Team 9

In The Spotlight

Automatic Tracking LED Spotlight System
Team Members

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Outline

❖ Introduction
❖ Our Solution
❖ Design
  ➢ Optics
  ➢ Graphical User Interface
  ➢ Actuation
  ➢ Tracking
❖ Budget
❖ Deliverables
❖ Conclusion
Existing Spotlights

- Labor Intensive
- Hazardous Working Conditions
  - Heights
  - Extreme Heat
  - Loud Sounds
- Lack of Central Control
Our Solution

- LED Spotlight
Our Solution

- LED Spotlight
- Robotic Light Actuation
Our Solution

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- LED Spotlight
- Robotic Light Actuation
- Actor Sensing
Our Solution

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- Tracking
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- User Interface
Our Solution

- LED Spotlight
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- User Interface
Optics

- Design Alternatives
  - Elliptical
  - Parabolic (PAR can)
  - Parabolic (focused)

http://upload.wikimedia.org/wikipedia/en/2/2d/Followspotoptics.JPG

http://www.fas.harvard.edu/~loebinfo/loebinfo/lighting/PAR.gif
Optics

- Design Choice
  - Parabolic Reflector (7.5° beam angle)
  - Lens-less
  - Custom Grid Attachment
Lighting

- Chip-On-Board LED array
  - 80 kW (1kW typical for incandescent)
  - 9000-10000 lumen output
  - 3500K Color Temperature

http://media.digikey.com/Photos/Bridgelux/MFG_Vero%2029.jpg

http://media.simplyled.co.uk/media/catalog/product/cache/1/image/410x/9df78eab33525d08d6e5fb8d27136e95/g/u/gu10-5w-ww-60o-front-lower-res_2.jpg
Thermal Management

- 75% of LED power used
- Synthetic jet and heatsink
  - Thermal Wattage = 82W
  - Resistance = 0.49 C/W
- Max temperature recorded at 81 C

Lighting Control

- LED driver module
- RedBoard controller
- Overheat protection
- Actuation passed commands

GUI Design

❖ QT Libraries (C++ Based)
  ➢ Widely Used
  ➢ Developer-Friendly

❖ Options
  ➢ Live View Of Stage
  ➢ Actuation Control
  ➢ Lighting Intensity Control
  ➢ Tracking Mode
    ➢ Manual
    ➢ Automatic
GUI Design
GUI Design

- Communication
  - Apache Thrift
    - Client: GUI Software
    - Server: Tracking Software
Actuation Design

❖ Mirror Pointing or Direct Pointing
❖ Mirror Driven by Combination Belt-Gear Drives
Actuation Design

- Mirror Pointing or Direct Pointing
- Mirror Driven by Combination Belt-Gear Drives
Actuation Design

- Encoders Measure Motor Position
- Gearing to Gain Encoder Resolution
Actuation Design

- Custom Pan Control Board

- Microcontroller (ATMEGA 328P)
- Motor Driver (TI DRV8313)
- Ethernet Module
- 12V -> 6V, 5V Regulators
- Encoder Input
- E-Stop Connection
- 1/8” Headphone Connector
Actuation Design

- Custom Tilt Control Board
  - Microcontroller (ATMEGA 328P)
  - Motor Controller
  - 6V->5V Switching Regulator
  - Encoder Input
  - 1/8” Headphone Connector
Tracking Design

❖ Near-Infrared Beacon
➢ Near-Infrared LED
➢ Small Size
➢ Constant Current LED Driver
➢ Battery Status Monitoring
Tracking Design

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Tracking Design

- Hardware
  - General Purpose PC

- Software
  - Written in C++
  - OpenCV
Tracking Design

- Feature Extraction
  - Brightness
  - Shape
  - Size
  - Expected Position
  - Expected Blink Pattern

- Tracking
  - Kalman Filter

- Resulting Estimates
  - Location and Velocity
  - Target Present
Team Operating Budget

- $775 Approved Budget
- $780.77 Actual Spending
- Highest Cost Components: LED and Driver

Original Budget

Actual Budget
Deliverables

- Final Spotlight System
- User Manual
- Final Design Report
- Mechanical and Electrical Schematics
- Code
- Final Website
Lessons Learned

❖ Better Group Accountability and Time Management
❖ Mirror Pointing Paradox
  ➢ Mirror Pointing Chosen for Smaller Moving System
  ➢ Lack of Lenses Shrinks Spotlight, Expands Mirror
  ➢ Mirror Pointing Now has the Larger Moving System
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Questions