Multispectral Illuminator (MSI)
PSYCH221 Final Project
1100 – 1110, 18 March 2008

Max Klein
STARLab - VLF Group
Office: Packard 351, x33789
Lab: Packard 075, x60333
maxklein@stanford.edu
Motivation

- Multispectral imaging provides more information about objects than what the human eye can resolve
  - Eyes have three cone types with significant overlap, no UV or IR
  - RGB imaging does not provide enough information to recreate actual spectra
  - Commonly used in medicine (Pulse Oximetry, lesion detection, etc) and geophysics (MGS, terrain mapping)

- Multispectral imaging can be performed in various ways
  - Broadband light, sensors at individual wavelength bands
    - Fastest to sample, most expensive and complex to build
    - Cannot determine fluorescence
  - Narrowband light, sensors broadband or at multiple narrow bands
    - Slower to sample (serial by wavelength), less expensive to build
    - Can determine fluorescence with latter option

Existing illuminator / sensor capabilities in the lab are prohibitively slow for use on live (human) scenes
Existing Products

- Existing Commercial products use only 3 colors
  - Sufficient for direct viewing, night clubs, etc
  - Insufficient for imaging / reflectance viewing
  - Color Kinetics, now owned by Philips, appears to be industry leader
    - American DJ, Eliminator Lighting, MBT also produce LED Par Cans

- Lab setup is tungsten lamp plus filters/gels
  - High intensity output
  - Must manually select color
    - Slow to take sequence of images
    - Many filters available
  - Produces significant amount of heat
Design Criteria

- Multiple narrow-band spectral channels
  - 6+ wavelengths required
  - Independently controllable
  - Pulse Width Modulation desirable, not necessary for imaging
  - Must use “inexpensive” COTS LEDs and components
    - 1W Luxeon LumiLEDs within budget
    - Metal core PCBs not within budget
  - Higher intensity is better
    - Should be maximized based on available components
  - Fast (~100ms or better) switching time between channels
    - Prevents registration blur between images
  - Illumination time of up to 30sec may be necessary
    - Photometric readings, etc

- Camera Control / Coordination
  - Lighting unit should be computer controlled to allow integration with dSLR controller software
  - Alternatively, lighting unit can directly control camera
    - Shutter speed, aperture control, etc not available with this option
Design Features

- **8 wavelengths available**
  - 430nm, 2x royal blue, cyan, green, amber, red, 880nm, 940nm
  - 430nm LEDs extremely dim comparatively

- **24 clusters of each 9 LEDs**

- **Thermal Management**
  - Copper pour on front for LED heat sinking
  - LM75 thermal probe for automatic shutdown
  - Copper pours on back for current regulator heat sinking

- **Microcontroller Based**
  - RS232 control from PC
  - Slave port for chaining multiple lights together
  - Optically isolated camera focus and shutter control
  - PWM available on all 9 channels

- **Misc Statistics**
  - 4 copper layers, 7mil min trace/space
  - 60W maximum allowable power consumption
  - 30W nominal with one channel active
Spectral Output, Absolute

Absolute Spectral Radiance of MSI and White Target at -1 m
Spectral Output, Normalized

Normalized Spectral Radiance of MSI and White Target

Wavelength (nm)
Live Demo:

Multispectral Illuminator With Automatic Camera Control