

Smart Lighting Activities

The following are hands-on activities to provide additional background for smart lighting.

Using an LED as a Light Sensor

The project *Measuring Vegetation Health* (<http://mvh.sr.unh.edu/>) contains some very useful information on LEDs and their application as sensors at http://mvh.sr.unh.edu/mvhinvestigations/light_investigations.htm.

As described in some detail on the MVH website, a simple light meter that senses only a narrow band of wavelengths can be realized using just an LED and a multi-meter. This approach has been used to make the ALTA® Reflectance Spectrometer, shown below.

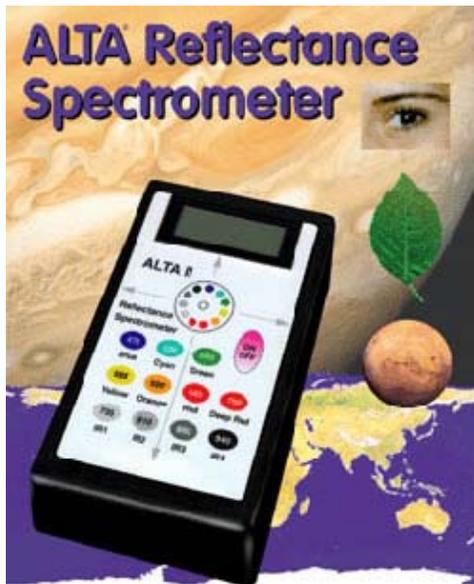
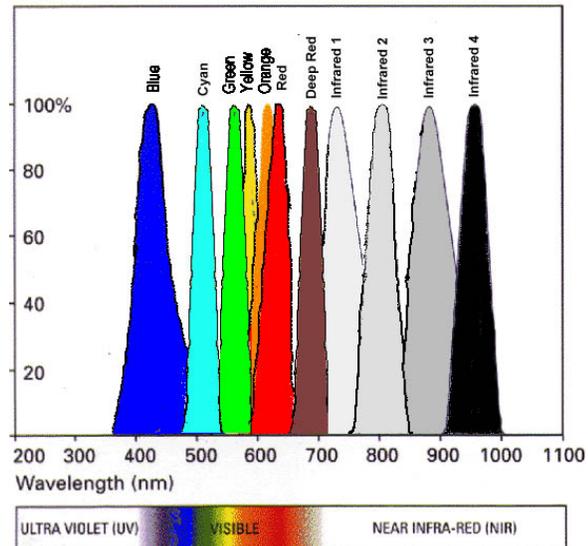


Figure 1. LED Emission Spectra



At the right, the emission spectra for the LEDs used in the ALTA are plotted. You can see that any individual LED can be used to sense light of a very specific color

Using a USB Microscope to See the Structure of a Packaged LED

We have several *Dino-Lite Pro* USB microscopes that can be used to look at how LEDs are mounted in a standard package and also to demonstrate the emission of light from the

LED die. Information on the microscope can be found at <http://www.dino-lite.com/>.



Some examples of photos taken with the *Dino-Lite*:



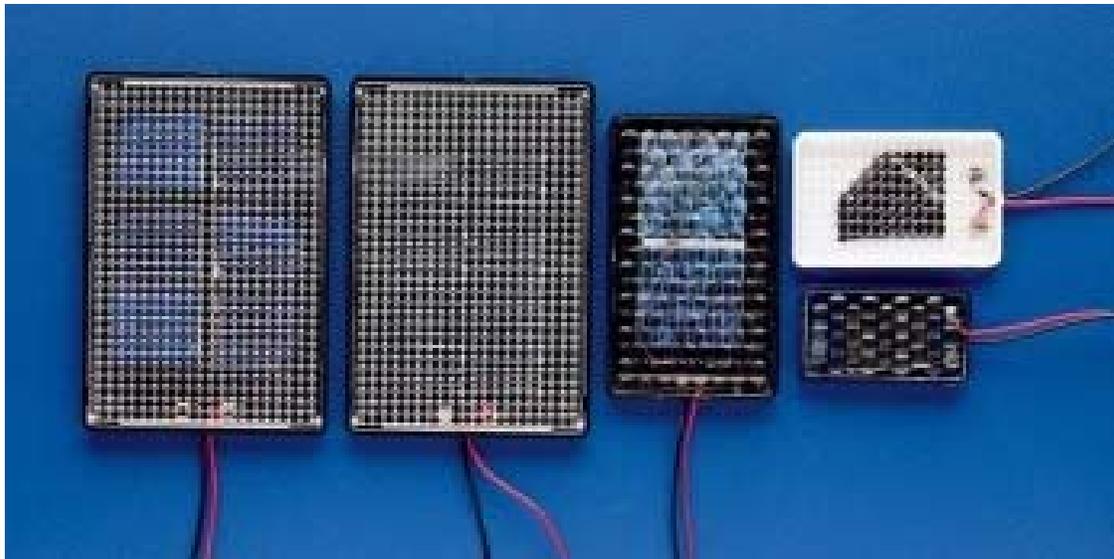
It can also be used to show the structure of the pixels in an LCD displays used in TVs, laptops, cell phones, etc.

Dino-Lite photos can be taken with or without illumination provided by an array of white LEDs. For small objects like those shown above, it generally works better to use room light. Otherwise, the images show light from the individual LEDs in the array. Turning off the LED array and using the light from an LED that is powered on can show where the light is emitted. Usually LEDs are too bright to see any detail because the image is washed out. To see the LED light more clearly, use one of the intensity control (dimming) methods discussed in the activity on **Power for LEDs**. Any of them will work, but the most elegant is the use of PWM to dim the light. The images can be quite beautiful.

There is more information in the description of the LED Design Activity used for Smart Lighting Outreach at http://smartlighting.rpi.edu/resources/PDFs/LED_Design.pdf.

Using a Solar Cell and the Mobile Studio to Observe the Flicker from Commercial Light Bulbs

A small encapsulated solar cell also makes a very good light intensity detector. There are several available through Edmund Scientific. The one we usually use produces up to 3V and 20mA and costs about \$10. Connect the black wire from the solar cell to Channel 1 GND on the Mobile Studio board and the red wire to A1+ for channel 1.



Shown below is the signal obtained in this manner for a solar cell illuminated by a Phillips 40W equivalent LED bulb. This was obtained running the experiment remotely using TeamViewer, a very powerful tool for remote experimentation that is free for non-commercial use. The light intensity is not constant because of the ripple in the DC power supply built into the base of the LED bulb.



TeamViewer also will transmit video if there is a camera attached to the computer running Mobile Studio. The image from the video shows the solar cell, the Mobile Studio board and a small plastic Einstein doll holding up the board. There is also a temperature measurement circuit that consists of an LM35DZ sensor and a 9V battery (really, that is all there is). Because the temperature is constant, we have not bothered to display it on the figure above. The data can be sampled every few minutes using the Data Tracker program available on the Mobile Studio website.



For this activity, the light from all three standard types of bulbs (incandescent, CFL and LED) should be observed and compared. Note that LED bulbs can have a wide variety of ripple characteristics, depending on the type of power supply they use.



There is more information in the description of the Comparing Light Bulbs with Modern Instrumentation Activity used for Smart Lighting Outreach at http://smartlighting.rpi.edu/resources/PDFs/Comparing_Light_Bulbs.pdf.

Monitoring Environmental Sensor Data Using Data Tracker

At the bottom of the Mobile Studio Download Software page you will find the Analog Data Tracker executable. Download this software if it is not already installed on your computer. Click on the icon for it and you will see a small window that will look something like this. For the example shown here, the calibration feature has been used to convert the measured voltage of channel 2 to degrees Celsius.



If Start is selected, the voltages measured by the two analog input channels for the Mobile Studio will be recorded every 10 minutes. For this version of Data Tracker, the duration of the sample is 5ms. In a newer version, the duration can be modified from its default value if more averaging is desired. This tool can be used for many applications. Think of an experiment you would like to do in which you would use Data Tracker.

Using Thresholds to Control the State of Some System (e.g. temperature)

Another executable found on the Download Software page is Thresholds. There is a simple video describing what can be done with it at <http://hibp.ecse.rpi.edu/~connor/Mobile%20Studio/Videos/Threshold.mp4>. Note that this video was made when the Mobile Studio pages looked a little different than they do today, but the information has not changed. This is a very valuable tool for projects that require some kind of control (e.g. a thermostat to control temperature).

Other Executables

There are other executables to download and try out if you have time. The list will grow whenever someone writes a new one.

