near infrared digital photography

Looking Through the Visible, into the Invisible

by eric h. cheng

What You Will Need:

- Digital camera or camcorder
- One of the following Kodak Wratten filters: #25, #29, #70, #89B, #88A, #87, #87B, or #87C (listed in the order of visible light each filter blocks, from low to high)
- A means of fastening the filter to your camera
- Tripod
- Adobe Photoshop 5.0

Optional:

- Component images from *PEI* Web site: *www.peimag.com*

Infrared photography has been around for at least 70 years, but until recently it was accessible mainly to photographers well versed in the process of traditional photography. This tutorial will lead you through the process of procuring and manipulating near infrared images with a digital camera or camcorder.

With the charge-coupled devices (CCDs) in digital cameras and camcorders, the technique becomes easier to master. When fitted with a filter that blocks all visible light, these devices can be used to capture images in the infrared spectrum. The LCD screens on these cameras further simplify the process because you can preview the images in real-time. This feature was unavailable in traditional photography without using filters that admit at least some visible (red) light.

Before we begin, find out whether your camera has an infrared blocking or "hot mirror" filter installed. If so, you may have to disassemble the camera to remove it (of course, this could void your warranty).

To find out if your camera has such a blocking filter, see if it picks up the beams emitted by a common infrared remote control. These fairly bright beams are easy to see in the LCD preview area of the camera. If your camera does not have an LCD, try capturing an image of the beams while depressing any button on the remote. If there is no visible infrared beam in the image, you'll know there is an infrared blocking filter installed. Olympus, Agfa, and Nikon digital cameras do not have the filter, so you can use them out of the box.

Figure 1. Filter, step-up rings, lens hood

Have a variety of filters on hand to play with. The Wratten #87C filter blocks out all visible light. Because Wratten filters gradually filter out more and more light as the wavelength increases, the #87C will also filter out much of the infrared light you're trying to capture. I use the #87 filter because it filters out all visible light, yet admits enough of the infrared spectrum to capture clear, crisp images. The #25 filter lets in a

significant amount of red light, and is often used in traditional photography because it allows image previewing through the viewfinder. (Edmund Scientific Inc. reportedly sells a visible light filter for $5; ask for a 1-inch diameter circular filter, part no. H43948; phone: 609-573-6250. At this price, however, the filter probably has limited optical quality.)

The table to the right shows the percentage of light transmission at various wavelengths for some of the filters listed above. You can figure out the approximate behavior of the other filters by comparing them to the table.

	%Transmission	#25	#89B	#87	#87C
Visible Light	@550 nm	..	..	..	..
	@600 nm	50.00	..	..	..
	@650 nm	87.60	..	..	..
	@700 nm	89.50	11.20	..	..
	@750 nm	89.50	83.10	03.50	..
Infrared Light	@800 nm	89.50	88.10	56.90	3.00
	@850 nm	89.50	89.20	78.50	48.40
	@900 nm	89.50	89.90	81/90	80.60
	@950 nm	89.50	90.40	83/60	86.50
	@1000nm	89.50	90.50	85.30	89.20

Equipment

A tripod is absolutely essential for digital infrared photography. Even though the newest consumer/prosumer digital cameras can be pushed to ISO 320 or greater, typical shutter speeds in daylight will still be 1/15-1/30 second.

You will also need a way to attach the filter to your camera. If your camera is threaded, then it's easy. Buy a gelatin filter holder and some step-up rings, or a threaded glass filter, which is much more expensive. If your camera is not threaded, then you'll have to be creative.

My equipment includes:

- Nikon Coolpix 950 (28mm thread)
- Agfa ePhoto 1280 (46mm thread)
- Kodak Wratten 87, 88A, 25 gelatin filters
- B+W 87 52mm glass filter
- Nikon AF-1 gelatin filter holder
- Nikon HN-12 lens hood
- 28-37mm step-up ring (available at CKCPower)
- 37-52mm step-up ring
- 46-52mm step-up ring
- Bogen tripod & ball head

Figure 2. Nikon Coolpix 950 (top) and Agfa ePhoto 1280 with Wratten filters attached.

The Agfa ePhoto produces grainy, dim photos with both the #87C and #87 filters, due to the poor CCD sensitivity and the limited time the shutter can be left open. The Nikon Coolpix, however, produces wonderfully bright, clear images.

In any case, you'll probably need image editing software to "pull out" the image from captures made by low-end digital cameras. Auto-leveling in Adobe Photoshop (shift-cmd/ctrl-L) usually does the trick. If you don't have Photoshop, find an image editing program that allows you to expand the variation between the darkest and brightest tones in the photo, to achieve more contrast.

Acquiring Infrared Images

Shooting infrared photographs is simple, but there are a few things you should have in mind. First, make sure no light can leak through the filter attachment mechanism you're using on your camera. Be sure to turn off the camera's automatic flash. Since very little light will be penetrating the visible light filter, your camera will most likely underexpose the image if it tries to use the flash. Finally, set the camera to the highest ISO rating.

Now you're ready to shoot test photographs to make sure that your setup works. Remember to use the tripod.

If the images come out dark, your camera is underexposing. My old Agfa ePhoto 1280 took pictures so dark that I thought my experiments had failed (see the next page for an example). A dark exposure can be caused by any number of things, but most likely, it happens because even at the maximum aperture setting and minimum shutter speed your camera offers, not enough infrared light can come through. Although it's not ideal, you can use Photoshop Levels to expand the dynamic range of the picture. Try doing this by opening

the image in Photoshop, and hitting shift-cmd/ctrl-L to Auto Level the image (Image>Adjust> Auto Levels).

To ensure your camera is capturing the maximum allowable light, try manually adjusting the aperture to the maximum setting and the shutter speed to the slowest setting. Also, try switching to a filter that lets in more visible light, such as the Kodak Wratten #25. If the images are still too dark, you'll have to work with what you have.

The JPEG artifacting in images captured with the Agfa ePhoto 1280 is due to the low dynamic range. Yet the unique texture in the resulting images does lend them a sense of nostalgia.

In some of your infrared captures, you may notice faint streaks of color. This is normal. The streaks are probably the result of the strange way the CCD responds to this spectrum of light. It could also be the result of trace amounts of red light that the filter has let through. You could try desaturating the image (shift-cmd/ctrl-U) or forcing it to grayscale (Image>Mode> Grayscale). In practice, I've found that forcing the image to grayscale preserves smooth textures better than desaturation does.

You may also notice small, brightly colored spots in your image if your shutter speed was very slow and/or you've pushed your camera to higher ISO ratings. These spots are the result of CCD noise, and can be removed with manual retouching or with software like Qimage Pro or Camera Bits Quantum Mechanic.

A View into the World of Infrared

The image we are about to create gives us a good view into the world of infrared. You will need: one infrared photograph and one full-color photograph taken from exactly the same spot (the tripod is indispensable for this); a photograph of a filter, frame, or similar object; and Adobe Photoshop 5. We'll use the frame/filter to outline the infrared portion of the image in the final composite. If you don't want to deal with all that framing, you can borrow the one I used in the image above. You can also borrow my images.

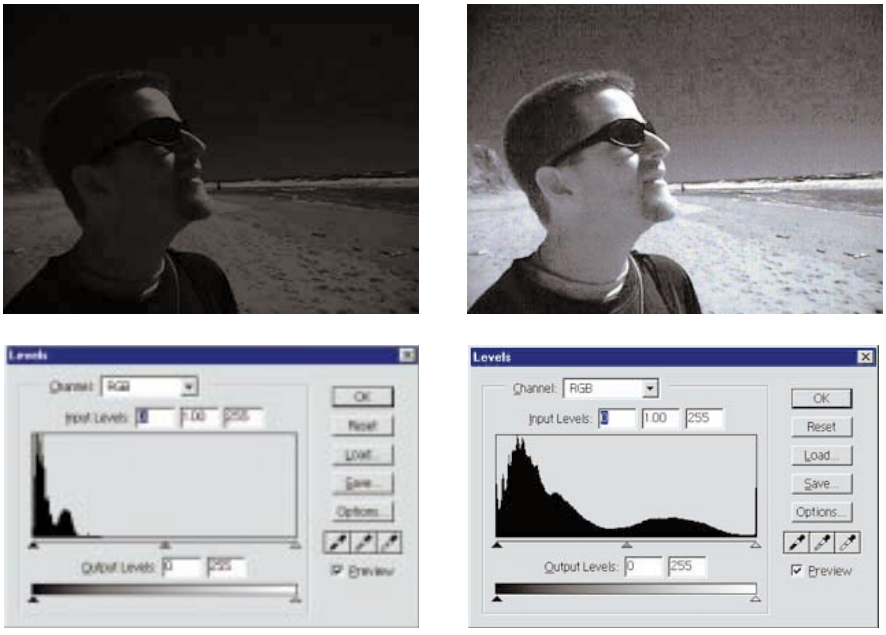
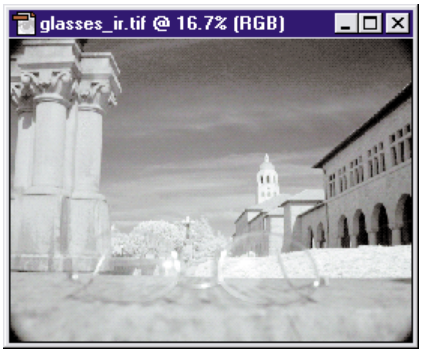


Figure 3. Auto-leveling the image reveals how much detail the camera actually recorded (source: Agfa ePhoto 1280).



Open the image of the filter or frame (filter.jpg, if you're using mine). Cut out the entire filter or frame, leaving the center (glass) portion behind. If you do not know how to do this, use my image for now, and read up on masking later—it's a good image manipulation skill for your arsenal.

Now, open both the color and infrared images. You may want to use Photoshop Auto-Levels on the infrared image (shift-cmd/ctrl-L), or you could manipulate both images to make them look perfect before proceeding to the next step.

Our goal is to merge the three

Figure 4. The original infrared and color images (left), and the masked filter (above).

images into a final product. First, click on the window with the color photo to make it active. Copy the contents into a new Photoshop document: cmd/ctrl-A to select the entire image, then cmd/ctrl-C to copy it to the clipboard.

Now, create a new Photoshop document (cmd/ctrl-N). Accept the defaults in the window by clicking OK (this automatically sizes the new canvas to the size of the image in the clipboard), and paste the image into the new window (cmd/ctrl-V). You will see a copy of the color image in the new window. If you don't see the Layers control window, make it visible by selecting Windows>Show Layers. Double-click on Layer 1 and rename it something more descriptive, like "Color Image." Now save the document and continue. We'll refer to this new document as the composite image from now on.

Now we need to copy the contents of the infrared photo into the composite image window as a new layer. Do this by repeating the steps above. Click on the infrared image window, hit cmd/ctrl-A and then cmd/ctrl-C. Click on the composite image window, and hit cmd/ctrl-V to paste into a new layer. A new layer called "Layer 2" will appear in the Layers tab in one of the control windows. Double-click on Layer 2 to change the name to something more descriptive, such as "Infrared Image." Then repeat the same steps with the filter image, and rename this new layer "Filter."

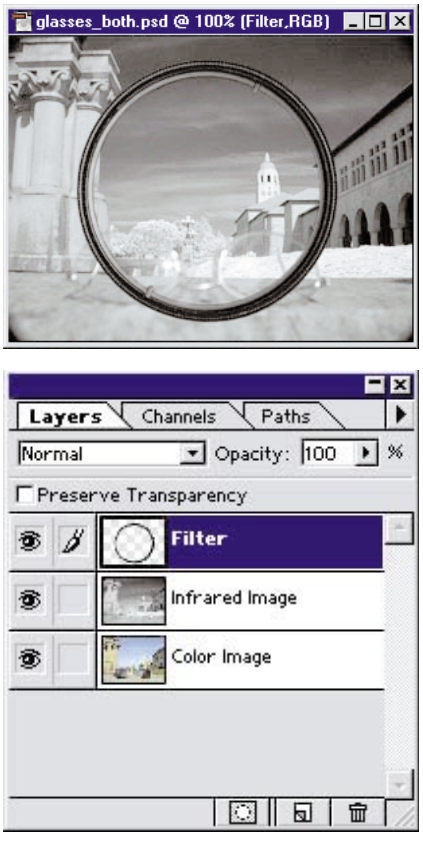


Figure 5. The Layers palette and current image.

Now we have a document with three layers: a color image, an infrared version of the same image, and a filter. In the composite image window, you should see only the infrared image with a filter on top of it, because the color layer is blocked by the ones above it in the list of layers.

The next step is to scale the filter to an appropriate size, then apply a mask to the infrared layer to let the color image show through everywhere except the area inside the filter. Select the layer "Filter" so that it is highlighted in the Layers palette. Now, select Edit>Transform>Scale. Click on one of the corner rectangles, and drag the cursor around while holding down the mouse button. When you let go of the mouse button, the filter will resize itself to fit in the bounding box you just specified. Hold down the shift key while resizing to constrain the proportions of the filter.

You can also move the filter around by clicking anywhere inside the box and dragging the cursor while holding the mouse button down. Adjust the size and position of the filter until you are happy with them, then double-click anywhere in the box to commit your changes (or press return/enter).

The final step is to reveal the color image in the area around the filter by creating a layer mask to control the way in which different areas within the layer are hidden and revealed. In particular, we want to hide all portions of the infrared image outside of the filter and reveal the portions inside the filter. We could simply erase the entire area around the filter, but creating a layer mask lets us hide the area without destroying the original image. Click on the "Infrared Image" layer to make it active.

Select the Lasso tool from the control panel (Figure 6) and trace a circle along the ring of the filter while depressing the Mouse Lasso tool button. Make sure you keep the lines from the Lasso tool completely within the black area of the filter ring. When you've completed the ring, release the mouse button. You should see a moving dotted line along the path you traced. Don't be concerned with drawing an exact circle; the filter will hide any irregularities in the line.

Figure 6. The Lasso tool.

Now that we've selected the portion we want to keep, we have only to create the layer mask. Select Layer>Add Layer Mask>Reveal Selection. The color image should suddenly appear around the filter, leaving the final image. Save the image, and you're done. ◀

Questions about infrared digital imaging? Feel free to contact Eric Cheng at eric@echeng.com, *or visit his Web site on digital infrared photography:* www.echeng.com/digital_photo/infrared.html.

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