

Using Webcams for IR Radiation Detection

Dan Burns

Los Gatos High School and LLNL

dburns@lgsuhd.org

Introduction: Video and still CCD cameras have the capability to detect near infrared radiation out past the 1 micron wavelength. The human eye is not capable of detecting wavelengths larger than about 0.75 microns. This allows CCDs to be able to detect electromagnetic radiation that is invisible and reveal it as images and movies. This creates many novel educational activities for students to explore IR radiation in the classroom and beyond. I describe how to modify an inexpensive computer webcam and some uses for it below.

Hardware: The fact that CCDs are sensitive to IR is a detriment to good photography. The lens of the camera does not focus IR, resulting in a fuzzy picture. To get around this, all CCD cameras have a built in IR blocking filter. Some IR still gets through. The cheaper the camera, the less effective the IR blocking filter. You can demonstrate this by pointing a remote control at any CCD camera, even a cell phone camera. When a button on the remote is pressed, the IR LED can be seen flashing in the camera display. The IR blocking filter must be removed to make a good IR camera. This will void the warranty and possibly wreck the camera. That is why a computer webcam is a good choice. They are cheap and easy to disassemble. The IR blocking filter comes in several types. The worst is a coating on the lens. This must be scratched off which can degrade image quality. Second worse is a filter attached to the CCD chip. This must be carefully removed to avoid damaging the CCD. The best are small filters that are part of the lens housing. These can be easily popped out without any risk.

I tried 3 different webcams for my experiments. Because I like to use a Mac, this was more difficult. All newer Macs come with a built-in webcam. That is why very few vendors make Mac compatible Webcams. I tried the IceCam2 by macally. It worked well with my Mac but unfortunately the IR blocking filter was a lens coating. I was able to scratch it off with an Exacto knife with acceptable results. I wouldn't recommend it. Next I tried a Logitech QuickCam Connect. Currently there is no Mac driver for this webcam. The IR filter was a small square piece of plastic that was easily popped out of the housing. This camera worked well on a PC and my Mac laptop running Windows XP. I recommend this one the highest. I then tried the Logitech QuickCam Chat Web Camera because there is a Mac driver available for it. Unfortunately it had an IR blocking filter coated on the lens. I was able to put the lens that cam with the QuickCam Connect into this Webcam. That is what I have been using.

The other modification that must be done is to install a filter that only passes IR radiation. There are sources describing how these can be made using exposed color film and floppy disk material on the internet. I chose to use filter material from Edmund Scientific Optics. It is a Wratten Filter number 87C. Although more expensive (\$65), one piece would be enough to make dozens of IR cameras. An internet search for Wratten 87C could result in a cheaper price. This filter can be attached over the lens of the camera for easy removal. I chose to place it inside the lens housing of the webcam so it is more secure.

<http://www.edmundoptics.com/onlinecatalog/displayproduct.cfm?productID=1493>

Software: The software that comes with the Logitech webcams is the best. It has settings for low light levels, still and video capture, and some basic editing tools. I also used a free Mac

application called Maccam. If you are going to use a Mac webcam, make sure it on the list of compatible cameras listed on the Maccam webpage:

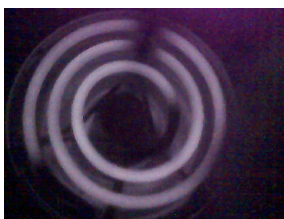
<http://webcam-osx.sourceforge.net/>

Applications: There are many things that can be explored with an IR Webcam. Some of the things I have observed a hotplate, toaster, toaster-oven, hairdryer, and a range top burner warming up. These are all easily visible in IR even when there is no orange glow detectable to the eye. I even touched the hotplate when it first came visible and was not burned. I am going to try measuring the hotplate temperature while doing IR imaging. Fluorescent light sources a visible, the warmer ends showing up brighter. Compact fluorescents show up brighter. Reflected fluorescent light is invisible. A room illuminated by fluorescent light only is very dark. Incandescent lights are very bright and can light up the whole room. The filament can be seen for a few seconds after they have been turned off. Different color LEDs are interesting. Red shows up well but any color more toward the blue end of the spectrum were very dim. IR LEDs show up as intense lights. Remote controls can be used as IR flashlights to “see” objects in an otherwise dark room. LCD monitors show up as a dull glow and nothing showing from the display. Some have a bright corner where the backlight is located. Another classroom application is to give students different materials (black plastic, cloth, bag of sand etc.) to see what the IR from a remote control can pass through. There are many surprises.

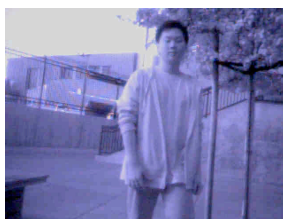
Objects can be seen in a daylight lit room and outside. This is from reflected IR radiation from the sun. There are many things to be discovered observing this reflected IR too. Some black clothing looks light colored and some light clothing looks dark. Objects can be seen in foliage that might otherwise be missed. The sky and the moon can be seen too. I have just started exploring using the camera for reflected IR. Please send me any discoveries you make. Below are some links that I found helpful for this project and some sample images.

<http://www.hoagieshouse.com/IR/>

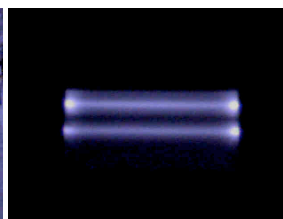
<http://www.instructables.com/id/Infrared-IR-Webcam/>



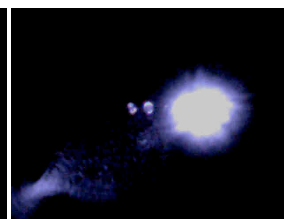
Hot Plate



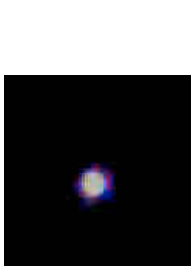
Black Shirt



Fluorescent



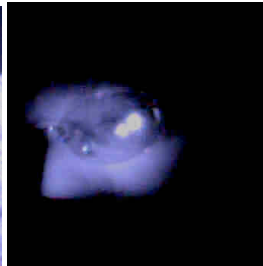
LEDs



Moon



Daytime Trees



IR LED Flashlight



\$20 Bill