Infrared Photography

Physical evidence documentation through forensic photography remains one the most important aspects of crime scene investigation. Subsequent analysis of photographs will often yield clues investigators can use to reconstruct the events of an incident, or may provide the proof necessary to gain a conviction at trial. Traditional photography records images in the visible light spectrum, and typically will record on film or in a digital file that which the human eye can see. Forensic photographers are often challenged with evidence where traditional photographic techniques are unsuccessful at documenting the evidence necessary to reconcile the facts of a particular case. For years forensic photographers have had a variety of specialized techniques available for documenting evidence under challenging situations. Infrared photography can be used in a variety of these situations to gain result that could not be obtained by photographing in the visible light spectrum.

Infrared techniques can be applied in the field or in a laboratory environment. In some instances the only opportunity to document the evidence is in the field at the crime scene. Until recently the only available option to the forensic photographer involved infrared techniques that used conventional film sensitive to wave lengths of light in the infrared range of the electromagnetic spectrum. Complicated workflow often made this technique difficult and expensive to utilize, and lead to underutilization of the technique. Advances in technology have now made digital imaging options available to the forensic photographer for performing infrared photography in both a field or laboratory environment. In many cases the digital workflow will yield results that are equal to or better than results obtained using traditional techniques.

Comparing the workflow of film techniques verses digital techniques will help the photographer gain a better understanding of the uses and limitations of infrared photography in a forensic environment. Infrared photography has a variety of forensic applications using reflected infrared photography and infrared fluorescence photography. Forensic applications examined here will include document examination, aerial photography, bloodstain documentation, gunshot residue, biomedical photography and surveillance.

Figure 1 – Electromagnetic Spectrum, Courtesy Michael J Brooks, Brooks Photographic Imaging.
photography.

When people think of light, they are generally referring to visible light, or light the eye can see. In reality the visible portion of the electromagnetic spectrum is a very small portion of the entire spectrum. Light is measured as a wavelength and visible light is generally expressed in nanometers. The human eye is sensitive to wavelengths from 400 to 700 nanometers. Different colors of light are different wavelengths ranging from violet on the low end and red on the high end. Infrared radiation consists of longer wavelengths ranging from 700 nanometers to 15,000 nanometers.

Photographic emulsions and digital sensors can be made that are sensitive to some of these wavelengths making this energy of particular interest to forensic photographers. Generally forensic photographers’ record images in the near infrared range from 700 to 900 nanometers with film, although emulsions can be made that are sensitive up to 1350 nanometers. People tend to associate infrared energy with heat. Thermal infrared energy is not recorded by film or digital camera sensors, but rather the amount of near infrared energy that either reflects of or absorbs into an object or substance. By eliminating the visible light utilizing filters, forensic photographers are able to record images that the unaided human eye could not otherwise detect.

In the year 1800, William Herschel discovered infrared radiation in his examination of the refraction of sunlight through a prism. He used a series of thermometers during his examination to reveal the existence of wavelengths beyond red in the visible spectrum, calling his discovery the “thermometric spectrum”. Today we know this portion of the spectrum to extend from 700nm to approximately 1mm where it overlaps with radio waves. However, infrared photography can be conducted in the near infrared range of 700nm to 1000nm using filters and an infrared sensitive recording method (film or IR digital cameras). Although infrared is associated with heat, thermography (thermal photography) uses different equipment and methods and should not be confused with infrared photography.

Infrared sensitive film has been around since the 1930's, therefore the practice of infrared photography is not a new area of scientific study. Some of oldest applications of infrared reflected photography are still in use today, including its use in document examination, visualization of certain injuries, detection of blood and other substances on fabric, carpet and other surfaces, as well as low light surveillance photography. Recently however, digital camera technology has progressed to a level making it possible to capture high quality infrared images. Over the past five years or so (2000-2005), various enterprising individuals have learned how to modify or “convert” digital cameras in order to allow the capture of infrared images. A few companies now offer IR conversion or do it yourself IR conversion kits for certain digital cameras. In 2006, Fuji introduced the S3 Pro UVIR camera, the first professional digital camera specifically developed for ultraviolet and infrared photography.

Infrared photography with film can generally be accomplished using normal photographic equipment with some considerations. The camera body itself and any accessories such as bellows must not transmit infrared energy. On a single lens reflex camera the viewfinder should be covered during exposure to prevent unwanted light from entering the camera body. Many cameras come with an opaque accessory viewfinder cover, or infrared opaque tape can be used.
Some cameras have a window on the back of the cover where information on the film canister can be read. This window should also be covered. Loading infrared film into the camera and exposing the camera to a bright incandescent light from all sides is an effective means of testing equipment. The absence of visible fogging after normal development indicates the system is not transmitting infrared energy and can be used for infrared photographic techniques. Some camera models use infrared emitting LED’s for sensing film loading and frame counting. These cameras are not suitable for infrared photography, as the infrared device will fog the film. Textured or coated film pressure plates can also cause reflections and other artifacts to appear on infrared film because the film does not have an anti-halation layer.

Another consideration relates to the focal length of the lens. The effective focal length of the lens is different when photographing in the infrared spectrum. Most of the filters used for infrared photography are opaque and block most or all visible light from passing through them. This means the photographer cannot see through the lens to focus on the subject. Aberration correction of chromatic errors on conventional lenses is wavelength dependant. The effectiveness of the correction is optimized for visible light and usually does not extend into the infrared. Uncorrected chromatic and spherical aberrations in the infrared region result in an effective reduction in resolution of infrared images. As a result, in the infrared range the lens will come to focus further from the camera compared to the best point of visible light focus. The photographer must turn the focus ring slightly closer after achieving the best visible light focus. Some lenses, especially older film camera lenses, have an infrared focus index mark that tells the photographer how far to turn the focus ring. Many newer lenses, especially auto focus and digital camera lenses do not have this index mark.

Optimal infrared focus must be determined by testing. As an alternative, photographers can use small apertures and rely on depth of field to minimize the problem with optimal focus. To increase the effectiveness of this method, a dark red filter such as #25 or #29 can be placed over the lens. The camera is focused with this filter and then replaced with an infrared filter prior to exposure. Stop the lens down to at least f11 or smaller to increase depth of field.

Infrared sensitive film must be used to capture images. Conventional black and white films are sensitized to a practical limit of 680 nanometers. Extending the limit into the infrared causes the film to lose efficiency; therefore, as the emulsion is extended into the infrared, the sensitivity
is progressively less. Conventional films will require much longer exposures if used to record infrared. The real limit of conventional black and white film is 1240-1350 nanometers. (Scientific Photography and Applied Imaging, Sidney F. Ray, 1999) The most common type of film used for infrared applications is Kodak High Speed Infrared Film. In the infrared region this film is sensitive from 700 to 900 nanometers. Infrared film is not only sensitive to infrared radiation, but is sensitive to ultraviolet and all wavelengths in the visible light spectrum. Infrared film is not very sensitive to green light. When exposed through a deep yellow or red filter most ultraviolet, blue, and green light is blocked allowing the image to be formed by mainly red light and infrared wavelengths.

Infrared film may not have an anti-halation layer making them subject to halation. (Circular or halo effects around bright light sources or specular reflections caused by light reflecting off the film base back to the emulsion) Infrared films are also highly susceptible to fogging due to the potential of light piping along the film base, and the potential lack of opacity to infrared radiation of the light trapping lips on the film canister. Infrared film must therefore be loaded into the camera in complete darkness making field use difficult and impractical. A dark bag can be used in the field. Prior to use test the bag for infrared opacity by using an unexposed strip of film and uncover it inside the dark bag at least twice as long as it normally takes to load the film in the camera. Develop the film and examine it for fogging. The effective film speed of infrared film is dependant on the filter used to create the exposure. Starting ISO numbers provided by the manufacturer are guides and experimentation is necessary to achieve acceptable results.

Camera light meters are calibrated to function in the visible light spectrum and cannot be relied upon to provide accurate exposure information when photographing in the infrared region. Experimentation and bracketing are required. Forensic photographers who perform infrared techniques regularly, especially under similar lighting conditions, can develop a chart of approximately correct exposure times for different filter combinations to reduce the amount of trial and error in performing infrared photography. If electronic flash is used guide numbers can be developed to assist with exposure computation.

Digital cameras can be used in some infrared applications. Typically digital cameras come from the manufacturer with a hot mirror filter or a UV/IR cut filter installed in front of the sensor. The purpose of this filter is to prevent ultraviolet and infrared wavelengths from reaching the sensor. These wavelengths reduce the quality of color images made in the visible light spectrum and are therefore unwanted by most photographers. Even these filters will transmit some infrared energy, however the results are unpredictable. These cameras are generally not suitable for infrared photography without modification. Several companies have emerged who will perform these modifications; however, doing so will void the manufacturer’s warranty. Any camera with the hot mirror filter removed can be used in the visible light range only if an equivalent filter is used on the lens.

Once modified these cameras can be used in the same manner as film cameras with the same limitations indicated above. Fuji’s recently introduced UV/IR camera is designed specifically for the forensic photography field. This camera is modified by the manufacturer and does not have a hot mirror filter installed internally. This camera is sensitive from 350 nanometers (near
ultraviolet) to 1000 nanometers (near infrared). The advantage of this camera is that it has a live
preview function allowing the photographer to focus the camera to the optimal focus point for
infrared wavelengths, and preview the effects of different infrared filters. Live preview may also
be used to evaluate the exposure based on the camera settings used at the time of the preview
reducing the amount of bracketing necessary to achieve a proper exposure. Introduction of this
camera has made the difficult workflow for infrared photography much easier allowing it to be
used more widely in field and laboratory environments.

Regardless of the decision to use conventional film equipment or digital equipment the set
up for performing infrared photographic techniques is largely the same. Set up for each of the
two techniques including infrared reflected, infrared luminescence (fluorescence), and infrared
surveillance varies depending on the technique chosen. Although the set up varies between the
techniques a variety of filters are required for each of them. The most common reference to
infrared filters is by their Kodak Wratten rating although the only one currently available from
Kodak is the 87C. The 25 and 29 red filters are classified as standard black and white filters, but
also work in infrared photography. These filters are readily available. Infrared filters block the
visible light, therefore, once placed on the lens the photographer cannot see through them to
focus or preview the effects. Infrared filters with approximately the same transmission curves as
the original Kodak filters are available from a variety of manufacturers as shown in the chart
below. A complete set of these filters can now be obtained from Peca Products, Inc.

### Brand Equivalent Filters

<table>
<thead>
<tr>
<th>Tiffen (Wratten)</th>
<th>Equivalent Filters</th>
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<tr>
<td>18A</td>
<td>Schott UG-1, Hoya U-360, B+W 403, Peca 900</td>
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<td>Schott - none, Hoya – none, B+W none, Peca 912</td>
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<td>89B</td>
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<table>
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<tr>
<th>Wratten Rating</th>
<th>0% Transmission (nm)</th>
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<th>Schott-Glass</th>
<th>B+W</th>
<th>Heliopan</th>
<th>Cokin</th>
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<tr>
<td>25</td>
<td>580</td>
<td>600</td>
<td>OG590</td>
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<td>600</td>
<td>620</td>
<td>RG630</td>
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<td>-</td>
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<tr>
<td>89B</td>
<td>680</td>
<td>720</td>
<td>RG685</td>
<td>092</td>
<td>5695/569</td>
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<td>B72</td>
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<td>700</td>
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<td>750</td>
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<td>795</td>
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Figure 3 – Filter equivalency and band pass chart, Courtesy Michael J Brooks, Brooks Photographic Imaging
As seen in the chart each of the filters transmits a different range of wavelengths in the infrared spectrum. Infrared filters are opaque to all visible light. The 25, 29, and 70 pass some visible red but not the lower wavelengths in the visible spectrum. The purpose of filters in infrared photography is to block the visible light and isolate particular wave bands in the infrared spectrum. Whether using film or digital, the introduction of visible light will mask the effects of the infrared radiation.

Infrared radiation is found in many everyday light sources used in photography. In some, such as tungsten, photoflood, halogen, and incandescent bulbs, heat generates a good deal of the infrared radiation. The sun is a natural source of light but is an irregular infrared source since the rays shift according to the time of day. Atmospheric conditions may also interfere. The xenon tubes in electronic flash units are an ideal source of infrared in the 800-900nm range. Prolonged heat is not an issue and they provide freedom of directing the angle and distance of illumination. In addition, they are lightweight and portable.

A number of “alternate light sources” specifically developed for forensic applications can be tunable in the range of near infrared wavelengths. These light sources use 300-500 watt xenon arc lamps and include the following models:

<table>
<thead>
<tr>
<th>Model</th>
<th>Manufacturer</th>
<th>Lamp</th>
<th>Band Range (Optional IR)</th>
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<tbody>
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<td>Polilight PL500</td>
<td>ROFIN</td>
<td>500W Xenon</td>
<td>350-650nm, 700-1100</td>
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<tr>
<td>Omniprint 1000A</td>
<td>Melles Griot</td>
<td>400W Xenon</td>
<td>300-570nm, 700-1100</td>
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<tr>
<td>Spectrum 9000</td>
<td>Melles Griot</td>
<td>300W Xenon</td>
<td>300-750nm, 700-1100</td>
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<tr>
<td>Crimescope CS16-500</td>
<td>SPEX Forensics</td>
<td>500W Xenon</td>
<td>415-670nm, 630-830</td>
</tr>
</tbody>
</table>

Infrared reflected photography can be defined as a technique of focusing an infrared image with a camera and lens onto an emulsion or digital sensor sensitized to infrared radiation to obtain a record of how the subject reflects or transmits varying amounts of the infrared radiation.
falling on it. Figure 4 below illustrates the typical set up to perform this technique. The illustration depicts a digital camera, however, the set up for film is the same.

![Infrared Reflected Photography](image)

An infrared energy source emits radiation that falls on the subject. In varying degrees the infrared energy and visible light absorb or reflect off the subject. A barrier filter (infrared filter) is placed over the lens to block the visible light from passing through the lens and exposing the infrared sensitive emulsion or sensor. The filter is necessary because the emulsion and/or sensor are also sensitive to visible light. A record of how the subject transmits or reflects the infrared radiation is subsequently created. Filter choice depends on the properties of the materials in the subject. If for example the photographer is attempting to differentiate between two types of black ink that appear the same visually, the correct filter must be selected to capture an image depicting that the materials reflect or absorb infrared radiation differently. Since the effect cannot be visualized through the camera itself, the photographer must rely on trial and error, or have available another means of previewing the effect. An infrared viewing scope with macro capability can be used. Holding the filter between the scope and the subject will provide a preview of the approximate results that can be expected in the image. Actual results will often vary somewhat from the filter effect previewed through the scope. These devices are also very expensive excluding many agencies from practically using this technique. A digital camera with
a live preview feature allows the effect to be previewed on the LCD screen or on a video monitor via a video connection from the camera.

An alternative to the setup described above involves the use of a forensic light source that only emits radiation in the infrared region of the electromagnetic spectrum. Light sources of this nature are commercially available and are commonly referred to as alternate light sources (ALS). With an alternate light source that allows user control of the center bandwidth emitted from the source the infrared barrier filters may not be necessary, provided the technique is performed in complete darkness. A means of previewing the effect of different wavelengths reduces substantially the amount of experimentation and is necessary to make this technique practical. The same preview techniques described above will work here as well.

Infrared luminescence photography can be defined as a technique of focusing an infrared image with a camera and lens onto an emulsion or digital sensor sensitized to infrared radiation to obtain a record of how the subject emits luminescence in the infrared region when illuminated with visible light. Figure 5 below illustrates the typical set up to perform this technique.
Luminescence occurs when certain materials emit infrared radiation caused by a shorter wavelength of visible light or ultraviolet radiation falling on the material. Although referred to as luminescence the effect is really a form of fluorescence. For purposes of this description the terms are used synonymously. When the effect occurs, some of the visible incident light is absorbed by the subject, converted to a longer wavelength and emitted by the subject as infrared radiation. Duration of the effect is very short lasting only nanoseconds (Billionth of a second).

Reflected infrared radiation and visible light will mask the effect of the luminescence on the infrared sensitive emulsion or digital sensor. Two filters are necessary to prevent this from occurring. A blue green filter sometimes referred to as an exciter filter is placed over the light source. This limits the incident radiation to shorter wavelengths of light preventing any infrared radiation emitted by the energy source from falling on the subject. The second filter, referred to as a barrier filter is placed over the lens to prevent the visible light from passing through the lens. The technique is performed in darkness to prevent any ambient infrared radiation from falling on the subject and subsequently passing through the lens. Since the exciter filter prevents any infrared radiation emitted by the source from also striking the subject, the only infrared radiation allowed to pass through the lens is that caused by the excitation. An image of the luminescence is then recorded on the emulsion or sensor. Commonly used excitation filter material is Corning 9780 blue green glass. Electronic flash is a very effective light source for infrared luminescence photography although the settings for correct exposure must be arrived at through experimentation and experience.

Given the proper setup, the forensic photographer is now equipped to apply these techniques to specific forensic applications. In document examinations alterations and forgeries can be detected. Differentiating between visibly identical inks and pigments is accomplished by observing differences in the way they transmit or absorb infrared radiation or whether or not they exhibit luminescence. Infrared reflected and luminescence photography can reveal writing, printing, or other markings under obliterations on documents.
The photograph at left is a check with obliterated writing on the back side. At right is a photograph taken using infrared reflected technique with Kodak High Speed Infrared film with an 89B barrier filter. The obliteration in this case is only slightly visible.

The photograph at left depicts a blue writing obliterated with blue ink. The photograph at right was taken using infrared luminescence technique with Fuji S3 UV/IR using a Peca 914 (89B) filter. Note the added time above the obliteration is dropped completely and the time can be read through the obliteration. ISO 400, F3.5, 1/180, electronic flash through corning 9780 glass.
Illegible charred, aged or worn documents can often be rendered legible in infrared photographs. Success with charred documents can vary with the amount of charring present in the subject. Another potential use includes photographing erased writing.

Dyes used in cloth and the physical properties of the cloth itself affect the manner in which infrared energy transmits or reflects off the cloth. Reflected infrared photography can be useful for differentiating between pieces of cloth that look the same in visible light but are actually different. Reducing backgrounds on dark cloth, cloth with busy patterns, or other surfaces to reveal the presence of stains is an excellent application for infrared reflected photography. Often times, visibly dark or even black cloth can be rendered nearly white. Substances such as blood patterns can be revealed where traditional photographic techniques fail. Cloth with visibly busy patterns can be rendered as a single tone or less distracting pattern, revealing information not visible to the unaided eye. Gun shot residue can also be visualized using infrared reflected photography in some circumstances. The examples illustrated in the photographs show a variety of different cloth patterns, colors, and fiber compositions. In some of the illustrations the
technique worked very well for showing blood and in others the results were marginal. With bloodstains the background surface appears to affect the results of how the blood appeared on the fabric in the infrared photographs. In general the 87A equivalent filter generated the best results for reducing the background and darkening the blood. In some cases other filters performed better so some experimentation is still suggested. All of the illustrations provide good examples of how infrared photography can be used to eliminate patterns and reduce backgrounds on different types of cloth. These techniques can be used on other surfaces as well.

The photograph at left depicts black polyester fabric with a bloodstain. The photograph at right was taken using infrared reflected with the Fuji S3 UV/IR digital camera with Peca 906 (87A) filter. The black cloth is rendered white and the bloodstain readily visible. ISO 400, F16, 1/90, Tungsten cross lighting

The photograph at left depicts plaid cloth with a bloodstain. The photograph at right was taken using infrared reflected with the Fuji S3 UV/IR digital camera with Peca 906 (87A) filter. A portion of the pattern is reduced in tone and the bloodstain is visible. ISO 400, F11, 1/10, tungsten cross lighting
The photograph at left depicts synthetic upholstery with a bloodstain. The photograph at right was taken using infrared reflected with the Fuji S3 UV/IR digital camera with Peca 906 (87A) filter. The fabric is rendered white with pattern neutralized and the bloodstain readily visible. ISO 400, F16, 1/20, Tungsten cross lighting.

The photograph at left depicts red fleece cloth with a bloodstain. The photograph at right was taken using infrared reflected with the Fuji S3 UV/IR digital camera with Peca 906 (87A) filter. The red color is rendered as white and the bloodstain is readily visible. ISO 100, 22, 1/8, tungsten cross lighting.
The photograph at left depicts red felt cloth with a bloodstain footwear impression. The photograph at right was taken using infrared reflected with the Fuji S3 UV/IR digital camera with Peca 906 (87A) filter. The red color is rendered as white and the bloodstain is readily visible. ISO 400, F11, 1/20, tungsten cross lighting.

The photograph at left depicts denim cloth with a bloodstain and gun shot residue. The photograph at right was taken using infrared reflected with the Fuji S3 UV/IR digital camera with Peca 908 (87B) filter. The denim is rendered much lighter. The bloodstain and GSR are rendered dark and are indistinguishable from one another. ISO 400, F11, 1/180, tungsten cross lighting.
The photograph at left depicts red pattern rayon cloth with a bloodstain. The photograph at right was taken using infrared reflected with the Fuji S3 UV/IR digital camera with Peca 906 (87A) filter. The cloth is rendered white with pattern dropped and the bloodstain readily visible. ISO 100, 22, 1/8, Tungsten cross lighting.

Top left photograph depicts denim with gun shot residue. The photograph at top right taken with infrared reflected, Peca 906 (87A) and Fuji S3 UV/IR at ISO 100,F22, ¼ tungsten cross lighting. Note the GSR now appears dark against a light background. The photograph at left depicts the same fabric with GSR now appearing light against a darker background. The lower left photograph taken with Fuji S3 UV/IR and Spex Crime Scope alternate light source at 750 nanometers. Camera settings ISO 400, F2.8,1/1.4.
The photograph at left depicts plaid cloth with a bloodstain. The photograph at right was taken using infrared reflected with the Fuji S3 UV/IR digital camera with Peca 906 (87A) filter. A portion of the pattern is dropped. The vertical lines are darker and the bloodstain is visible. ISO 100, F16, 1/8, tungsten cross lighting.

The photograph at left is military camouflage cloth with a bloodstain. The photograph at right was taken using infrared reflected with the Fuji S3 UV/IR digital camera with Peca 900 (18A) filter. All but the dark blue/black pattern on the cloth is dropped. The dark blue/black area in the infrared photograph appears to have slightly more tonal separation than the record photograph. The bloodstain is only faintly visible in the dark area and lightly visible on other areas of the cloth. ISO 400, F22, 1/15, tungsten cross lighting.
Another application for infrared reflected photography relates to biomedical uses and documentation of injuries. Infrared energy will penetrate the human skin up to 3 millimeters with longer wavelengths penetrating further in the wavelengths recorded by this technique. The American Board of Forensic Odontologists publishes Bite Mark Guidelines and suggest the use of alternate light sources (UV and IR) and special film for photographing bite marks in addition to conventional photography. In a paper on Photography and Forensic Practice Dr. B. R. Sharma suggests using infrared photography to show details below the surface of the skin. Infrared energy is strongly absorbed by blood. Visible light photographs are suggested for bite marks. Additionally reflected ultraviolet photographs can show details on the surface of the skin while infrared photographs can show details below the surface of the skin. Difficulty in performing this technique on a live victim with film equipment has precluded its widespread use in the past. With easier digital workflow allowing for more precise focus and the immediate ability to evaluate exposure, infrared photography is easily integrated into bite mark documentation. Bite mark documentation is the most commonly suggested use for infrared photography as it relates to injuries; however, circumstance can and likely will arise where the use of reflected infrared photography will be beneficial for documenting other types of injuries to humans.

Surveillance photography in low light or darkness requires a slightly different setup. Surveillance is not a forensic technique per se, however, with the increasing availability and affordability of digital cameras sensitive in the infrared region, use for surveillance in law enforcement is becoming more common. Figure 6 below depicts the typical set up for surveillance using an infrared sensitive workflow. Again, infrared photography is not thermal imaging and surveillance photography is a modified application of the infrared reflected technique. The technique still requires an infrared emitting light source. A barrier filter is used over the light source to eliminate the visible light from the source. Failure to do so would subject the photographer to detection by the subject. Even with a barrier filter over the light source a faint red glow may be emitted from the light. High intensity infrared emitters can be purchased commercially and are specifically designed for this type of application. A long focal length high-speed lens with a maximum aperture setting f 2.8 is suggested. Generally a lens with a minimum of two millimeters of focal length for each foot of camera to subject distance is suggested. No filter need be used over the lens. In surveillance photography typically the goal is to obtain identifiable images of a person engaged in an action. A barrier filter over the lens would preclude the photographer from taking advantage of all available ambient light and infrared energy. The goal is to get enough light and/or infrared energy to achieve a
properly exposed photograph sharp enough to identify the subject. Some precautions need to be taken when analyzing black and white, or grayscale surveillance photographs. Since materials reflect or transmit infrared energy differently than visible light, the tone of clothing in infrared surveillance photographs may not match the actual tone when viewed in visible light only. Refer to the black cotton and polyester cloth images above. Under infrared the black cloth exhibits nearly white tone. Because this technique uses infrared energy and available ambient light the degree of tonal difference in the photographs will depend on the ratio of visible light verses infrared energy used to create the image.

Figure 6 – Infrared Surveillance Photography
Infrared techniques can be applied to aerial and reconnaissance photography. When infrared photographs are made outdoors grass, and foliage of deciduous trees will appear white whether taken from the ground or the air. Chlorophyll exhibits high transmission of infrared and the underlying cell structure reflects infrared energy. The result is the infrared contrast in a landscape or aerial photograph will vary greatly from a visual light photograph. Infrared energy
can penetrate through haze and can help make objects in the distant appear clear. Infrared aerial photographs can help to distinguish the difference between deciduous trees and grass; from coniferous trees, dead or diseased trees and burned grass which typically appear dark on infrared photographs.

Although infrared photography has been used for a number of decades in law enforcement, the techniques have only recently become available with digital equipment on a widespread affordable basis. Whether forensic photographers choose film or digital media the basic techniques of infrared reflected and infrared luminescence remain the same. The movement to digital imaging as a replacement for conventional photography has made the use of infrared photography more convenient to integrate into regular workflow for agencies of all sizes. Infrared photography can be used successfully in the field and the laboratory. Use of the techniques described herein will allow the forensic photographer to capture demonstrative images that could not be captured by other means. Providing an illustration of every possible use for infrared photography is not possible in this examination. As with many photographic techniques, experimentation and persistence will yield additional uses and applications for infrared imaging, especially as its use becomes more widespread. Examples provided here including document examination, bloodstain pattern documentation, gunshot residue documentation, aerial photography, and surveillance photography are not all inclusive and are meant to give the forensic photographer a base upon which to build a foundation of experience. As the forensic market for specialized imaging equipment expands manufacturers will become more responsive to the needs of the profession. Future advances in technology will continue to increase the number of tools available to forensic photographers. Consequently, forensic photographers will need to develop skills for working in a modern technology based work environment while maintaining basic knowledge of the principles of photography. Doing so will continue to facilitate advances in the forensic imaging field allowing law enforcement to provide a higher level of service to their communities.
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