Appendix A
Infrared (IR) Camera Introduction

Figure 1. An image of our infrared camera made by FLIR.

What is it?

- Uses infrared light spectrum
- Colors based on relative temperature

Uses

- Find inadequate insulation
- Identify vampire devices
- Detect failing appliances
- Structure hotspots
- Spot heat from lighting
- See through smoke
- Thermal night vision

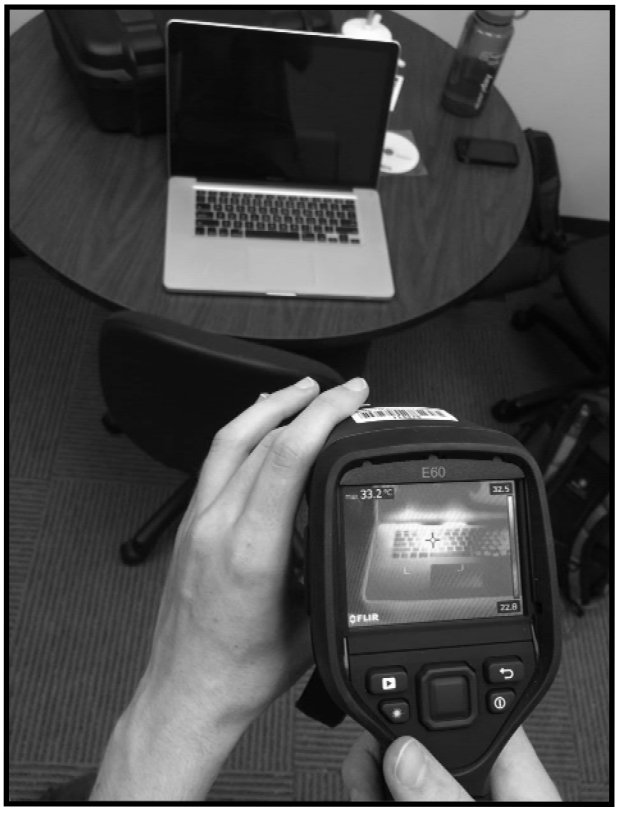

Figure 2. The view of what is seen by the camera operator.

IR cameras work like regular cameras, except they detect infrared wavelengths in the electromagnetic spectrum instead of visible wavelengths, as do regular cameras. One notable difference between regular cameras and IR cameras is that IR cameras use Germanium lenses instead of glass lenses because infrared radiation doesn't pass through glass very well. The camera we have shown here automatically adjusts the color scale. The camera scans to find the highest and lowest temperature and then assigns the "hot" color to the highest found temperature and the "cold" color to the lowest found temperature. This means that yellow represents the hot spot on the laptop, as show in Figure 2. The color assigned to a temperature depends on the range of temperatures that surround it.

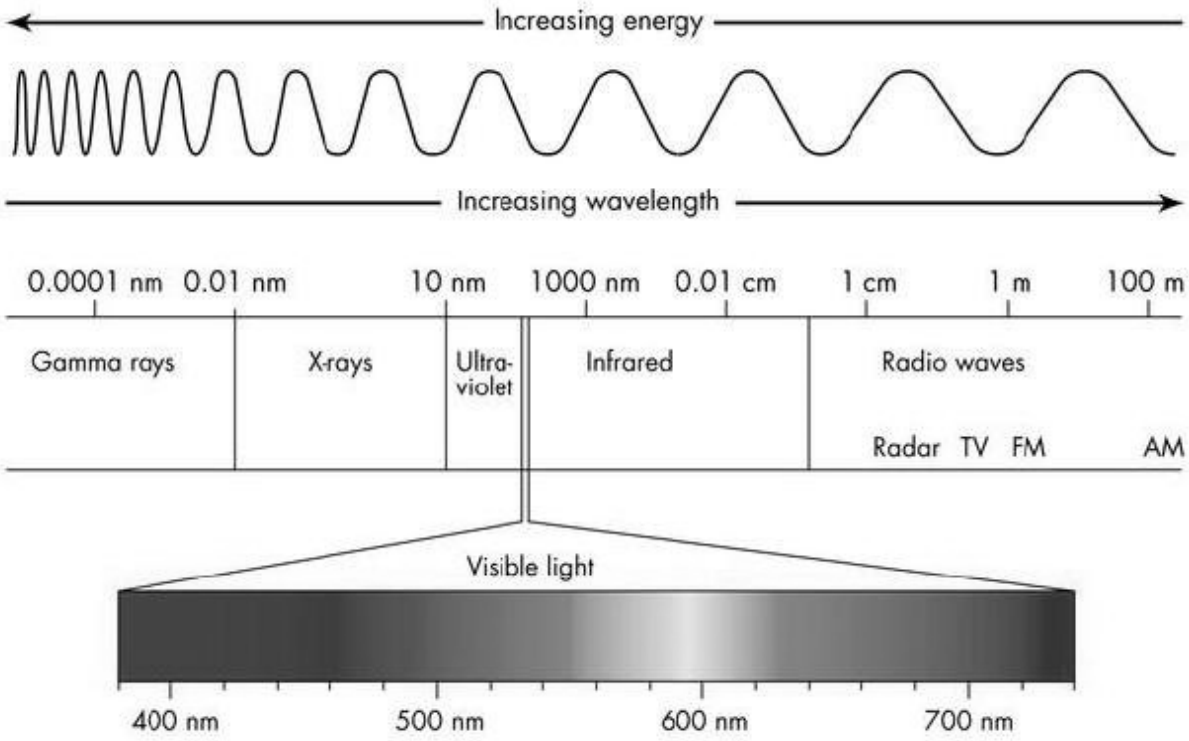

Figure 3. The infrared spectrum is shown. What we are interested in, the infrared wavelengths, are just to the right of the visible spectrum. This means that the wavelengths are longer than those of visible light.

Source: http://9-4fordham.wikispaces.com/file/view/em_spectrum.jpg/244287321/em_spectrum.jpg

Reveals Differences

Figures 4 and 5 illustrate how infrared imaging can be used to see things that are otherwise impossible to see. Figure 4 shows two seemingly identical mugs. However, as shown in Figure 5, the mug on the left has been filled with cold water, and the mug on the right has been filled with hot water. One really interesting aspect of this image is that we can see the reflection of the heat, the infrared radiation, from the hot mug on the cold mug and on the table.

Figure 4. Two identical mugs in the visible spectrum.

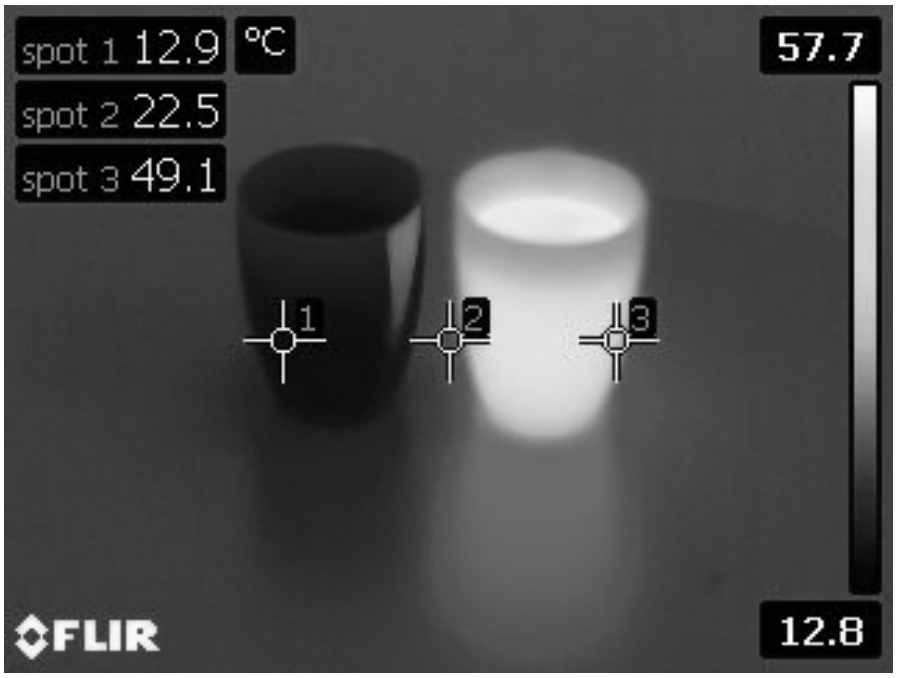

Figure 5. The two mugs viewed in the infrared spectrum.

Shows Hot Spots

The picture in Figure 6 is of a couple of phone chargers. The charger at spot 1 is not charging and therefore its temperature is similar to the room temperature at spot 3. The charger at spot 2 is charging a phone and is much warmer than its surroundings.

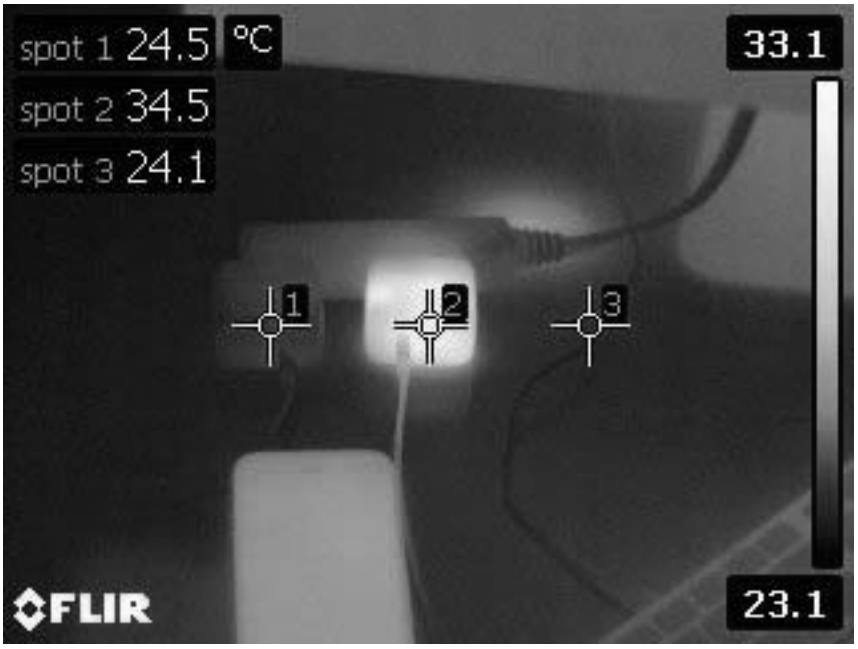

Figure 6: Phone chargers.

Shows Cold Spots

The same air vent is shown in Figures 7 and 8. As shown by the temperature scale, the air vent is colder than the surrounding ceiling.

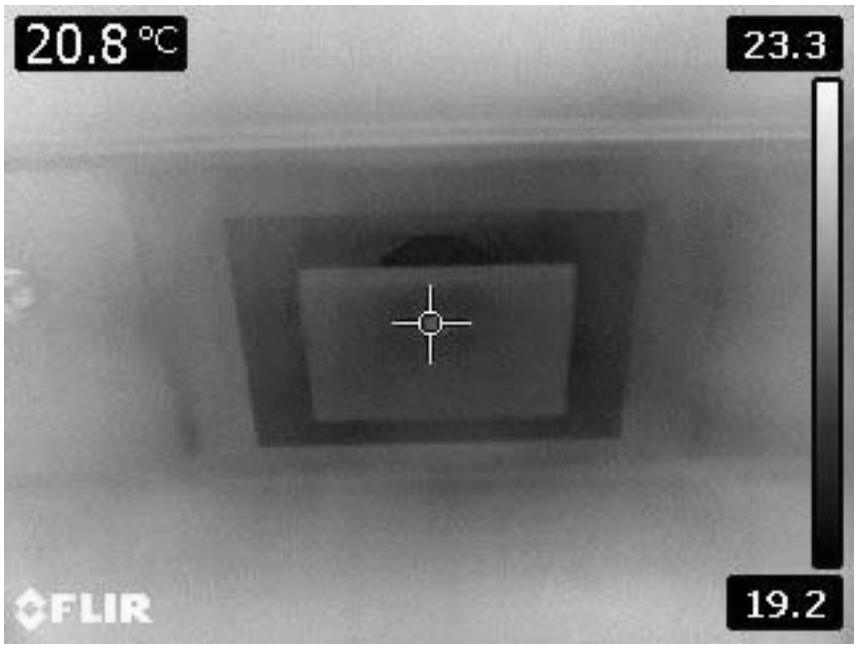

Figure 7

Figure 8

Germanium Lenses

Glass is an excellent reflector of infrared radiation. Shown in Figure 9 is a reflection in the screen of an iMac of the person taking the picture with the infrared camera. This demonstrates why germanium lenses are used instead of glass lenses

Figure 9

Residual Heat

Figure 10 shows a water bottle being held by a hand. Previously, the water bottle was all the same temperature as the upper, untouched portion is in Figures 10 and 11. Figure 11 shows the residual heat remaining on the water bottle a couple of seconds after the hand was removed.

Figure 10

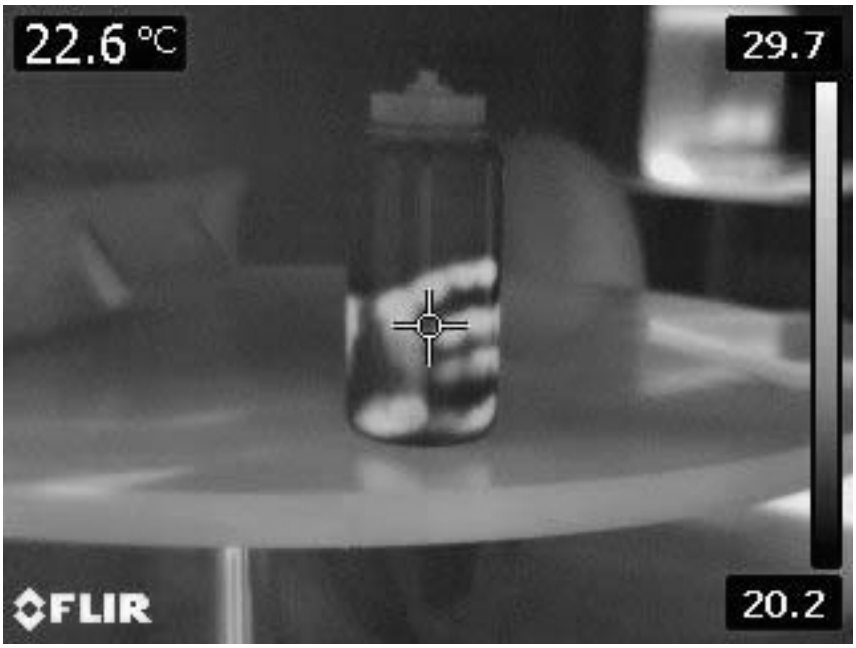

Figure 11

Heat Signature Through Solid Objects

Figures 12 and 13 show images of a mini-fridge in infrared and visual wavelengths, respectively. As the fridge cycles on to remove heat from the interior, the heat is dumped into the environment through the coils that wind around the body of the fridge. With visible wavelengths, these coils are completely invisible through the sheet metal. However, because of the heat they are dumping, they are easily seen when viewed through infrared radiation.

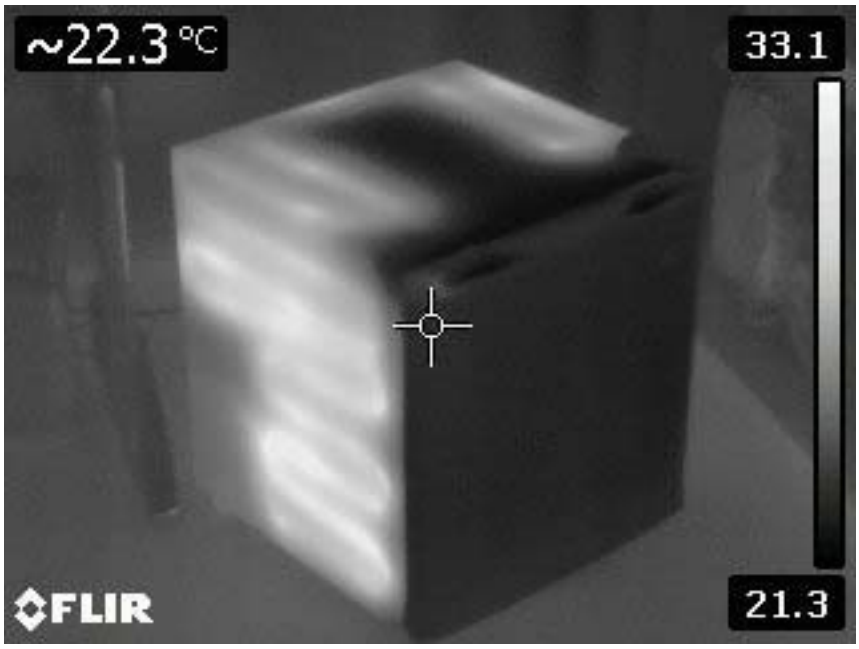

Figure 12

Figure 13

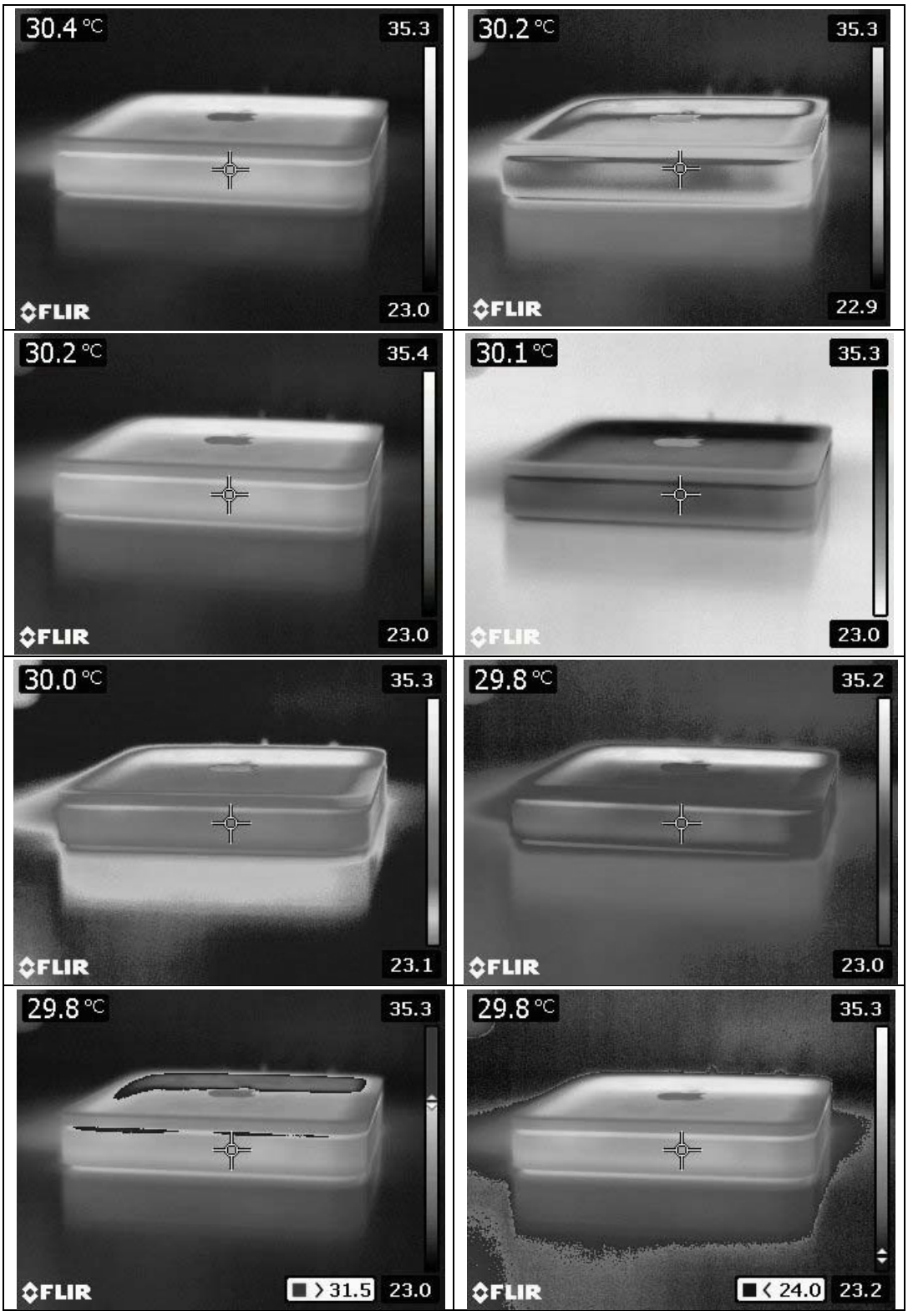

Figure 14. Pictured above are the different color schemes that can be used by the infrared camera according to your preference or application.