

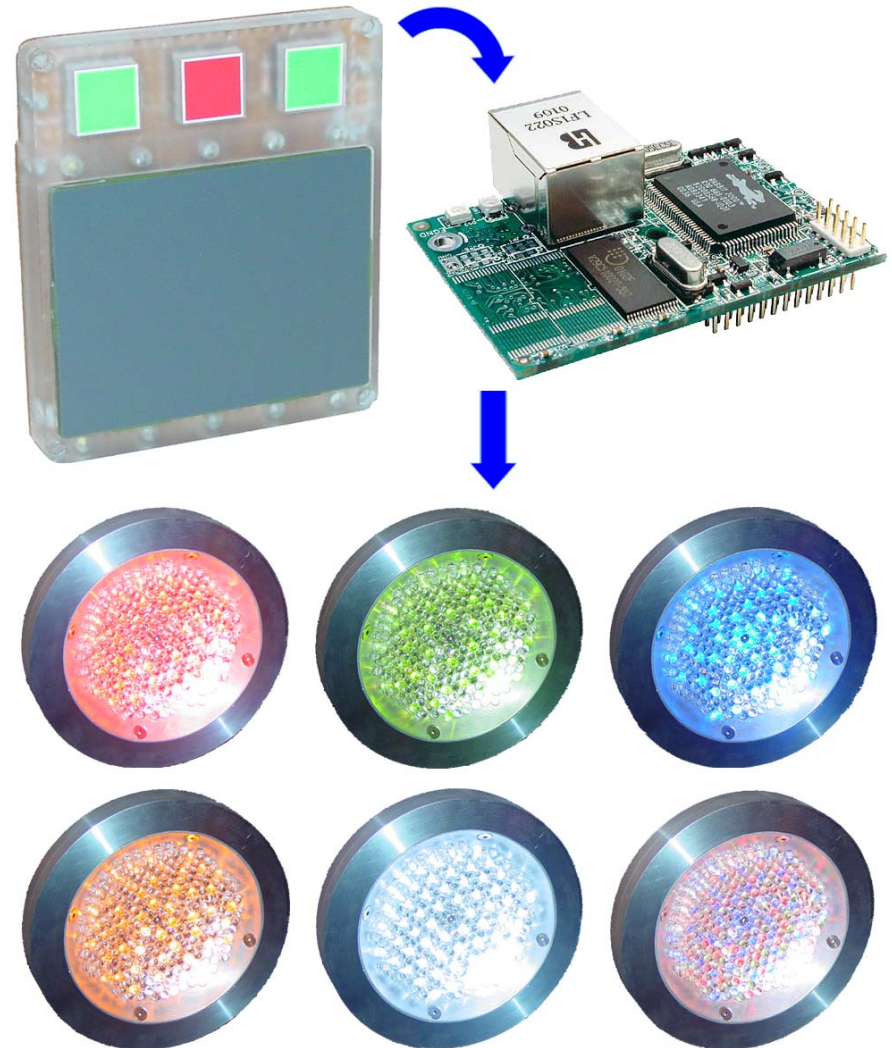
An Independent Development Project:

LED Lighting Control and Interface

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Overview

- Motivation
- Design Questions
- Design Goals
- Use of Color
- Interfaces:
 - Touchpad Dimmer
 - TCP/IP Network
- Conclusion



Motivation

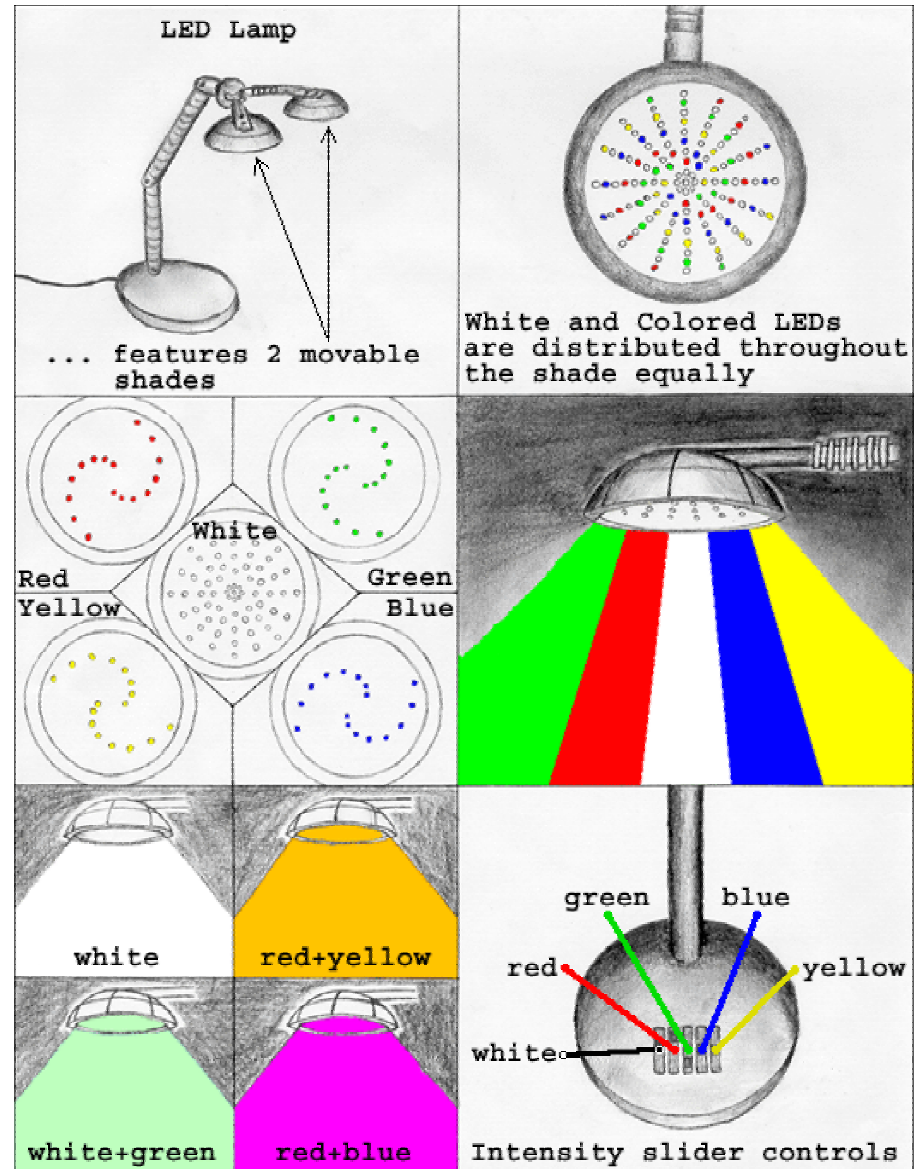
- Emergence of LEDs as lighting source
 - Energy efficient (see incandescent, fluorescent)
 - Size and durability
 - Versatility in application (color, control)
- “Super” bright LEDs in lighting experiment
 - Variable color temperature
 - Application as lighting + indicator source
 - Exploration of fitting user interfaces

Design Questions

- Range of application for a lighting project?
 - Neither too narrow nor too broad!
- How many LEDs are sufficient?
 - Flashlight ~ 3; 7 ft² Video Panel ~ 13,000
- Role of color?
 - An alternative to RGB?
- User control?
 - What level and granularity?

Disclaimer

- Mostly experimentation
- Some theory
- Little proof



Design Goals

- Lighting comparable to desk lamp
 - Illumination of typical desk surface area
 - Two light heads (shades)
- Varying color temperature
 - Granularity within reason (< 256 steps per color)
- Versatility in application
 - More than just a light source
- Level of control depending on application
 - LED clusters of similar color



Use of Color

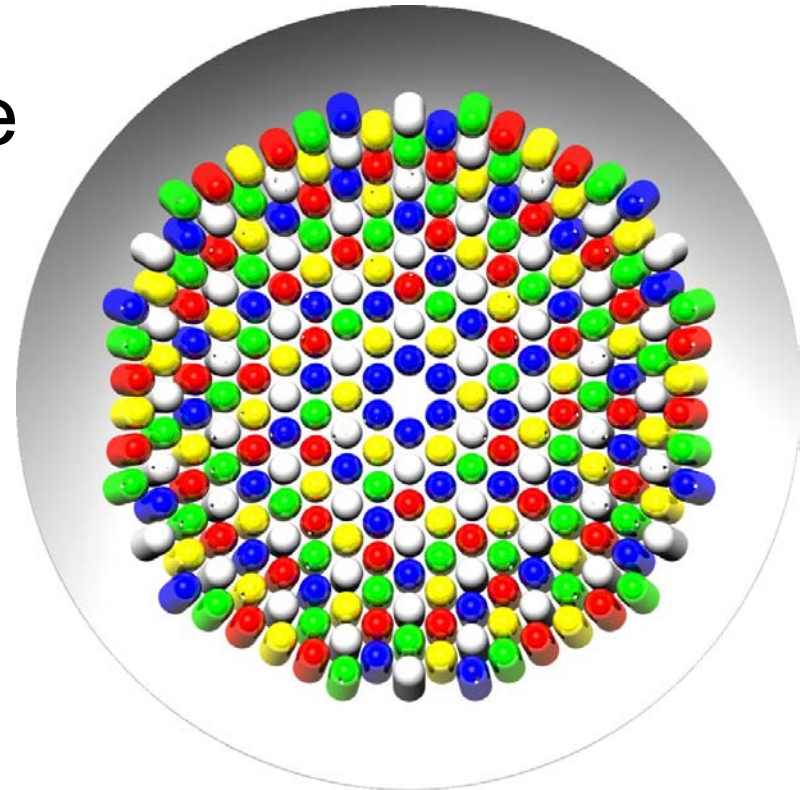
- Traditional light sources: Single color
 - But: Applications benefit from adjustability
- Typical rendition: RGB (Red, Green, Blue)
 - But: Is RGB the only option?
- Color theory historical perspective (~1860)
 - Hermann von Helmholtz: 3 perceptors:
 - Red, Green, Blue
 - Ewald Hering: 3 opposing colors:
 - Red-Green, Blue-Yellow, White-Black



Use of Color



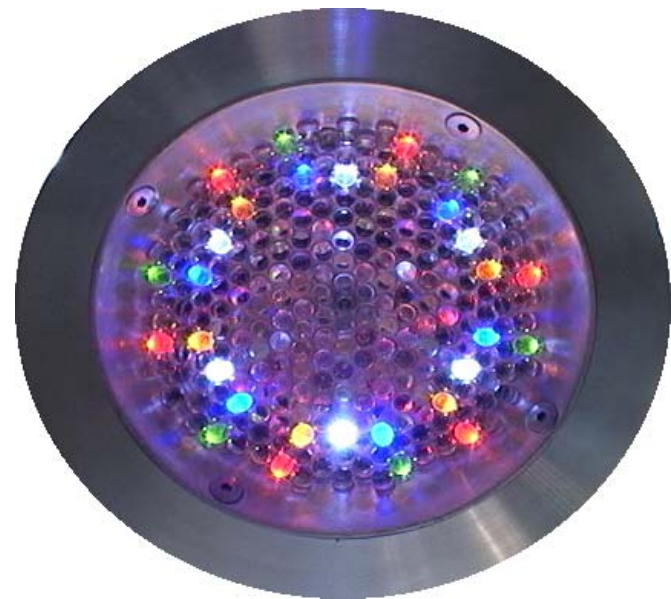
- Attempt to reproduce Hering's color-pairs
 - Equal distribution of Red, Green, Blue, Yellow
- White as base color (recall application)
 - Use more of white LEDs
- Arranged in beehive dome
 - Maximize space: hexagon
 - Radially symmetric
 - Concave for wider spread
- One LED light head:
 - 504 single-color LEDs



Use of Color



- Smallest controllable lighting unit
 - It shouldn't be one LED (too little contribution)
 - Choose six (one from each hexagon triangle)
- Colors are spatially equally distributed





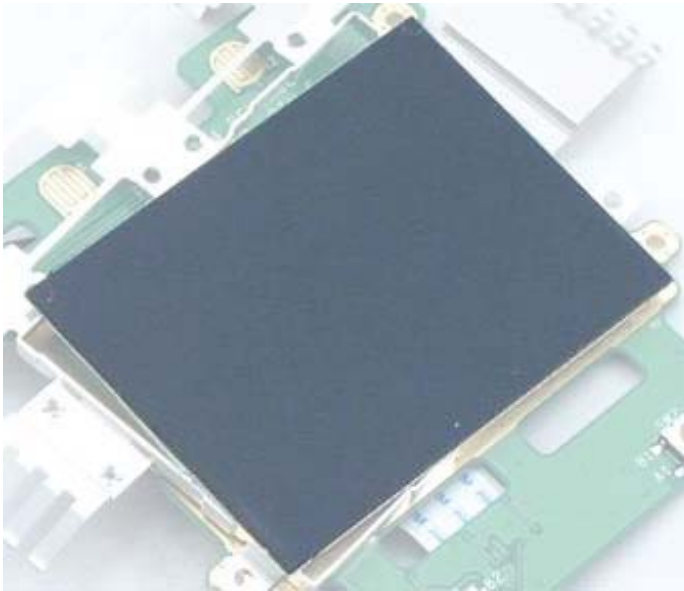
Use of Color

- Results:
 - Produce any color light
 - Produce white light not from mixing RGB
 - (White as pure as white LEDs can produce)
 - Induce yellow tones not from mixing R,G
 - Perceptively closer to sunlight or incandescent ones
- Drawbacks:
 - Spread of light from dome not blending perfectly
 - Better selection of LED diffusion and brightness
 - Use of tri-color LEDs for R,G,B (not Y,W)



Interface: Touchpad Dimmer

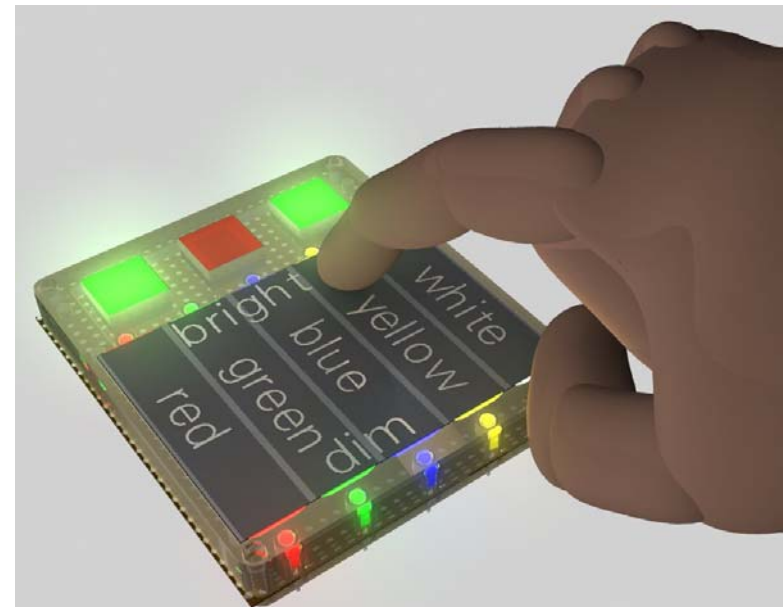
- Interface for typical light control
 - Dimensions:
 - Brightness
 - Color temperature
 - Goal: Simplicity in control





Interface: Touchpad Dimmer

- Implementation using Touchpad
 - 2D interface used as pointing device
 - Surface divided into “virtual” sliders
 - 5 vertical sliders, one for each color: R, G, B, Y, W
 - Effortless finger movement
 - Two dimensions
 - Vertical = brightness
 - Horizontal = color





Interface: Touchpad Dimmer

- Current implementation: two-dimensional
 - Color
 - Brightness
- Improvement possible in third dimension
 - Radial spread of light
 - New touchpads measure pressure of finger

Interface: TCP/IP Network



- Interface for custom applications
 - Dimensions:
 - Brightness
 - Color temperature
 - Selection of smallest lighting units (6-LED cluster)
 - Goals:
 - Customizability
 - Universal non-proprietary interface



Interface: TCP/IP Network

- Applications:

- Event modeling

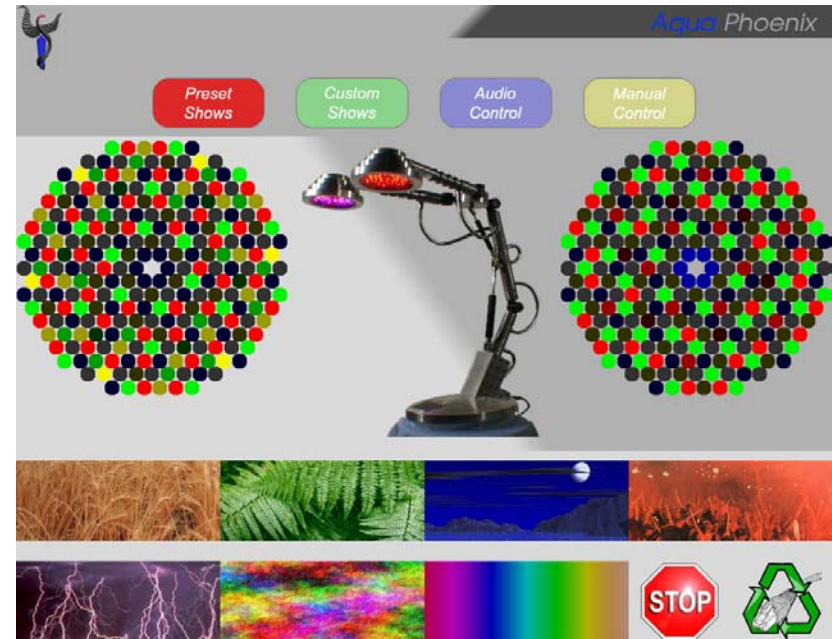
- While providing steady light, control other colors
- E.g. stock market event, door bell event
- Application for the hearing or otherwise impaired

- Sensor-based control

- E.g. weather, natural light

- Sound / music response

- Light shows



Interface: TCP/IP Network



- Implementation using Network Interface
 - Embedded wired network module
 - RJ45 jack
 - Standard IP address, e.g. 192.60.87.111
 - Responds to text messages (4 bytes)
 - < Head, Color, Cluster, Brightness >
 - Cluster: R, G, B, Y: { 1-8, ALL }, W: { 1-10, ALL }
 - Color: { R, G, B, Y, W, ALL }
 - Brightness: { 0-22 }
 - Head: { 0, 1 }





Interface: TCP/IP Network

- Current implementation:
 - Up to 50 events / sec (one every 20 msec)
 - No DHCP
 - No feedback (querying of state)
- Improvements desirable:
 - Faster, more events
 - DHCP (Dynamic IP address assignments)
 - Wireless
 - Network embedded in independent light head

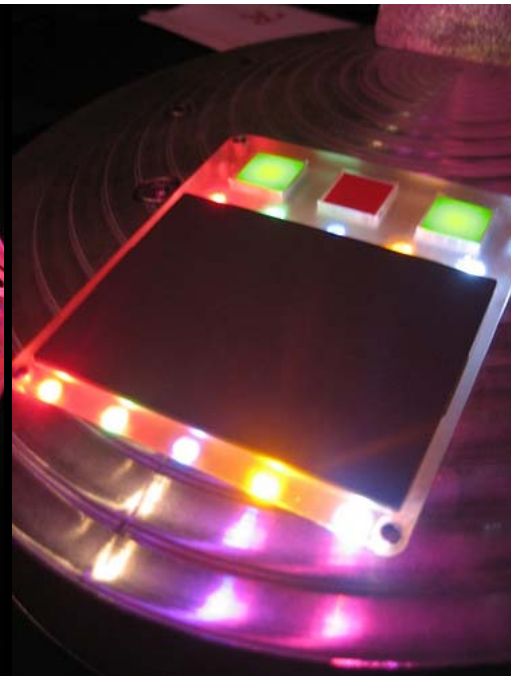
Conclusion

- LED light heads versatile, interesting, fun
- Network multiple light heads
 - Replace conventional indoor lighting?
- Provide control through
 - Simple light-switch-like interface
 - Application-based interface





Thank you!
Questions / Answers?





Biography

Alexander Haubold is a PhD candidate in Computer Science at Columbia University in the City of New York. His research focuses mostly on multimedia understanding and automatic summarization to build intelligent video browsers. In his spare time he avidly pursues projects in human computer interaction. The LED Lamp, one of his more ambitious projects, has been under development since 2001. It introduces a novel style of lighting and applies new lighting and lighting control techniques.