

LEDshred

Comprehensive Design Review

Team 5

ECE 416

SDP 2021

April 2, 2021

The Team



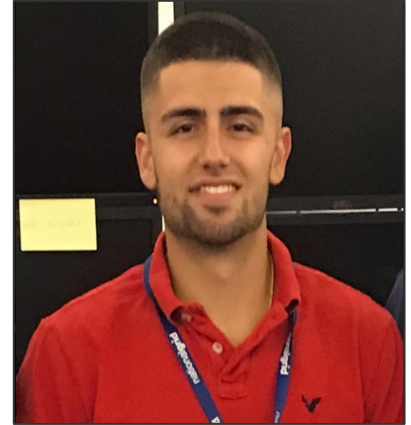
Jordy Mukania
Electrical Engineer
Team Coordinator



Isaiah Provencher
Electrical Engineer
Altium Lead



Jake Colapietro
Computer Engineer
Budget Management



Kivan Daruwalla
Computer Engineer
Software Development

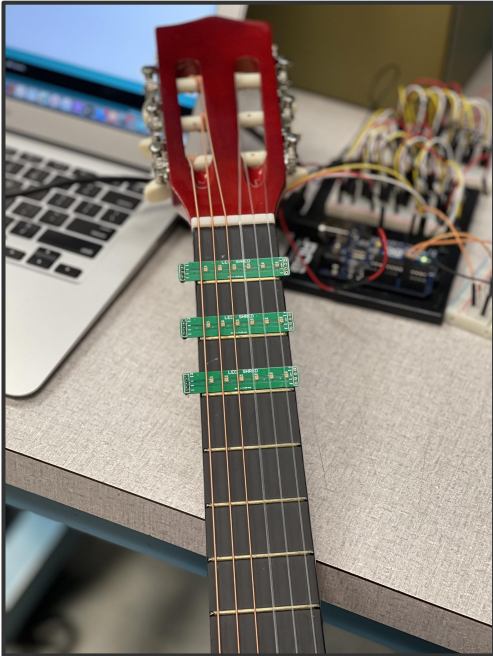
Problem Statement

- Guitar beginners easily discouraged to learn instrument due to difficulties of playing
- Tutors may be effective but usually very expensive
- Our product will use LED lights on guitar fretboards to “light up” notes in order to guide the user through playing
- Will provide feedback on their performance by checking whether or not correct notes were played
- Goal of overall system is to help users improve and play proficiently

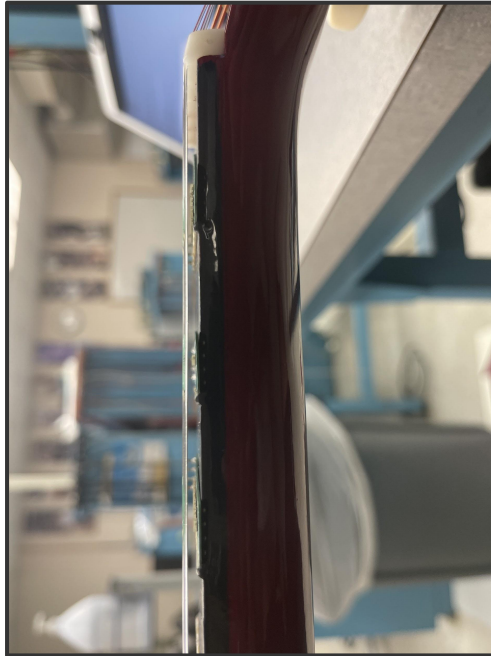


Frustrated guitar player

Visual Representation of Our Solution



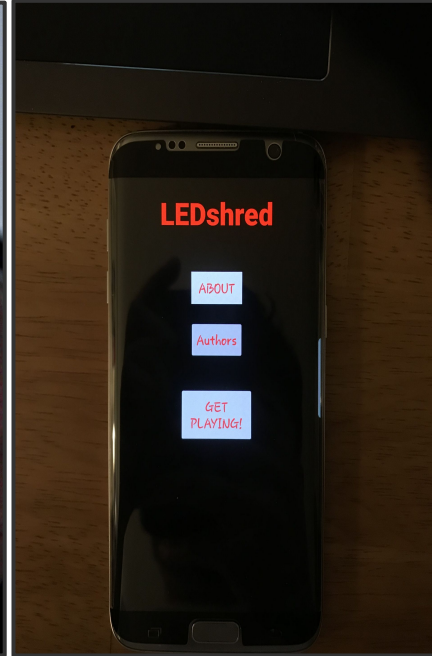
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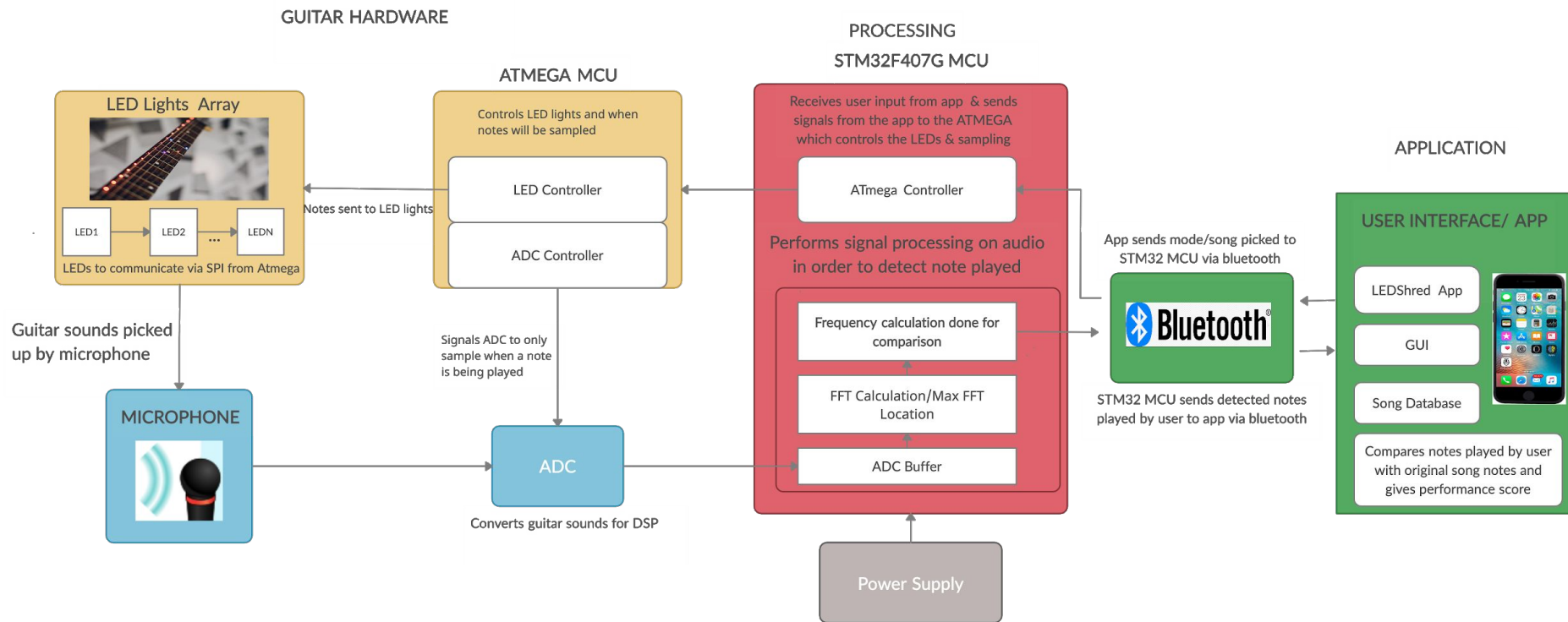
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System Specifications

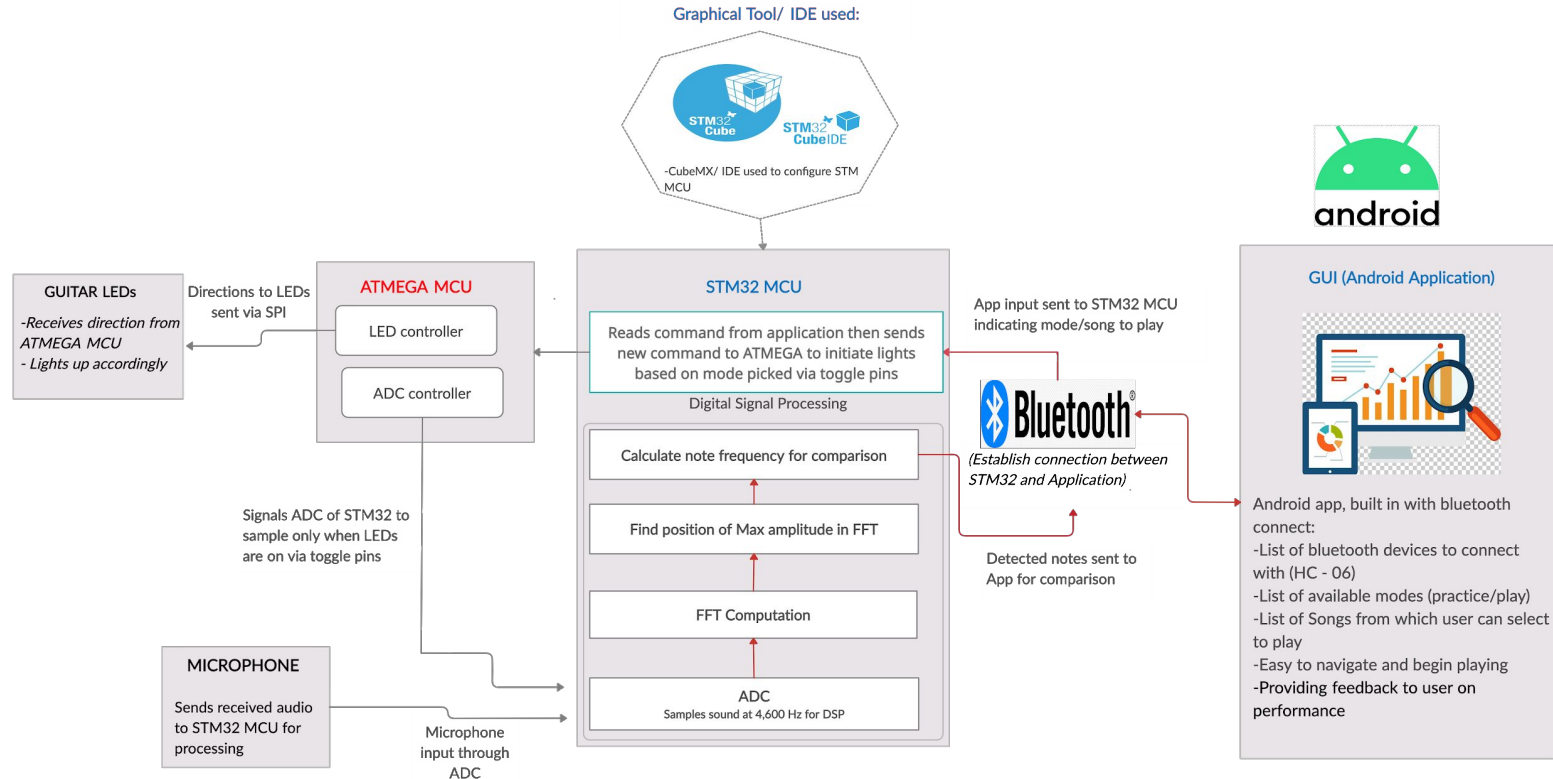
- LED lights attachable to any guitar (Typical 38 inch long guitar)
- 4 X 6 array of LEDs (4 fret rows with 6 LEDs across each string)
- Height of LEDs less than 2.5 mm
- Accompanied by app which supports bluetooth connectivity to user device
- Samples guitar notes at ~5,000 Hz
- Samples sound only at metronome of given song
- Correctly distinguishes a note (open and single notes) > 95%
- Offers user performance report within 5 seconds after play session is finished

Color Legend
Work in progress
Spec achieved

Updated System Block Diagram



Updated Software Block Diagram

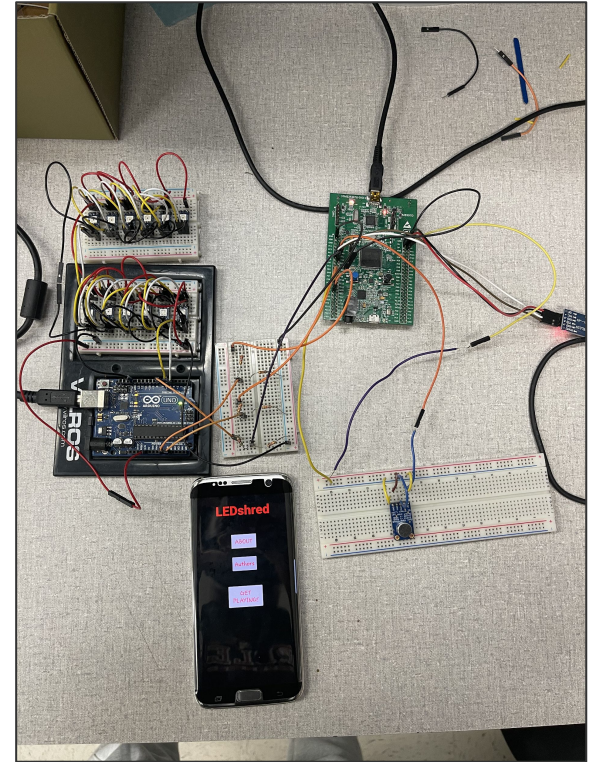


CDR Deliverables

Engineer	Deliverable
Jordy	Control LED lights with STM32 MCU using Atmega MCU as a peripheral as well as design PCBs for the guitar LED lights
Jake	Move note identification algorithm over to the STM32 MCU and continue testing input notes to improve accuracy. Also work to send the identified notes to user application
Isaiah	Design the main PCB for our system as well as working to improve the output of the microphone before the conversion to a digital signal
Kivan	Further design the Android application to get closer to the final model. Also work with the bluetooth module to ensure proper communication with other subsystems.

LED Lights

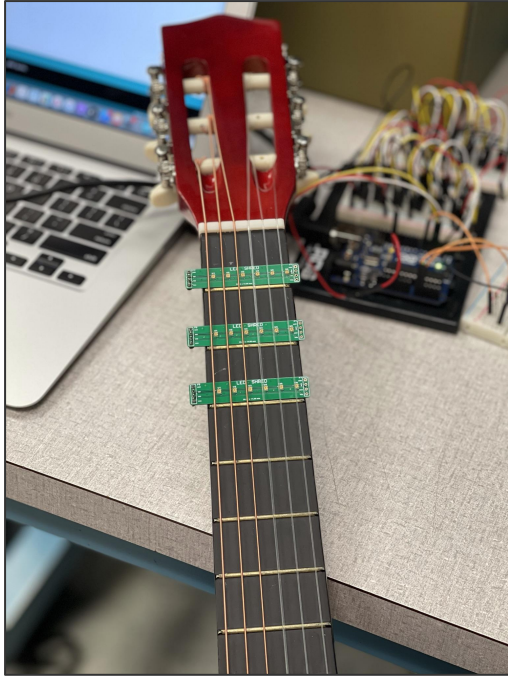
- LED array implemented with STM32 MCU
 - Main board that's connected to user application via bluetooth
 - Uses Atmega328P as peripheral to control the LED lights
- PCB with soldered LEDs fulfill height specification
- Able to use LEDs to “light up” corresponding guitar strings to represent notes user should play



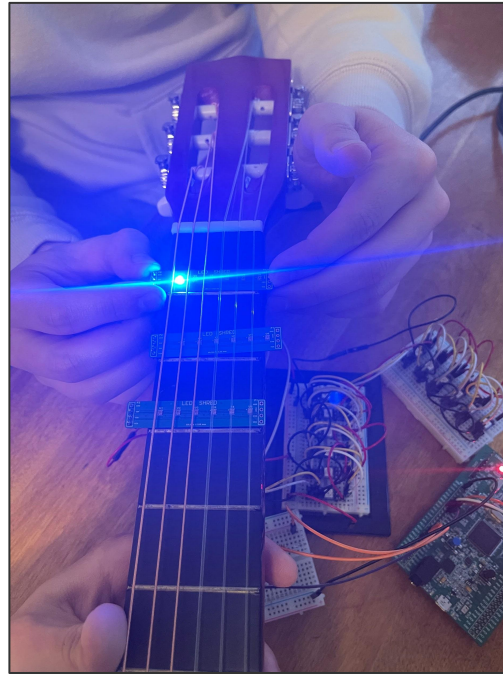
LED array connection with system

LED Lights (2)

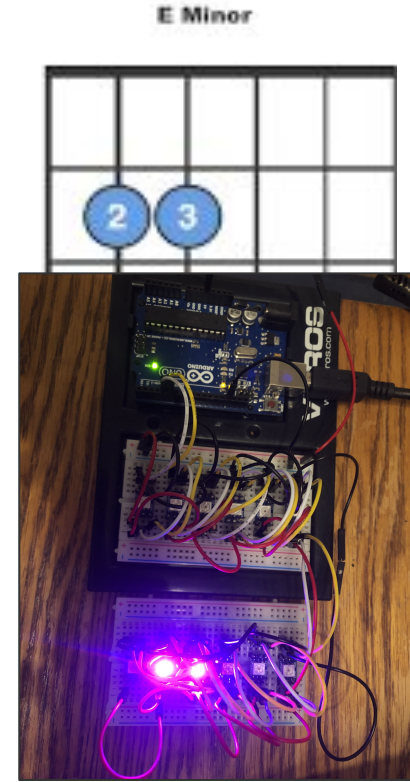
Figures showing planned implementation for future



1



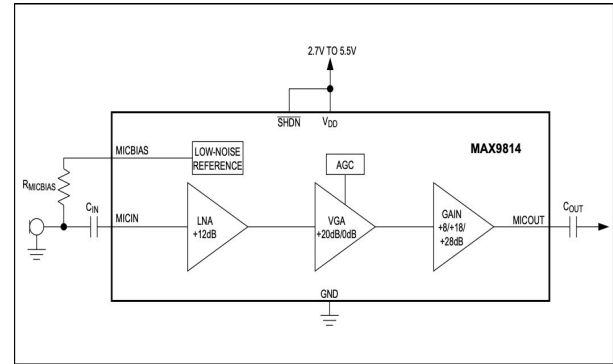
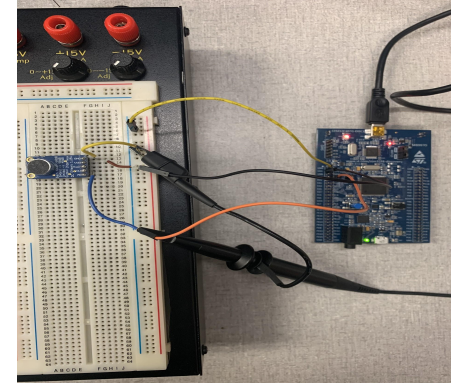
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3

Microphone

- The microphone picks up the signal played by the guitar and sends that directly to the ADC to be converted into a digital signal
- Able to match up the frequencies of notes on the guitar to what was picked up by the microphone and then processed by the microcontroller



Audio Processing

- Currently we have a working C program that takes audio input through an on board ADC.
- These values are processed and used to find the notes.

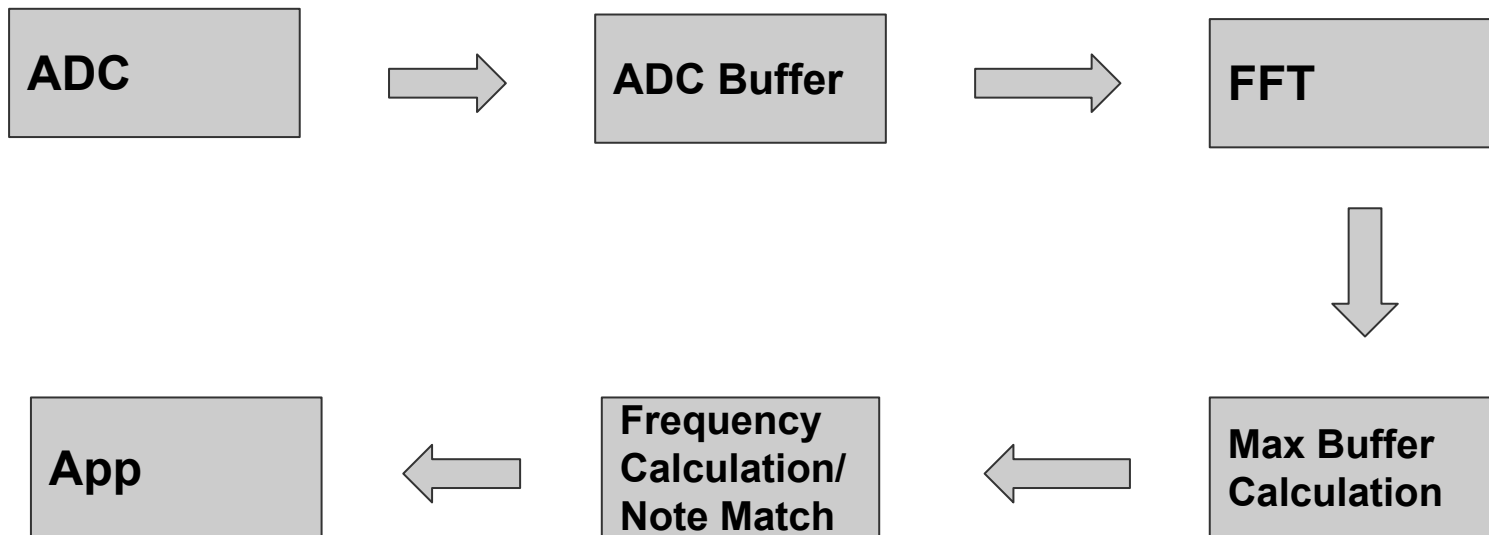
Play order	Frequency (Hz)
1	328.245
2	328.803
3	329.361
4	330.478

Figure 1

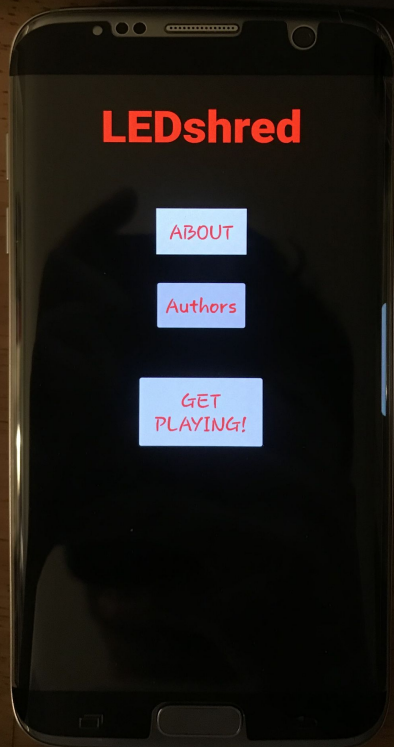
Play order	Note
1	E
2	E
3	E
4	E

Figure 2

DSP Algorithm



Homepage with option buttons



Deliverables

- Kivan Daruwalla

- Generate layout of application with available functionality ✓
- Make functionality on application work with data from MCU ✓

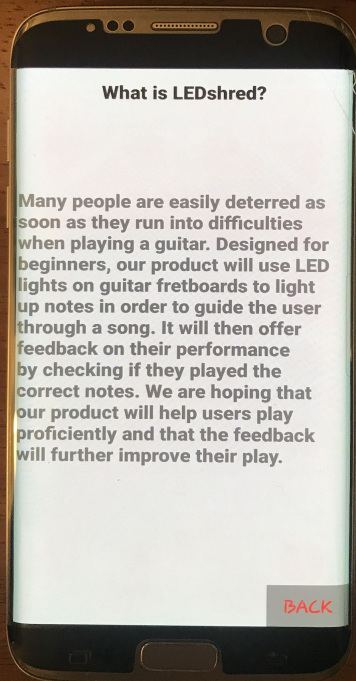
Home Page

- Allows user to select information about LEDshred or Authors
- Users can access the song list by tapping “GET PLAYING!”

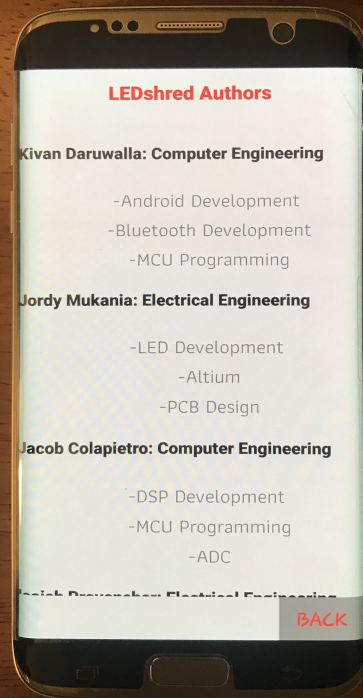
(First place user is brought when application boots up)

Android Application Layout (About/Authors)

About page with problem statement



List of Author names, majors, and roles (slide down)

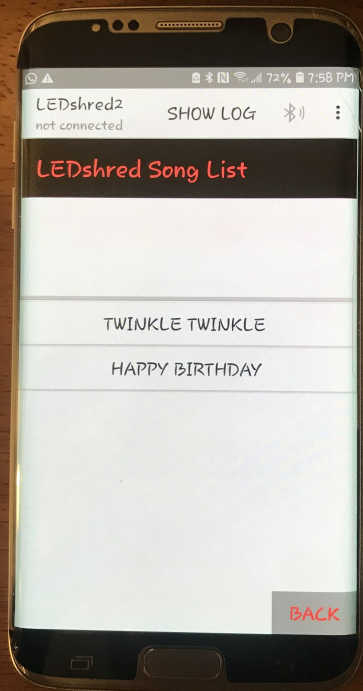


- *Kivan Daruwalla*
- About page providing information about LEDshred.
- Authors page providing background on our roles

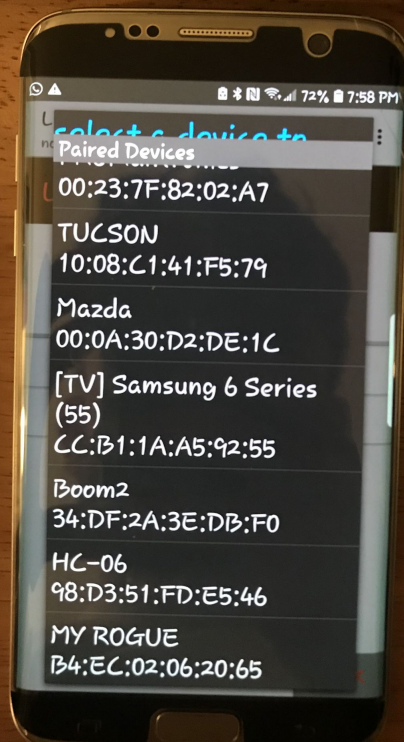
Back Button for Navigation

Android Application Layout (Songs/Bluetooth)

Song list for user to choose from



List of devices for user to pair with via Bluetooth

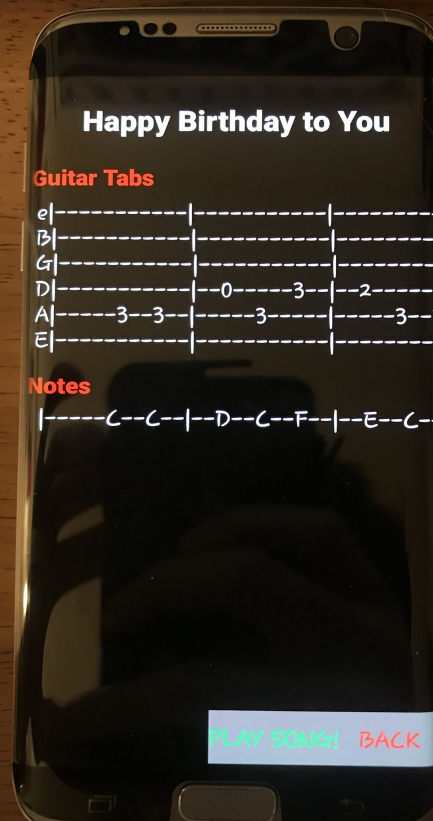
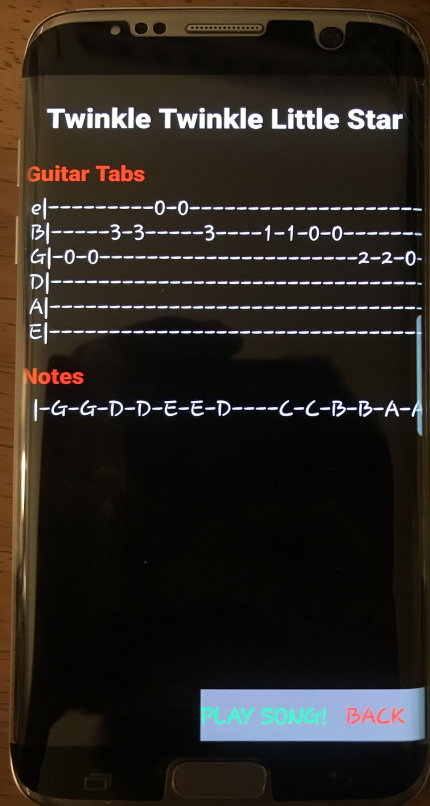


- *Kivan Daruwalla*
- Song list allows users to select which songs to play
- Paired device page allows for bluetooth connection to our system (via HC - 06)

Android Application Layout (Song Pages)

Individual Song Details (Tabs/Notes)

(Both Tabs/Notes scroll horizontally)

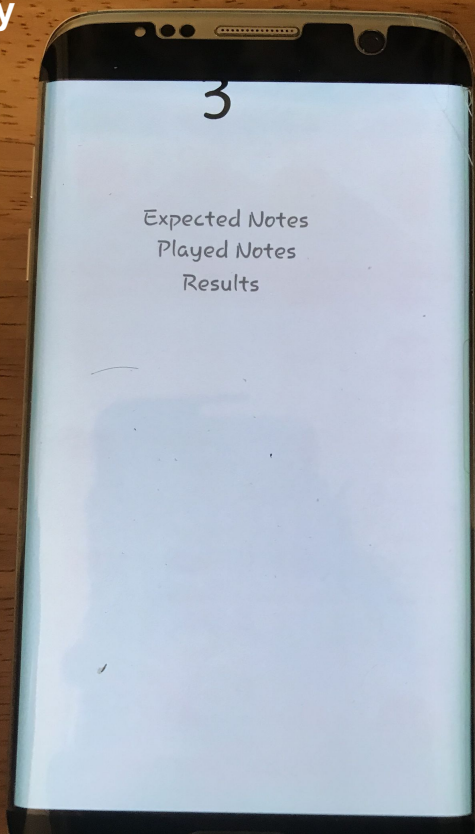


- *Kivan Daruwalla*
- For each song, Tabs and notes
- **Tabs:** show fret position on string for each note in song
- **Notes:** Represent the actual note on A to G scale.

(Allow user to learn song before trying to play)

Android Application Layout (Play Song / Results)

Countdown from 3 to indicate start of play

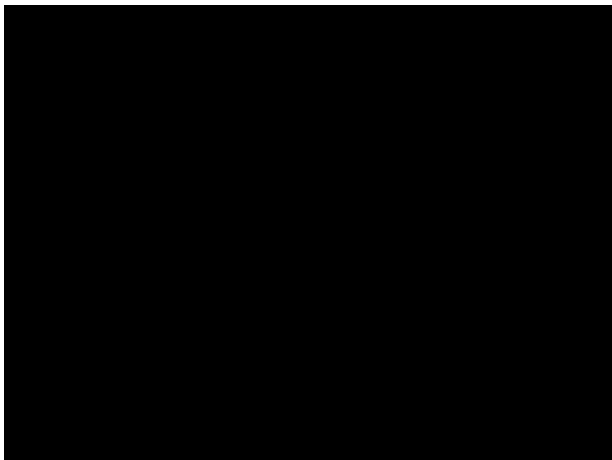


Results displayed to user on their performance (expected notes vs played)

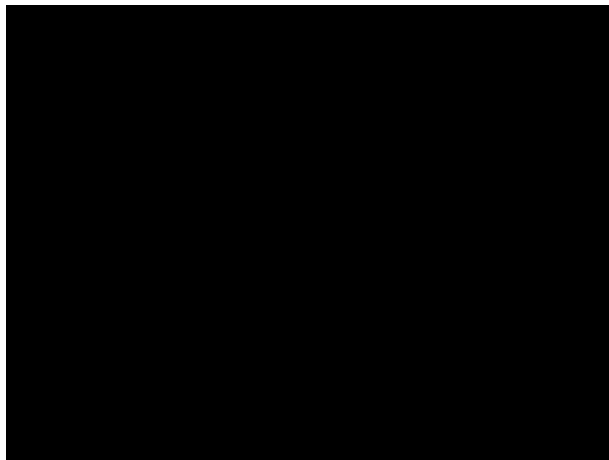


- *Kivan Daruwalla*
- Countdown from 3 to indicate user when to start playing along with LEDs
- After song is completed, users notes displayed as feedback
- **Correct Play Percentage:**
Compares notes played to expected and gives percent score

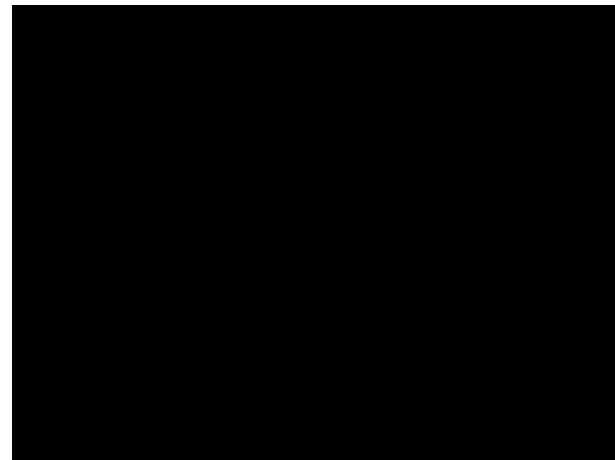
Integrated System Demo



Demo 1: System overview

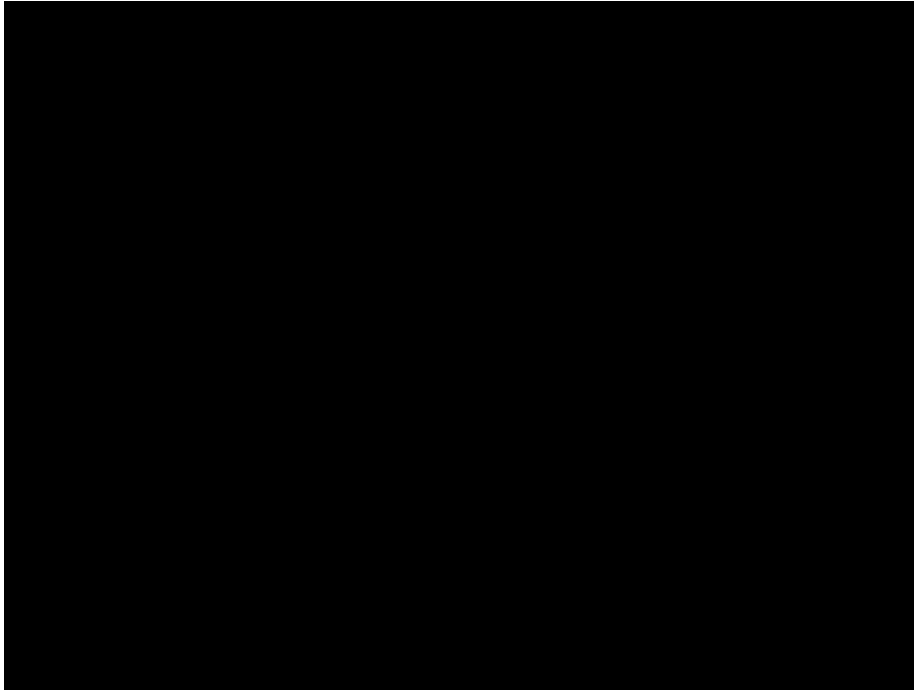


Demo 2: First six notes of Happy Birthday (slow) played at 100% accuracy



Demo 3: First four notes of Twinkle Twinkle Little Star (faster tempo) playing all G notes instead of actual song notes

Demo with LEDs on PCB



Video demonstrates no disturbances caused by LEDs under guitar fretboard. Can play accurately while system detects correct notes being played.

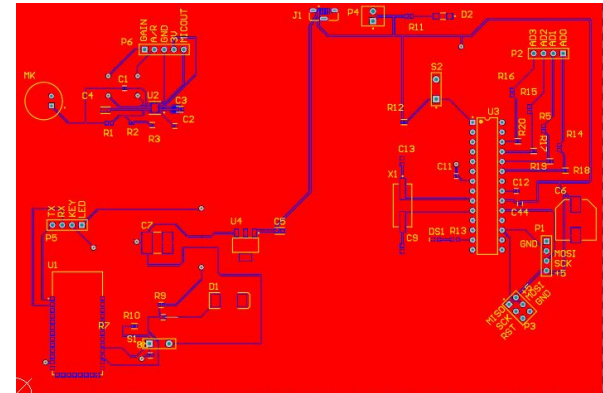
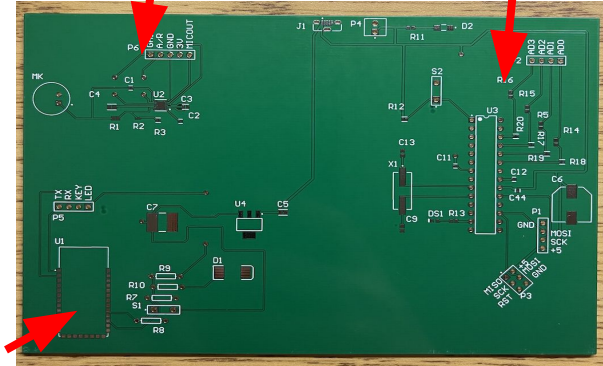
Custom Hardware PCB (1)

- Main PCB will have the microphone circuit, the microcontroller being used to drive the LEDs, and the bluetooth module as a link between the android application and the main microcontroller of the project
- We have also created custom PCB's for the LEDs in order to fit under the guitar strings without interference

*Microphone
Circuit*

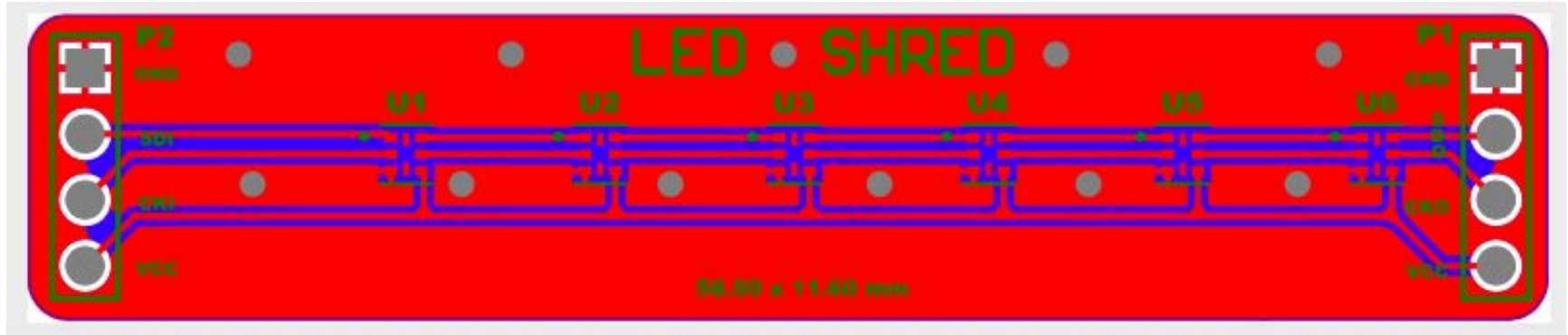
MCU for LEDs

*Bluetooth
Module*





Custom Hardware PCB (2)



PCB layout of LEDs

FPR Plan

- First four frets of guitar mounted with LEDs on fretboard across each string
- User able to input practice/play mode to app and LEDs on guitar will light accordingly as a guide to user
- Application will report practice/play performance based on notes detected by system
- Plan to show full connectivity between all of these systems for FPR

FPR Plan (2)

- Test system to ensure system specifications are met
 - Sampling different guitar notes and variety of songs to get an accurate measurement of system accuracy
 - Measure time for user to receive performance report upon multiple play trials
- Have both PCBs which connect to app via bluetooth mounted on guitar with power supplies connected for sleek and attachable design
- Have a guitar player play a couple of songs correctly and incorrectly to prove our systems' accuracy

List of Hardware and Software

CDR List

Hardware

- STM32 MCU
- Arduino Uno
- Dotstar LEDs (5x5 mm)
- Microphone breakout board
- Bluetooth module

Software

- STM32Cube IDE
- STM32CubeMX
- Arduino IDE
- Android Studio

Future List

Hardware

- STM32 MCU
- Dotstar LEDs (2x2 mm)
- Custom PCB w/ power supply
 - Includes bluetooth, Atmega, & microphone

Software

- STM32Cube IDE
- STM32CubeMX
- Arduino IDE
- Atmel Studio
- Android Studio

Project Expenditures

Total expenses so far

Item	Qty	Cost (\$)
STM32 MCU	2	62.57
Microphone	2	1.97
Dotstar LED (10 pack)	2	13.53
DOTSTAR breakout board (10 pack)	2	13.53
WS2812B Strip	1	20.88
PCBs for LEDs w/ stencil (1)	15	68.25
Micro LEDs for PCB (10 pack)	4	39.95
Acoustic Guitar	1	51.99
Microphone breakout board	1	16.79
Main PCB w/ stencil (1)	10	50.51
PCB parts for main PCB	5	129.88
		TOTAL: \$469.85

Possible future Expenses

Item	Qty	Cost (\$)
Flexible PCBs for LEDs	10	~100
LEDs for PCB (10 pack)	4	~30
		Total Projected Cost: \$130

Project Management: Gantt Chart from CDR to FPR

Task	Engineers	April 5	April 12	April 19
Main PCB soldering & debugging	Isaiah			
Developing final model of application with addition of new modes and songs	Kivan			
Finalize and improve note detection algorithm	Jacob			
PCB for LEDs soldering & debugging	Jordy			
Harden & Optimize LED configuration and finalize communication with App and MCUs	Jordy			
Integrate main PCB with system	Isaiah			
Test and ensure proper communication between bluetooth components and user application	Kivan Daruwalla			
Testing final system and ensuring it is fully functioning	All			
FPR Week	All			

Thank you

Questions?