CONTROL MODULE

The Control Module is the heart of our system. The two main tasks this component is responsible for are interfacing with the lighting data steam and calculating the rotation of the spot light. Since there is a need to constantly monitor incoming data from the DMX 512 control board, modify the information with the proper light rotation, and send the data out to the light, we felt this task justified a dedicated processor. Appropriately named the DMX Processor this portion of the control module is responsible for creating and reading all DMX communications. The second half of the control module is named the Triangulation Processor. Once the location software has updated the location of the user, this processor will convert this data into the required light rotation and pass the information to the DMX Processor.

TRIANGULATION PROCESSOR

The goal of the Triangulation Processor is to convert the location of a presenter on the stage into the proper angles to which the light needs to rotate. There are two different operational states of the triangulation program. When the system is set into active mode (auto tracking is active) or bypass mode (light operator controls light rotation), this processor will constantly update with the most current user location on the grid. Once this location is acquired, the light rotation is calculated and the proper data is passed to the DMX Processor.

\[ \theta = \tan^{-1} \frac{x - X}{y - Y} \]

\[ \phi = \tan^{-1} \frac{\sqrt{(x - X)^2 + (y - Y)^2}}{Z} \]

During calibration mode, the Triangulation Processor needs to determine the location of the light with respect to the stage. In order to accomplish this, the processor needs to acquire both the location of the user on the grid from the Blind Node and the rotation of the light when it is pointed at the user from the DMX Processor.

\[ x_0 = \frac{\tan \theta_1}{\tan \theta_2} \cdot (x_1 - x_2) \]

\[ y_0 = \frac{\tan \theta_1}{\tan \theta_2} \cdot (y_1 - y_2) \]

\[ Z = \sqrt{(x - X)^2 + (y - Y)^2} \]

\[ X' = X' - x_0 \cdot \frac{\tan \theta_1}{\tan \theta_2} \]

\[ Y' = Y' - y_0 \cdot \frac{\tan \theta_1}{\tan \theta_2} \]

WIRELESS DESIGN

- Uses the Zigbee 802.15.4 standard for mesh network communication
- Customized interrupts to allow for proper calibration of the reference node grid

BLIND/REFERENCE NODES

Blind Node
- Carried by the subject to be followed
- Contains a CC2431 processor with the Z-location engine software allowing it to determine its X,Y location
- LCD screen for configuration and initial calibration of the entire system to ensure accuracy
- Powered by a lithium-ion cell phone battery allowing for many hours of use between recharges

Reference Node
- A grid of reference nodes is placed either underneath or at the edges of a stage to provide a static grid from which the blind node can determine its position
- This is a very simple device as it is line powered, static and requires no inputs.
**Initial Problem**

What are the two big factors that can influence the effectiveness of a production on the stage, or a presentation? Time and money. There are people behind the stage and the curtain directing and assisting the actors, controlling the lights, and cueing the show. What is the common element between all of these things? The potential for human error. In order to increase the effectiveness of a production or presentation the potential for human error can be eliminated from certain systems. One of the systems that can be changed is manual control of spotlights. Our project is in the process of developing a device that will be able to supplement the manual control of spotlights with the potential for automated tracking of an actor/presenter on stage.

**Project History**

**FOGBox**
- Controls the High End Systems F-100 Fog Generator from the 1/4 in. jack power output
- Initially designed to compete with the existing solutions at a lower price point

**SLIDEBox**
- Allows remote operation of the KODAK Ektographic III slide projector through the remote plug
- 3 states: Advance, Reverse, Neutral

**WALLBox**
- Manages the power delivered to the devices plugged into its power strip
- 2 states: On or Off
- Gives show lighting designers control over a wider variety of devices

**WIRELESSBox**
- A redesign of Rosco’s flicker candle to incorporate wireless control and dimming capabilities
- Candle power provided by a 9v battery
- 55 min runtime at full power
Z-Location Engine

- Integrated into the TI CC2431 microprocessors
- Based off of the Intel 8051 processor design
- Allows for acquisition of the X,Y location of a “Blind” node when it is in a grid of “Reference” nodes
- Accuracy of approximately 0.25 meters
- Extremely low power usage

PCB FABRICATION

Due to budget and time constraints, we were forced to find a convenient, fast and cheap way to manufacture our own circuit boards. We found that the following process surpassed our expectations.

What You Need:

- Blank Circuit Board
- Photo Paper
- Acetone
- Toner Printer
- Scotch Pad
- Iron

What you do:

1. Lightly scuff the copper on the circuit board with the scotch pad and clean the surface with acetone.
2. Print the board layout onto photo paper using a toner printer and iron the pattern onto the circuit board.
3. Soak the circuit board in water to soften up the photo paper. Once the paper is wet rub off all excess paper using your finger or tooth brush.
4. Place the circuit board into a bath of Ferric Chloride for the acid etching stage. Check every 5 minutes until all excess copper is removed.
5. Wash away all the toner using acetone.
6. Drill holes and place parts.