ECE 445
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Project Proposal

# Music Response Light Show

Andy Groesch
TA: Lydia Majure

**I. Introduction**: In the entertainment industry, there is a demand for lighting systems that react to music in real time. On the supply side, there is a dearth of consumer friendly options, and the most visually stimulating systems are expensive and thus limited to entertainment venues. Furthermore, these professional grade systems typically display pre-determined combinations of lights. A music response light system for personal use would undoubtedly fulfill this niche, while also providing a new product not readily available elsewhere.

**Objectives**

Goals:

- Build and configure malleable LED trees
- Develop circuit for patterns
- Program onto arduino microcontroller
- Implement user controlled board for active control aspects

Functions:

- Circuit hears sound, displays a pattern
- Changes patterns/which combinations of LEDs are in use based on input from user
- LEDs respond based on tempo, amplitude, & frequency
- LED light intensity based on amplitude of signal and abrupt changes in beat

Benefits:

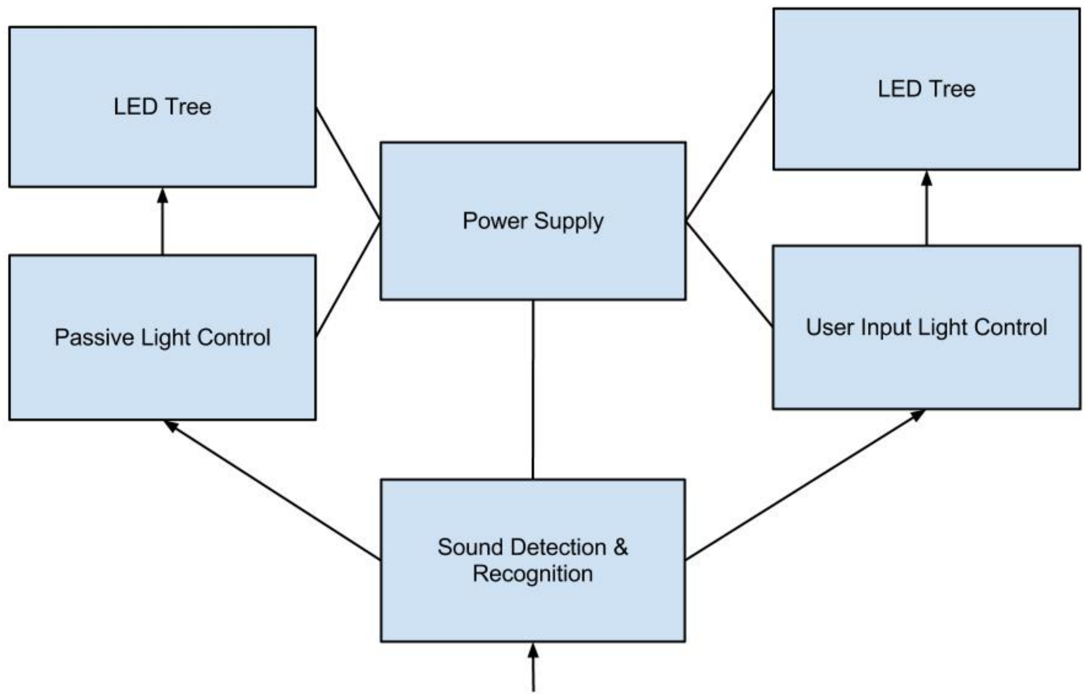
- Visual stimulation in conjunction with existing auditory installations
- Cost effective for all users
- Individuals with hearing impairments can enjoy

Features:

- The 'branches' on LED tree are moveable
- 8 different patterns to choose from
- User input affords randomness and variance to each production

**II. Block Diagram**

**Summary**: The LED trees will be in the front of the user. The orientation of the branches is up to the discretion of the user when setting up because of their malleable nature. A microphone will detect the beat and then change the brightness of the LEDs with respect to the amplitude of the waveform. Certain pre-chosen combinations of LEDs will be triggered by pre-determined events (discussed more thoroughly in the following description). All the components are connected through wired connections as wireless communications between the devices would be excessive. That being said, as the number of LED 'trees' scales upwards, wireless connections would provide the opportunity to put significant spacing to the trees, which would provide for larger trees.




**Passive Circuit:** The passive circuit will consist of an arduino microcontroller that accepts input from the sound recognition module and processes it, which is then sent to an array of LED trees. The arduino microcontroller will be programmed to direct certain configurations of lights to flash depending on the input. An example is that when an electronic song enters a build, the drums shift from bass to snare. This change would then be met with a different combination of lights to strobe with the beat than before the change. After the drop (of the build), the bass drums return; this would then direct the LED trees to display a new light pattern. Furthermore, the lights ideally would be dimmer before the build as opposed to after; this is because of the intensity of music at the aforementioned junctures. Making this distinction could lead to programming of the circuit such that the bass sensitive lights appear at near max intensity if they've been unused for longer than five seconds.

**Sound Recognition Module:** The module will have a microphone that detects music from its surroundings. From this, the music's basic characteristics will be sampled such that the tempo, frequency, and amplitude of the waveform are known. The sound recognition module then passes this information to the passive circuit for applying patterns to. The information is also passed to the user input light control for event detection (beginning of build, drop, chorus, climax, etc).

**LED Tree:** The LED tree will consist of strong, malleable wire similar to a tree in that is has a base that have wire 'branches' that extend out. The base has LED strands that connect to the User input panel. The branches have series of individual LEDs that respond to the passive light control. This setup was chosen because it provides new ways of arranging the LEDs each time the setup is deployed. Each LED tree will receive power from the power supply. One tree will be the output for the passive circuit response.

**User Input Light Control:** The user control pad will incorporate the signals from the sound recognition module and prepare light patterns for combinations separate from the passive logic circuit. The difference is that the user controls which patterns are chosen based on personal preference. This provides a random variable with this performing art that finds a harmony between man and machine.

**Power Supply:** The power supply will provide power to all necessary components. The functioning of the LED's/their brightness is directly tied to the voltage outputted by the two logic circuits, so the voltage must be over a certain threshold such that the circuit operates as intended.

## III. Requirements and Verification

**Requirements**

1. The LED trees must accept the input from the passive circuit and the user input module and respond with the correct patterns
2. The power supply must supply adequate power to all necessary LED's (quite a strain given how many will be in parallel), the two logic circuits (passive & user), and the sound recognition module.
3. The passive circuit must take the data from the sound recognition module and process it such that it provides a pattern for the LED trees to follow
4. The control pad must accept input from the user and respond accordingly by engaging the requested pattern of lights, including deciding which lights follow the passive circuit's patterns
5. The sound recognition module (more specifically the microphone) must detect audio in the air and process it such that the passive circuit and user input module

**Verification**:

1 Test the circuit of LED's for continuity and functionality
2 Power Supply: first run power supply through simple circuit to ensure it provides power, then slowly increase the impedance (LED trees) while ensuring that the power supply doesn't burn out any essential components
3 Play songs that are well known/understood compare that to passive light output
4 Test output signals from control pad and verify that they correspond to the user inputs.
5 Ensure that the microphone detects sound in the air and that it passes the signals onto the logic circuits

**Tolerance:**

The power supply must provide at least 3 volts to each LED to ensure that they function properly. This shouldn't normally be an issue, but once one considers that putting LEDs in series reduces the voltage by KVL in addition to the fact that the scale increases dramatically, this should always be a prevalent design concern. Ideally, the applied voltage would be relatively close to 3 volts; if the voltage is too far above 3 volts, this will be a waste in that more LED's could be added in other places to consume the same power. Furthermore, if the voltage is too high, the dissipated power in the circuit will cause irreparable damage. The voltage threshold depends on the tolerance of the specific LEDs.

## IV. Cost & Schedule

**Labor**

40 ($/hr)* 200 (hrs) * 2.5 = 20,000

**Parts**

| | |
|---|---|
| Arduino Microcontroller | $30-60 |
| LEDs (at least 3 colors) | $100 |
| Malleable metal wire | $20 |
| Power Supply | $30 |
| Microphone | < $10 |
| PCB | free |
| Estimated Parts Cost: | $220 |

Grand Total = 20,220

Schedule

| Date | Tasks to be Completed |
|---|---|
| 2/11/2013 | Begin learning DMX512 to program Arduino microcontroller<br>Buy Arduino microcontroller<br>Research specific part numbers for components |
| 2/18/2013 | Test power supply with LEDs<br>Buy parts |
| 2/25/2013 | Begin testing LED wire tree designs<br>Begin programming Arduino microcontroller<br>Develop architecture for user input light control |
| 3/4/2013 | Build prototype LED wire tree<br>Implement architecture for PCB; request revisions |
| 3/11/2013 | Test LED wire tree prototype<br>Develop PCB design for user input light control<br>Finish preliminary Arduino microcontroller programming |
| 3/18/2013 | Finalize LED wire tree design. |
| 3/25/2013 | Get Arduino microcontroller programming revised<br>Test PCB with LED tree prototype |
| 4/1/2013 | Assemble finalized LED wire trees<br>Finish programming Arduino microcontroller |
| 4/8/2013 | Assemble each module and connect them together |
| 4/15/2013 | Test Integrated system |
| 4/22/2013 | Fix Bugs related to system |
| 4/29/2013 | Test Final Project |