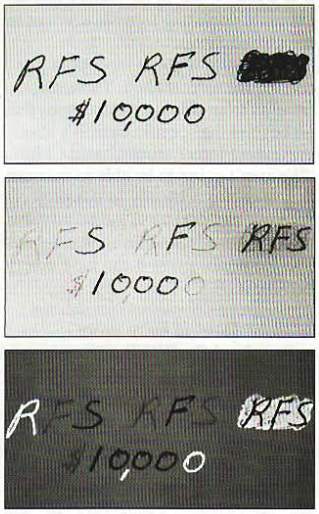
BEYOND VISIBLE LIGHT

The Fujifilm FinePix S3 Pro UVIR for the forensic-document examiner and forensic photographer

Written by Gerald B. Richards, MS

THERE IS SOMETHING NEW under the sun—relatively speaking—for the forensic-document examiner and the forensic photographer. For quite a few decades, these two groups of professionals have been using conventional film as a mainstay for examining evidence that is beyond the visible (VIS) spectrum, which is about 400 to 700 nm (nanometers). The areas most applicable to using film are the long-wave ultraviolet (LUV) spectrum, which is approximately 300 to 400 nm, and the near infrared (NIR) spectrum, which is approximately 700 to 1100 nm.

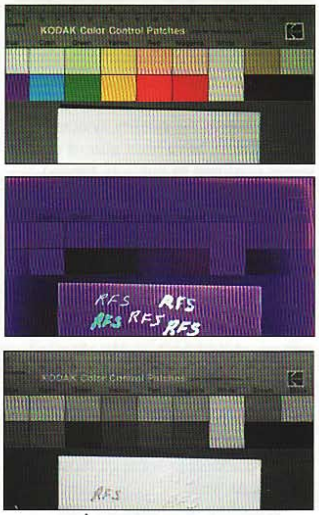


***Top Photo**—Text made with three different pens as imaged in the visible (VIS) portion of the spectrum. (87C filter on camera; incandescent lamp with 60-watt bulb; shot with f/5.6 at 1/180 second).*

***Middle Photo**—Same document but using near infrared (NIR) reflection imaging. (87C filter on camera; incandescent lamp with 60-watt bulb; f/5.6 at 1/180 second).*

***Bottom Photo**—Same document but using infrared luminesence (89B filter on camera; painting with blue Mini Maglite flashlight; f/2.8 at 20 seconds).*

Silicon-based, real-time television systems have been utilized since the late 1970s as a substitute or replacement for film. Also, many enterprising individuals have taken conventional CCD (charge-coupled device) cameras and removed the blocking filters in front of the sensors so they could accept ultraviolet and near infrared energy. Most CCD sensors are sensitive to energy from approximately 380 nm to 1000 nm. All three imaging systems—film, TV, and converted CCD cameras—have a number of advantages and disadvantages.



***Top Photo**—This photo is of a color chart with card containing text written with UV pens. (UV/NIR cut; VIS pass filter on camera; incandescent lamp with 60-watt bulb; f/4.6 at 1/45 second.)*

***Middle Photo**—Same document but using UV luminescence imaging. (UV/NIR cut; VIS pass filter on camera; 15-watt fluorescent black light; f/4.8 at 1/60 second).*

***Bottom Photo**—Same document but using UV reflectance imaging. (18A filter on the camera; 15-watt fluorescent black light; f/4.8 at 1/15 second).*

What we really want to talk about today is the new kid on the block: the Fujifilm FinePix S3 Pro UVIR camera. On this dedicated, commercially produced digital single-lens reflex (SLR) camera, the manufacturer intentionally avoided cluttering it up with blocking filters—and they optimized the camera's CCD sensor for use in the LUV, VIS, and NIR portions of the spectrum.

These specific design elements make the FinePix S3 Pro UVIR a new breed of camera.

In September of 2006, just after the camera's introduction, I was asked by Penn Camera to test and evaluate the new S3 Pro UVIR from the perspective of a forensic-document examiner and photographer. Based on this initial evaluation, a number of things became apparent, the foremost of which was that the camera had little value without additional equipment that would support its basic function of imaging in the LUV, VIS, and NIR portions of the spectrum. Penn Camera has since put together a camera, lens, and filter package designed specifically for forensic-document examiners and the forensic photographers. Interestingly, this special package is also useful for applications such as art and medical photography.

The S3 Pro UVIR camera is not a turnkey system

A photographer who is thinking about buying this particular camera should be aware that a good understanding of ultraviolet/near-infrared imaging and photography is necessary in order to be immediately successful. Otherwise, one must plan on using the camera as a means of acquiring that knowledge over a period of time. When using this camera, examinations and experimentation are conducted by manually changing filters, camera settings, and various lighting techniques. In this way, it makes an excellent learning tool.

There are some frequently asked questions regarding this camera. This is

one of them: "Will the S3 Pro replace or be a substitute for the Foster & Freeman VSC or other LUV/NIR imaging systems?"

The answer here is not clear-cut. The VSC is a highly automated system with numerous push-button control features and a wide variety of filtering techniques that make it an outstanding examination tool. On the other hand, it is expensive and relatively bulky for fieldwork. Although both systems will provide LUV, VIS, and NIR images, each has specific advantages and disadvantages. Cost obviously must be taken into consideration, along with the individual's requirements and skills.

Setting up the imaging system to fit your needs:

The first order of business would be to select a lens. The S3 Pro uses a Nikon lens mount, a feature that provides a relatively wide selection of lenses. I tried a Nikon 60mm f/2.8D AF Micro-Nikkor; a Tamron SP AF28-75mm f/2.8 XR Di Macro; and a Tamron SP AF17-50mm f/2.8 XR Di II. Each lens was evaluated at working distances for covering areas ranging from a 3-in. signature to an 8.5 x 11-in. sheet of paper, the most common image sizes for the forensic-document examiner. In addition, each lens was evaluated as to whether it formed a "hot spot" when images were produced using NIR reflectance. This is somewhat common with lenses not specifically designed for NIR.

For my work on a copy stand, I found that the Tamron SP AF28-75mm f/2.8 XR Di worked best with a copy stand working distance of approximately 13 in. for the signature and 22 in. for the full sheet of paper. Thirteen to 22 in. is reasonable for subject-to-camera distance, lighting, and viewing through an eyepiece or viewing screen.

Although all three lenses showed some hot spots with NIR reflectance, none were objectionable enough to override the good working distances. (There may be other lenses that offer a similar working distance but with a lesser hot spot or none at all. This, of course, would be a whole project in and of itself.)

The next thing needed is a good, sturdy copy stand on which to mount the new camera and lens. I have used a Canon copy stand and a heavy-duty tripod successfully *(Photo 1 on Page 34)*.

Tips on how to create the right lighting

We will need some energy—or lights—in the parts of the spectrum that our system will be imaging. Normal, incandescent light bulbs will work great for reflective imaging in the VIS and NIR portions of the spectrum. For LUV imaging, most "black" lights will work well, and they do not need to be expensive. I normally use two 15-watt florescent black lights that I purchased for approximately $20 each from a local hardware store.

The most difficult problem is usually finding a good blue/green light source to produce and image luminescence in the NIR. For this work, I prefer to use a very powerful portable handheld LED light, with 4 watts of optical power, from Light Diagnostics in Murray, Utah. This light is reasonably priced at about $800 and is great for both laboratory and fieldwork.

If you are on an extremely tight budget and would still like to produce NIR luminescent images, the S3 Pro provides an old-fashioned photographic means to this end. The S3 Pro will only allow a 30-second time exposure due to the heat produced by the sensor—but if you work at /f2.8 in a dark room, you can use a small blue/green flashlight to "paint with light". This technique of painting with light will produce quite acceptable NIR luminescent images, such as those used in the discrimination of inks by forensic-document examiners. The flashlight that I found to be most useful for this paint-with-light purpose is the blue L.E.D. Upgrade from Nite Ize, Inc. for the AA Mini Maglite. It is available for about $10 if you already have the $20 Mini Maglite. So, with a 60-watt incandescent white lamp, a 15-watt LUV florescent lamp, and Maglite upgraded with a blue LED, you are essentially in business as far as light sources are concerned.

Obviously, you can expand the intensity, variability, and functionality of your light sources as far as your budget will permit. After all, a $5,000 or $10,000 alternate light source (ALS) is difficult to beat—but not everyone can afford it.

Peca	Kodak Designation	Approx. Band Pass (nm)
900	18A	250 - 390 and 680 - 750
916	VIS	400 - 750
902	70	680 and up
912	88A	715 - 1120
914	89B	710 and up
904	87	760 and up
910	87C	800 and up
908	87B	400 - 435 and 910 and up
906	87A	910 and up (steeper slope than 87B)

***Chart 1**—This is a list of the nine filters that Peca Products offers, along with their Kodak equivalent numbers and their approximate band passes in nanometers (nm).*

Peca	Kodak Designation	Approx. Band Pass (nm)
900	18A	250 - 390 and 680 - 750
916	VIS	400 - 750
914	89B	710 and up
904	87	760 and up
910	87C	800 and up

***Chart 2**—If your budget is restricted, you should be able to obtain reasonable results with the five filters listed in this chart.*

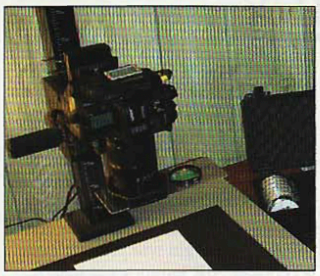


Photo 1—*You will need a good, sturdy copy stand—similar to the one shown here.*

The necessary filters for your photo-imaging session

The third facet of our imaging triad—and perhaps the heart of what we can do with the basic imaging system and energy sources (lights)—is composed of the special filters. These are used to restrict the wavelengths of light that we need in order to reach the sensor and do the job we desire.

Until recently, finding filters that can be used for LUV, VIS, and NIR examinations with an imaging system such as the S3 Pro was perhaps the biggest obstacle. There was no single source for most of the filters required for this work and suitable for cameras—and it was impossible to find a set of filters in one package. However, when the S3 Pro was introduced, Peca Products, Inc. saw an opportunity and produced a full set of filters for this camera in both 52-mm and 62-mm sizes. (It should be noted that the 52-mm filters may have some vignetting, depending on the focal length of the lens being used. The 52-mm filters are less expensive, however. The nine filters that Peca Products produce and sell can also be obtained as a package through Penn Camera. Chart 1 on Page 33 shows the Peca filters, and their Kodak equivalent numbers.

One of the great things that Peca has done with these filters is to provide on their website both a spectral transmission chart and table for each filter. This allows the forensic-document examiner or forensic photographer to see exactly what type or amount of energy is passing through the filter. Unfortunately, Fujifilm has not provided a spectral curve for the camera sensor, which would be helpful in matching the light sources and filters with the S3 Pro.

There are many filters and filter combinations that can be used with this camera, only limited by imagination, budget, and need. However, if budget is the main issue, a forensic-document examiner or forensic photographer could obtain reasonable results with just the five filters listed in Chart 2 on Page 33.

The value of a homemade filter slide

Although the filters can be threaded into the lens, changing them can be difficult and time-consuming. To make things easier, I devised an inexpensive solution—but it does take a few shop tools or crafting skills.

I produced a filter slide by purchasing a Cokin P filter holder and 67-mm lens-adapter ring. Such a holder is available for about $25 in most camera shops. The slide uses the bottom slot of the Cokin filter holder. The slide itself is made from a sheet of aluminum or stiff plastic. I used aluminum since I have the tools necessary for cutting light metal. The sheet needs to be .06 in. thick and 3.25 in. wide by 8 in. long *(see Photo 2)*. There will be two holes. Each hole will have a diameter of 2 in.

They should be centered on the 3.25-in. width of the slide—and be set in 2.25 in. from each end of the slide. The holes may need to be sanded to make them slightly larger so the filters will fit loosely in each hole. A small hole can be drilled at the very edge of the length of the slide, 1.0 in. from each end, with a small screw and nut inserted to act as a stop to center the slide hole with the lens opening. Again, this filter slide is not necessary to make the system work, but it does make life a little easier.

Summary

Fujifilm's FinePix S3 Pro UVIR can be a great asset to both the forensic-document examiner and the forensic photographer. Almost all of the UV/IR images traditionally obtained through film or television systems can now be captured in near real time at an excellent resolution. In addition, the Fujifilm FinePix S3 Pro UVIR system is reasonably priced, extremely portable, and has the added advantage of being available as a conventional camera for documentation when filtered properly. Although this is not a turnkey camera system, the serious examiner or photographer will find it a powerful tool that can provide many interesting images.

Useful inks to pertinent websites

FinePix S3 Pro UVIR Camera
www.fujifilmusa.com/S3ProUVIR

Penn Camera
www.penncamera.com

Foster & Freeman
www.fosterfreeman.com

Light Diagnostics
www.lightdiagnostics.com

Nite Ize, Inc.
www.niteize.com

Peca Products, Inc.
www.ir-uv.com/IR-UV%20Filters.htm

About the Author

Gerald (Jerry) B. Richards served as a Special Agent with the Federal Bureau of Investigation (FBI) for 23 years until his retirement in 1993. During this time he received three years of training in document and photographic examinations at the FBI Laboratory. After working as an Agent Examiner for several years, he was promoted to Unit Chief of the Document Operations and Research Unit and then later transferred as Unit Chief to the Special Photographic Unit. He currently teaches a three-credit-hour distance-learning course on the Technical Aspects of Questioned Document Examinations for Oklahoma State University. He also works as an examiner of documents and photographs under the business name of Richards' Forensic Services in Laurel, Maryland. He can be reached by telephone at the following number:
301-725-3778

***Photo 2**—This is the homemade filter slide described in the text of the article.*