

D4 - Synesthesia

Project Proposal

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Use Case

- Automate light show programming for musical performers
- Reduce lighting preparation time for performers
- Produce light shows that reflect the nuances of the music more

ECE Areas:

- Signals and Systems
- Software Systems



Requirement #1

Dynamic lighting in real-time

Motivation:

While maintaining complexity in the light programming, there should be no noticeable delay between music and lighting,

Sub-Requirements:

- Lighting should be triggered within < **100ms** of audio
- Audio processing should pick up on > **90%** of key auditory features of music
- Different lights should be able to operate in unison and independently over the course of a song

Requirement #2

Ease of use

Motivation:

This solution should be significantly easier for performers to use compared to programming the stage lights themselves.

Sub-Requirements:

- Setup time < **5 min**
- Performers should need to make < **3 adjustments per minute**
- If the system fails the **lights should continue to operate** in some basic mode

Requirement #3

Customization based on genre and performer

Motivation:

Different genres and performers will have personalized needs for lights and should be able to tune the lights to match their needs

Sub-Requirement

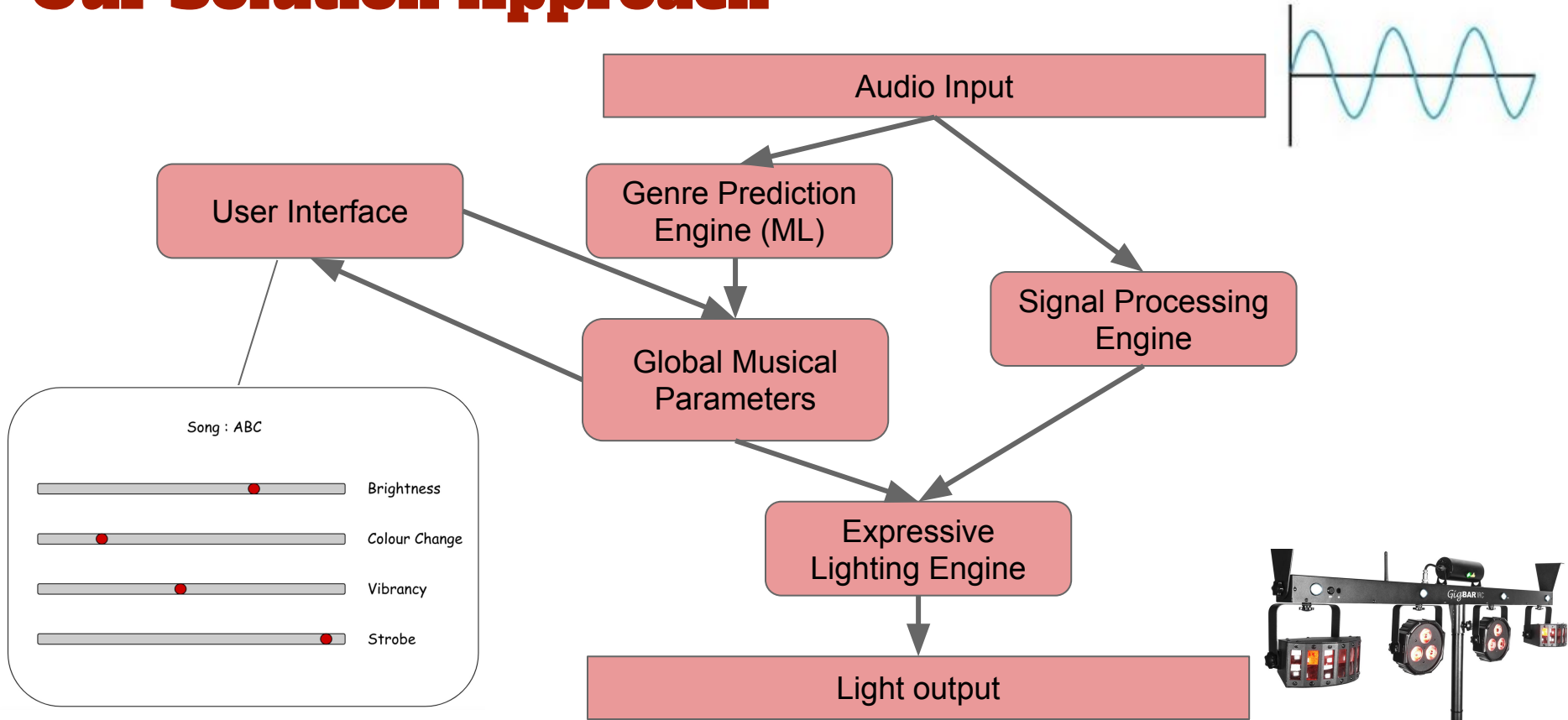
- Genre detection with > **90% accuracy**
- Manual overrides for most visual parameters

Challenges

How do we ...

1. **extract** a subset of relevant features from the audio?
2. **create** optimal frame intervals to split audio by and **determine** inflection points for light change?
3. **optimize** the signal decomposition to respond in real time with low latency?
4. **synchronize** the system to coordinate between multiple types of lighting?

Our Solution Approach



Testing and Verification

1. **Audio Classification Tests:** Measure accuracy of genre detection and auditory feature detection.
2. **Light Response Tests:** Test that the system is able to communicate with the lights and respond to the audio
3. **Customizability Tests:** Verify that genres differences and manual user overrides noticeably change lighting output using user focus groups
4. **Output Latency Tests:** Measure total latency from audio ingestion to light output.
5. **Multiple Outputs Tests:** Test whether multiple lights work synchronously and independently during a performance

Tasking and Labor Division

- I/O communication with lighting (DMX/QLC+)
- Genre Prediction Engine
- User Interface
- Signal Processing Engine
- Expressive Lighting Engine

Scheduling

Task	1/30	2/6	2/13	2/20	2/27	3/6	3/13	3/20	3/27	4/3	4/10	4/17	4/24	5/1	5/8
Interface for Audio and Lights						S									P
Visualization and UI		█				P									R
Backend Server			█			R									O
Login and Profile Management				█		I									J
Light Controller and I/O Communication		█				N									E
						G									C
Audio Decomposition and Processing															T
Audio processing of MP3 / web files		█				B									
Decomposition Criteria and Benchmarks			█			R									D
Audio Inflections to Light Control				█		E									E
						A									A
						K									D
Expressive Lighting Engine															L
Determining triggers		█													I
Generating Light Fixture groupings			█			S									N
Select appropriate light program from triggers				█		P									E
						R									
						I									P
						N									R
Machine Learning Subsystem						G									O
Training using Spotify's features		█													J
ML for Genre/Mood Detection			█			B									E
Develop Testing Tracks				█		R									C
						E									T
						A									
Testing and Integration						K									D
Software Interface <-> Lighting Engine							█								E
Develop Testing Tracks								█							A
Scenario Testing									█						D
															L
Housekeeping															I
Slack	█	█	█	█	█	█	█	█	█	█	█	█	█	█	N
Meeting Agenda	█	█	█	█	█	█	█	█	█	█	█	█	█	█	E
Meeting Minutes	█	█	█	█	█	█	█	█	█	█	█	█	█	█	

Key	Name
█	Abhishek
█	Parth
█	Rachana
█	All

Conclusions

- Proposed a system to **control lights with audio** inputs
- Hope to provide a system that can **analyze new audio** with **indecipherable lag**
- Plan to test **several genres** of music with **multiple lights**