service many industries, SPOT Imaging focuses on pathology.

"…When I was looking for a camera the Indiana Center for Biological Microscopy recommended SPOT Imaging cameras. They also advised to go with a company that gives good service and technical support. I am less interested in how the camera works than when I flip it on it does work every day because a patient is sitting in a bed waiting for a result..."

Carrie Phillips, M.D., Indiana School of Medicine

PathCast™ for Telepathology

PathCast is SPOT Imaging's specially-designed video conferencing telecommunication application for pathology. Using the PathCast interface can be simpler than ZOOM video conferencing, just click and join on the spot without pre-scheduling or emailing invitations.

Constant high-resolution video feed with the latest Dot 264 compression provides high video frame rate for peer-to-peer data transmission. Audio is high-fidelity with half duplex echo suppression increasing communication clarity. A communication industry standard concept, half duplex audio, was implemented to eliminate the feedback echo that happens when the microphone on the listening person's computer picks up the transmission and sends it back to the source. Half duplex audio turns off the listening computer microphone until transmission from the speaking computer has been silent for, typically, 0.6 seconds. The turn off and turn on continues stopping any echo feedback.

PathCast ensures CLIA certification of systems is maintained and defendable with fixed revisions and interface features along with HIPAA compliant data masks and storage modules. Tucked behind the institution's firewall PathCast ensures hospital level security architecture guards against data hacking.

SPOT Imaging Digital Microscope Camera Portfolio
SPOT Imaging's digital microscope camera portfolio covers the range of needs for clinicians.

	Microscope Cameras 5 Mp / 1080p HD Projection Designs			
	SPOT	**Olympus**	**Nikon**	**Optronics**
	Insight 5.1Mp	DP27-5Mp	DS-Fi3	Microcast Pro HD
Camera Price with Software	Moderate	High	High	Very High
Full Sensor Capture Resolution	2448 x 2048 (5.0Mp)	2448 x 1920 (4.7Mp)	2880 x 2048 (5.9Mp)	No Capture
Full Resolution Live Frame Rate	> 60 fps	15 fps	15 fps	60 fps
Presentation Mode 1080P HD	2448 x 1377 (oversampled 1080 HD)	1920 x 1080 (1080 HD)	1440 x 1024 (1.5 Mp)	1920 x 1080 (1080 HD)
Presentation Mode Frame Rate	> 60 fps	22 fps	30 fps	60 fps
Continuous Auto Exposure	Continuous Auto	Not available	Not available	Continuous Auto
Software designed for Pathologist	Pathology Software	No Pathology Software	No Pathology Software	No Pathology Software
Sensor Technology	sCMOS	Discontinued CCD	Discontinued CCD	CMOS
Fluorescence Imaging	Excellent	No	No	No
Sensitivity	High	Low	Low	Low

Summary
Microscope manufacturers are undeniably experts in their field of microscopy; however, designing digital cameras for the pathology market is not their prime focus. Instead most products are produced with the more lucrative bioresearch market in mind.

An expert in imaging pathology workflows, SPOT Imaging's specialty is digital microscope cameras and optimized software including telepathology applications. As chip makers push the boundaries, SPOT Imaging takes advantage of the leading-edge technology and leverages it to the advantage of pathologists. With tens of thousands of placed digital cameras, SPOT Imaging's cameras provide more capability with less effort on behalf of the pathologists, streamlining workflows.

SPOT IMAGING™
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