YouRap

Team B5 -
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Application Area

Rap is the most popular genre of music today in the US with 24.5% Market Share

(Almost) Everyone wants to rap! But...

- Digital Signal Processing
- Software Systems
- Hardware Systems

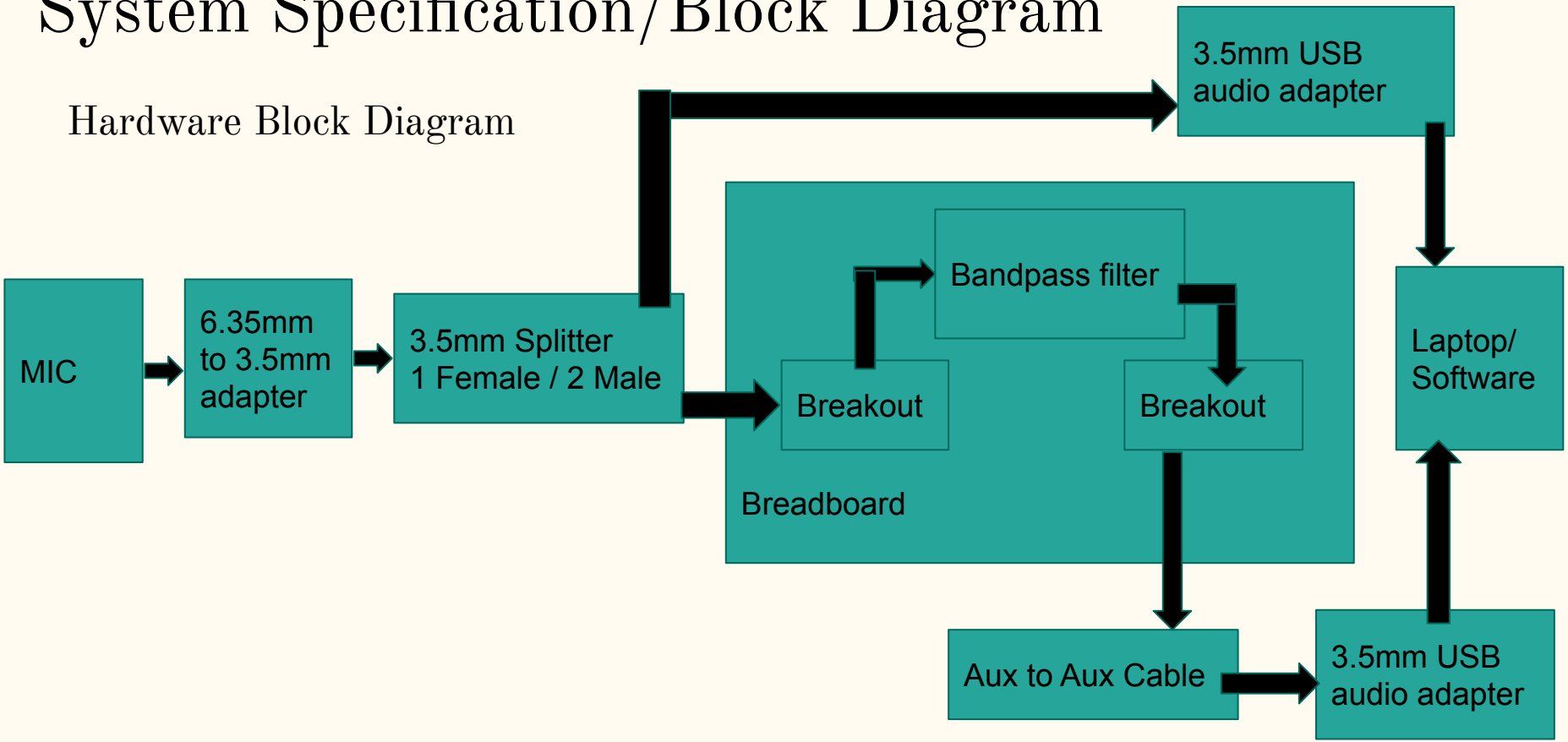
Solution Approach

We will be building a software suite webapp to help the user rap on time. The program will provide real-time live feedback on whether the user is too fast or too slow and their consistency. It will also allow users to add effects to their voice, post recording.

We are also building a noise filtering microphone setup using cheap, readily available hardware components for accessibility for 85$, which is less than half the cost of the industry standard XLR microphones + USB Converter (200$).

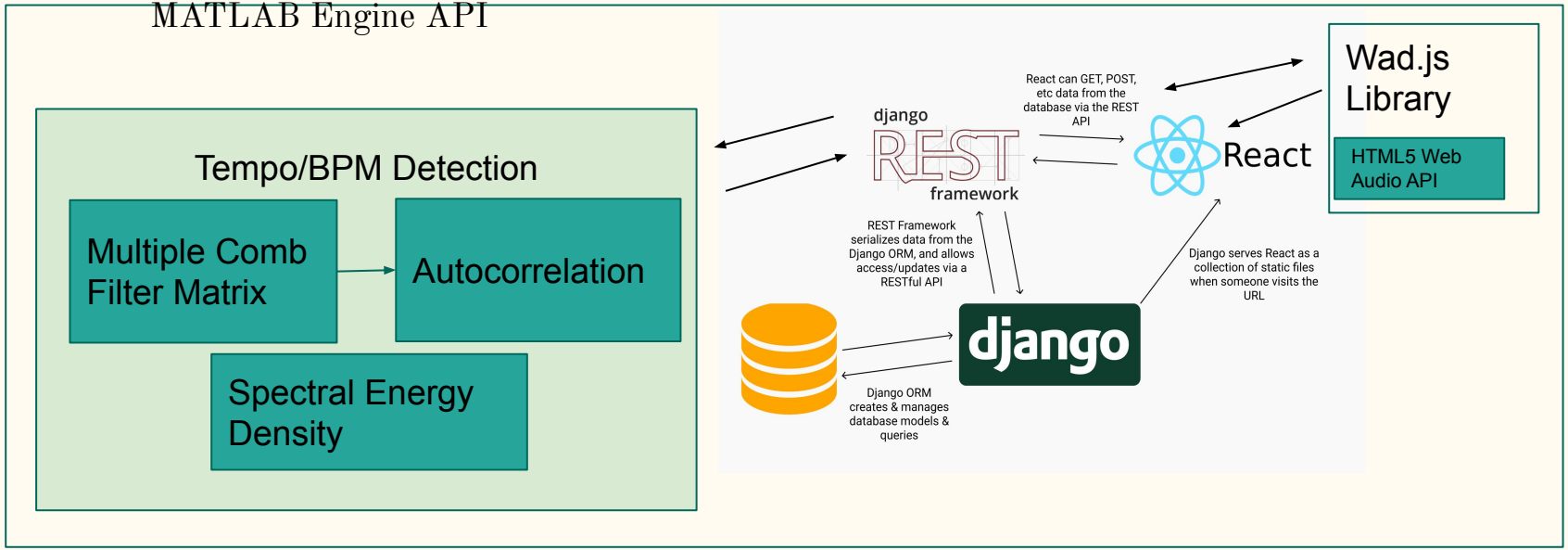
System Specification/Block Diagram

Hardware Block Diagram



System Specification/Block Diagram

Software Block Diagram



Base Software Stack Image taken from -https://blog.usejournal.com/react-on-django-getting-started-f30de8d23504

Implementation Plan

Rhythm and Beat Detection

- Comb filters and autocorrelation (Backing track BPM)
  - Comb filter sums signal at delayed versions whereby the lag which corresponds to the highest energy is the correct tempo
  - Autocorrelation will measure cross-correlation of a signal with itself; better at estimating tempo when a consistent, rhythmic beat is present
- Spectral Energy Density (User rapping input BPM)
  - For detecting the tempo at which a user is rapping by detecting spikes in energy
- On-beat detection
  - Compare backing track BPM to live vocal BPM to determine tempo accuracy
  - Every 3 seconds, if BPM varies by more than 5%, user is alerted

Implementation Plan

Noise Filter

We are going to use a circuit as a pre-filter, so we have a clear starting frequency range to work from. Then perform a more refined filter on software

Equipment (Total 85$)

- Singing Machine SMM-205 Microphone ($9.99)
- Two UGREEN USB Audio Adapters ($8.99 each)
- Two SparkFun TRRS 3.5mm Jack Breakouts ($3.95 each)
- YCS basic Splitter Cable 1 Female / 2 Male ($6.29)
- KabelDirekt - Two Sided Aux Cord ($7.99)
- OneOdio Headphones ($32.99)

We plan on interacting the parts together as illustrated in the Hardware Block Diagram

Implementation Plan

WebApp

Wad.js library will allow us to interface with microphones and headphones using inbuilt browser functionality due to the HTML5 Web Audio API allowing a lot of the processing to happen in the front end, greatly reducing the stress on the backend and thus increasing throughput.

Metrics and Validation

Testing goals:

Beat and Rhythm Detection

- 100% accuracy on detecting beats in a simple 4x4-beat
- 80% accuracy on detecting rhythm in slow speech

Final/Live metrics:

Rythm and Beat Detection

- 60% accuracy on complex user-input selected beats
- 60% accuracy on live user rapping

Metrics and Validation

Noise Filtered USB Microphone

- Target Metric - 25 dB signal to noise ratio

Noise Filter Validation using Oscilloscope

Benchmark against Shure SM58 X2U with

XLR to USB Signal Adapter

Metrics and Validation

Testing goals:

GitHub Feature Branch Workflow - Validation using Code Reviews

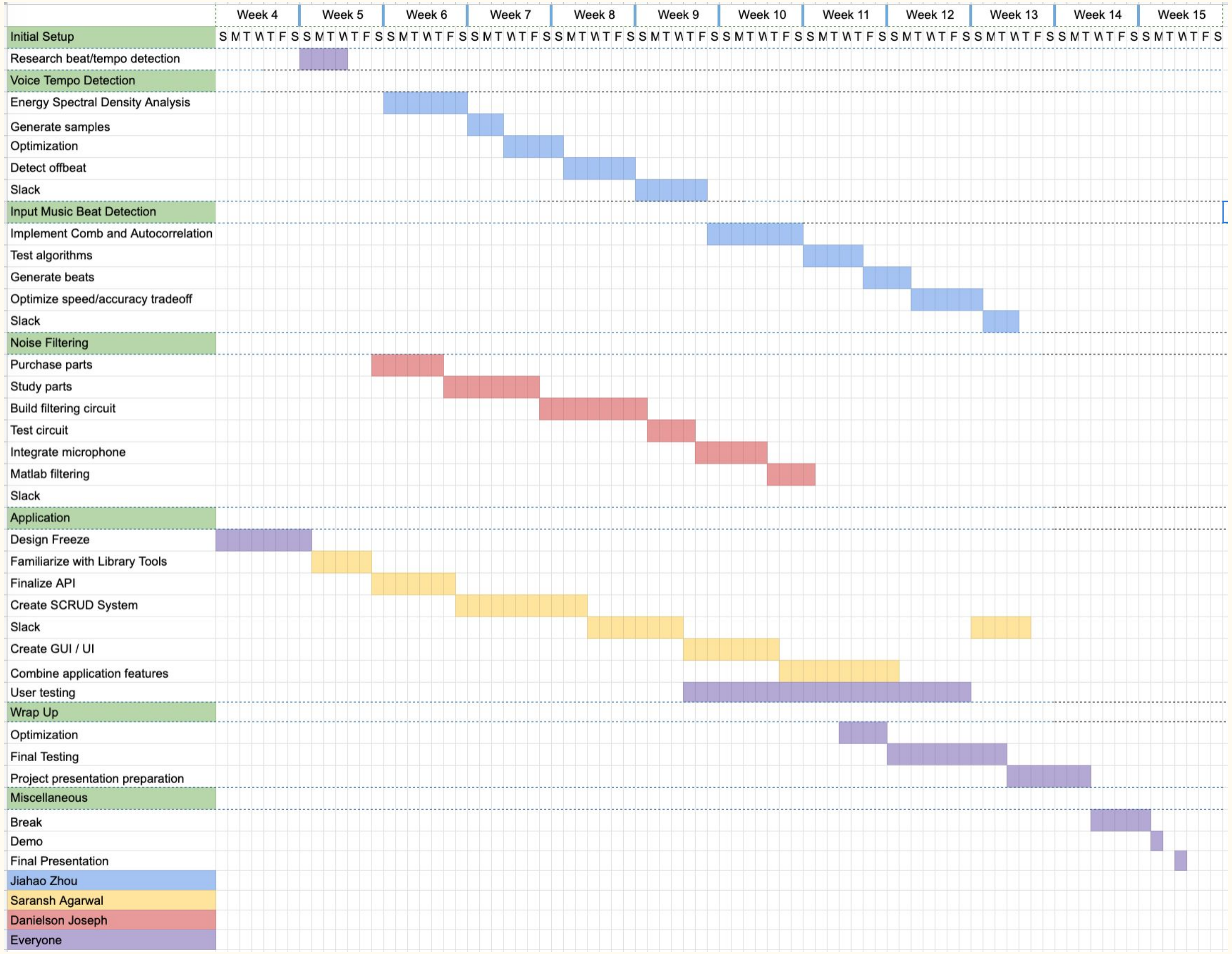
Blackbox Testing of the components

Web Application Metrics

- 1 second total delay
- 200ms target latency

Run locally on the machine, if time permits will try to deploy on AWS

Schedule



Week 4
Week 5
Week 6
Week 7
Week 8
Week 9
Week 10
Week 11
Week 12
Week 13
Week 14
Week 15
Initial Setup
Research beat/tempo detection
Voice Tempo Detection
Energy Spectral Density Analysis
Generate samples
Optimization
Detect offbeat
Slack
Input Music Beat Detection
Implement Comb and Autocorrelation
Test algorithms
Generate beats
Optimize speed/accuracy tradeoff
Slack
Noise Filtering
Purchase parts
Study parts
Build filtering circuit
Test circuit
Integrate microphone
Matlab filtering
Slack
Application
Design Freeze
Familiarize with Library Tools
Finalize API
Create SCRUD System
Slack
Create GUI / UI
Combine application features
User testing
Wrap Up
Optimization
Final Testing
Project presentation preparation
Miscellaneous
Break
Demo
Final Presentation
Jiahao Zhou
Saransh Agarwal
Danielson Joseph
Everyone