

# LEDshred

Final Project Review

Team 5

ECE 416

SDP 2021

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Advisor: Professor Amir Arbabi  
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# The Team



Amir Arbabi  
Advisor



Jordy Mukania  
Electrical Engineer  
Team Coordinator



Isaiah Provencher  
Electrical Engineer  
Altium Lead



Jake Colapietro  
Computer Engineer  
Budget Management



Kivan Daruwalla  
Computer Engineer  
Software Development

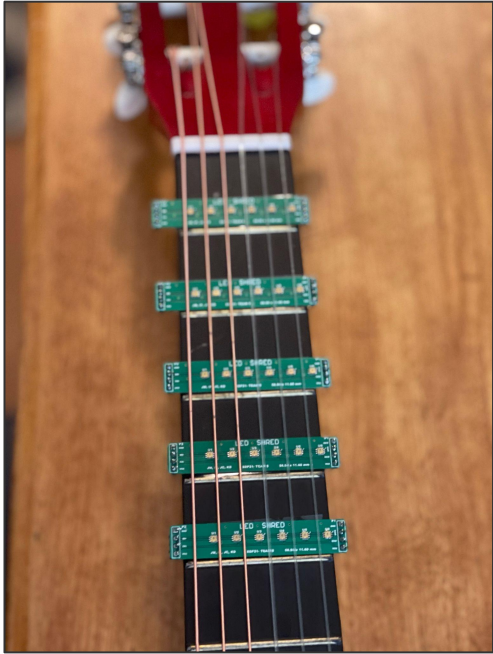
# Problem Statement

- 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

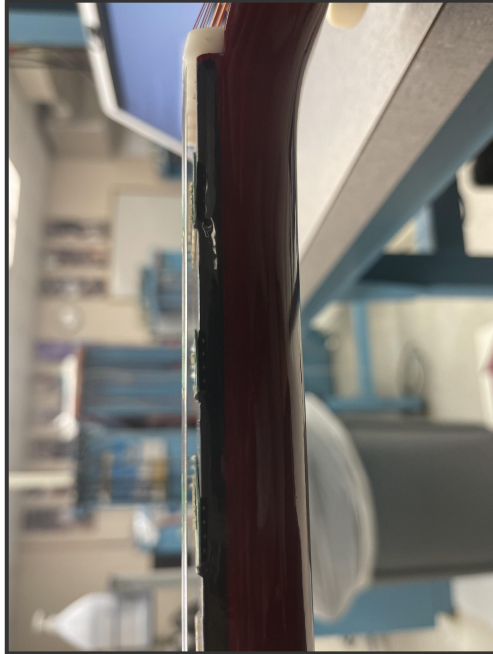


*Frustrated guitar player*

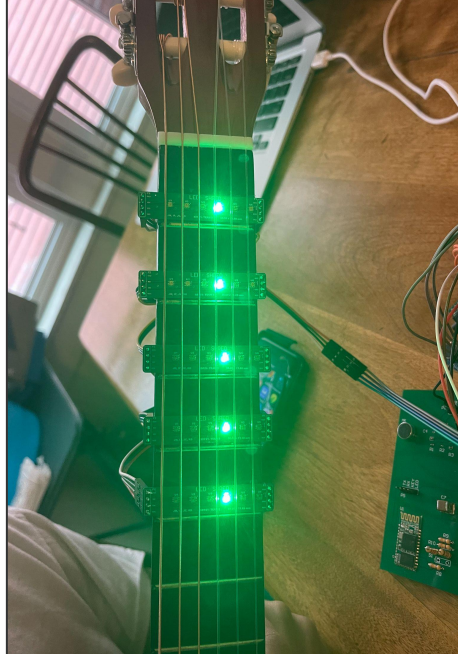
# Visual Representation of Our Solution



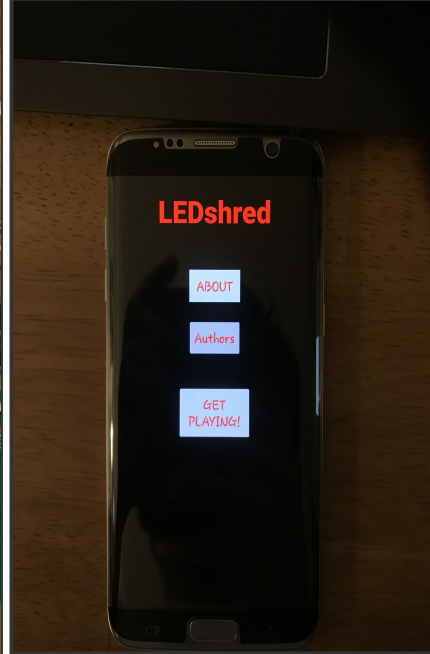
1



2



3



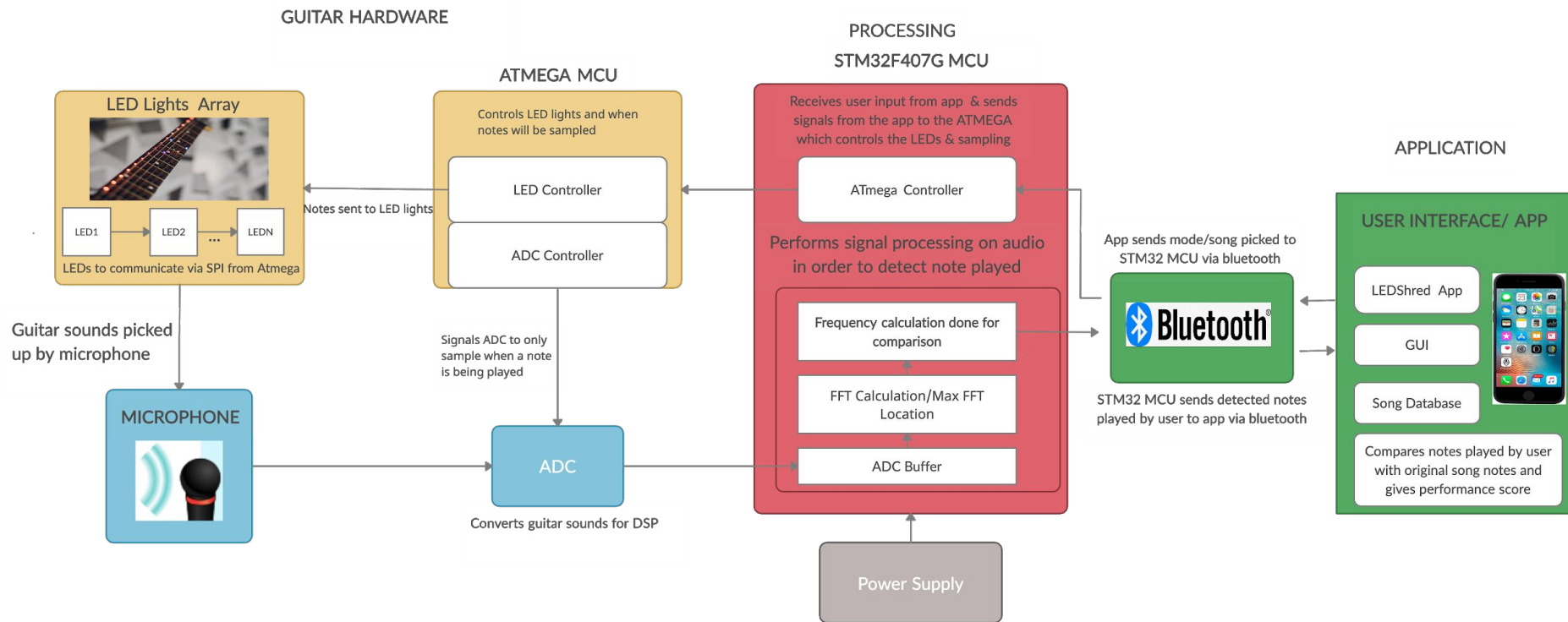
4

# System Specifications

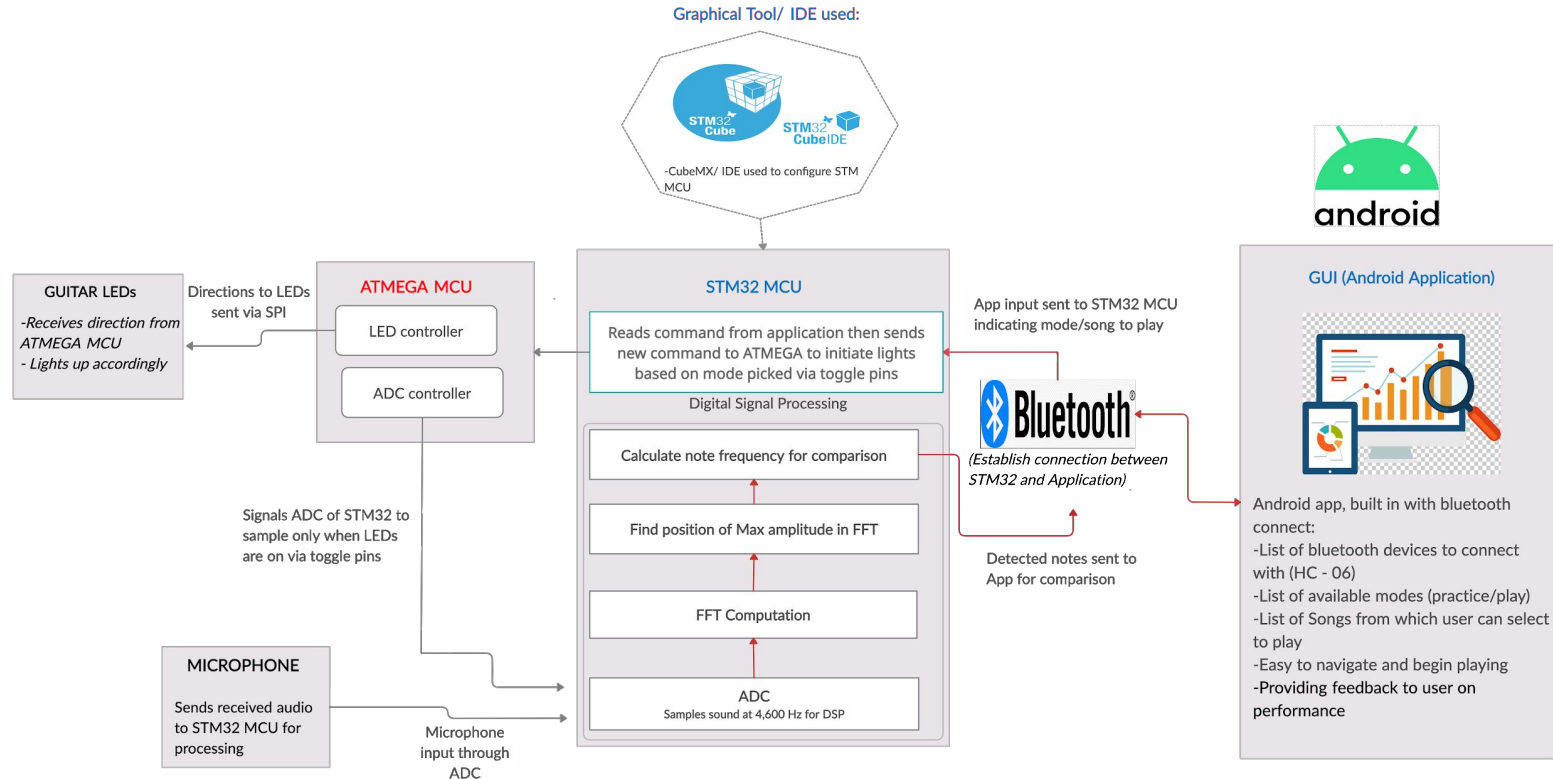
- LED lights attachable to any guitar (Typical 38 inch long guitar)
- 4 X 6 array of LEDs (4 fret rows with 6 LEDs across each string)
- Height of LEDs less than 2.5 mm
- Accompanied by app which supports bluetooth connectivity to user device
- Samples guitar notes at ~5,000 Hz
- Samples sound only at 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*  
*Spec achieved*

# Final System Block Diagram



# Final Software Block Diagram



# FPR Plan

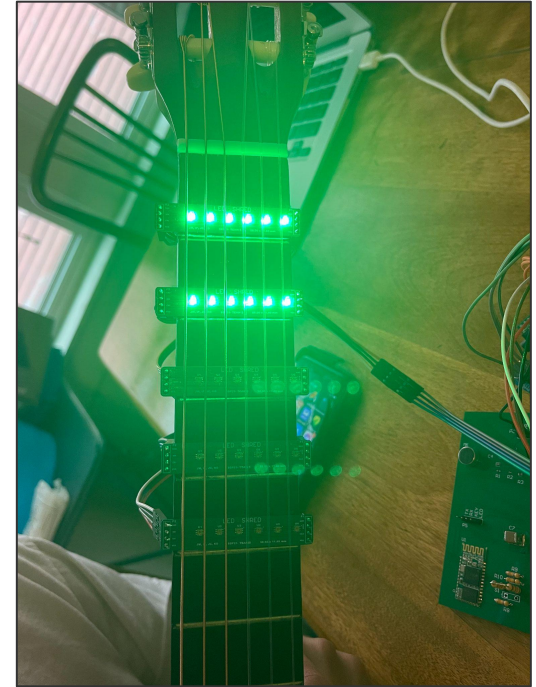
- First four frets of guitar mounted with LEDs across each string on guitar fretboard
- User able to input practice/play mode on app and LEDs on guitar will light accordingly to guide user through mode
- Application will report practice/play performance based on notes detected by system
- Plan to show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

# 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

# LED Lights

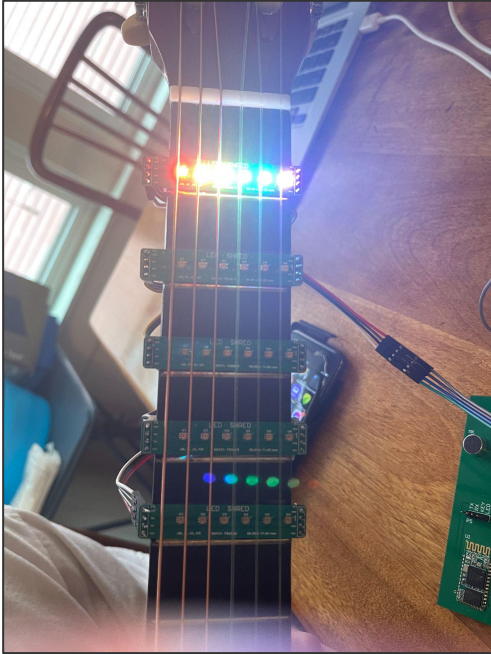
- LED PCB array fully implemented and mounted on guitar with main PCB
- Driven by Atmega328P which is MCU on main PCB
  - Acts as peripheral to STM32 MCU which is board that is connected to main PCB and bluetooth
- Lights fulfill height and number of rows specifications
- Able to use LEDs to “light up” corresponding guitar strings to represent notes user should play



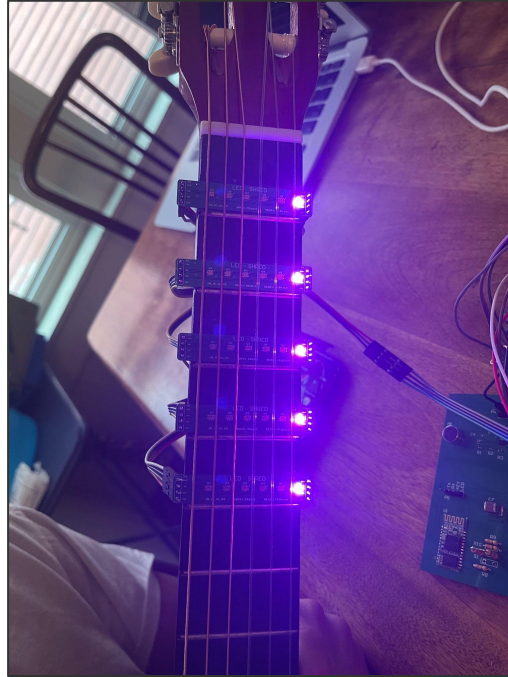
*Final LED lights connection on Guitar*

# LED Lights (2)

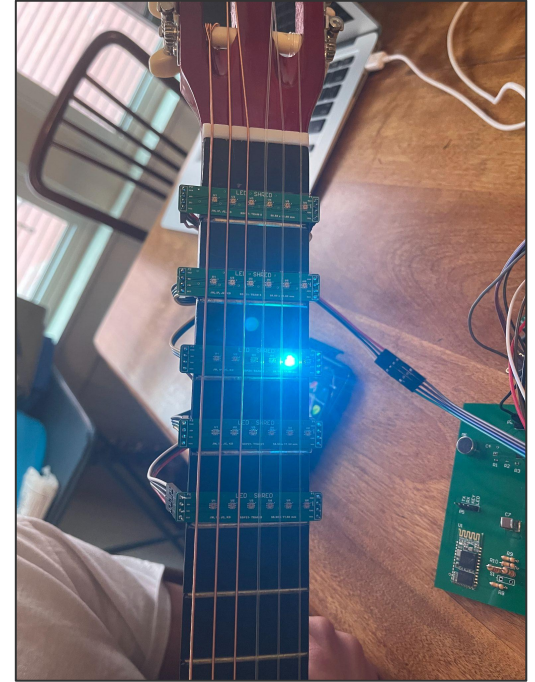
*Figures showing planned implementation for future*



1



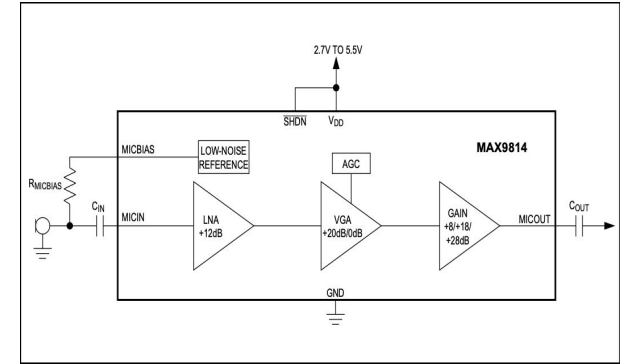
2



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.
- Our current note accuracy is  $\sim 97\%$

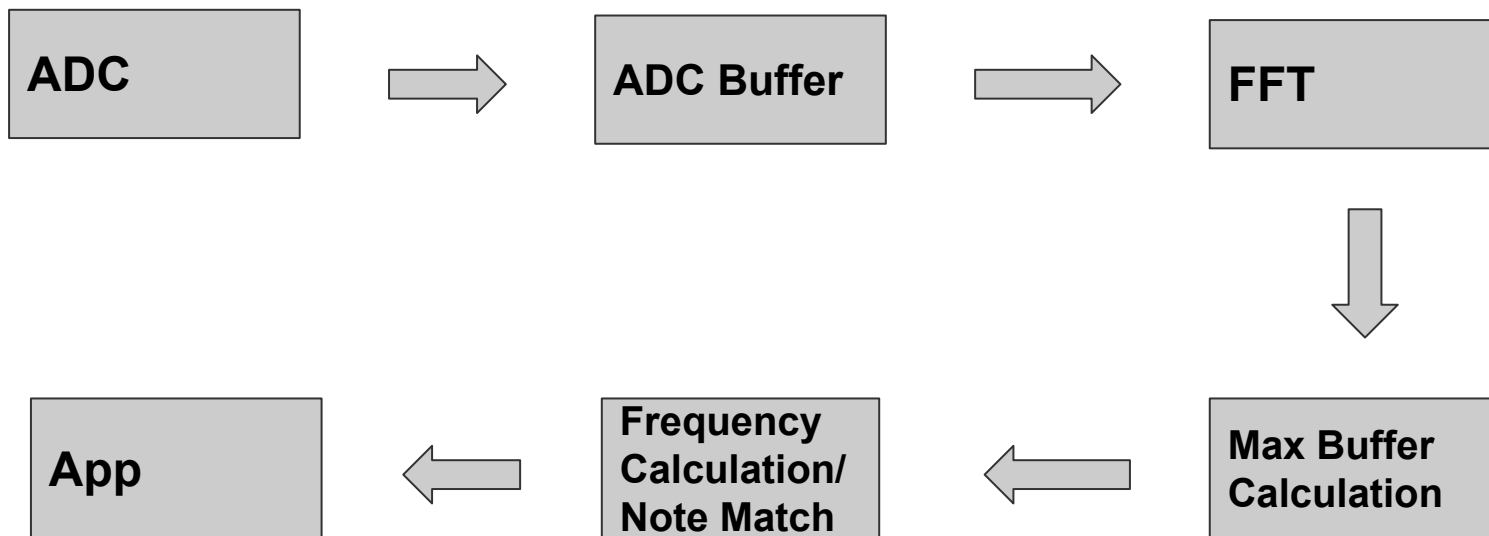
Play order	Frequency (Hz)
1	328.245
2	328.803
3	329.361
4	330.478

Figure 1

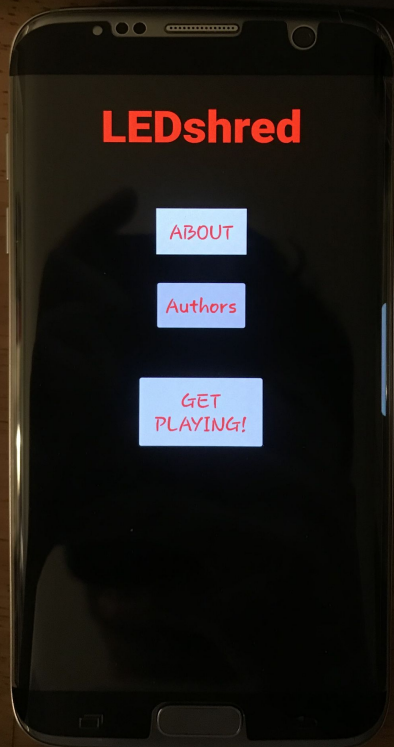
Play order	Note
1	E
2	E
3	E
4	E

Figure 2

# DSP Algorithm



## Homepage with option buttons



## Deliverables

- Kivan Daruwalla

- Develop final model of application with additional modes ✓
- Test and ensure proper comm between bluetooth components and user interface ✓

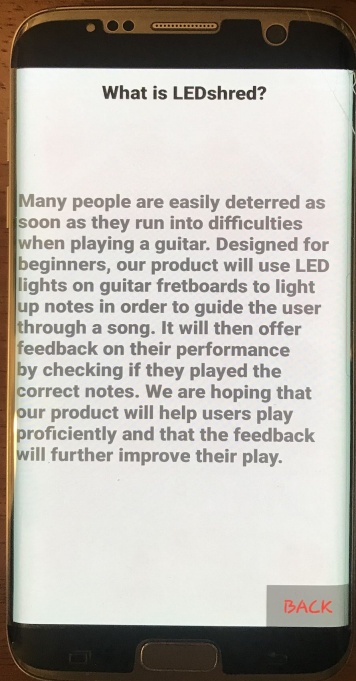
## Home Page

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

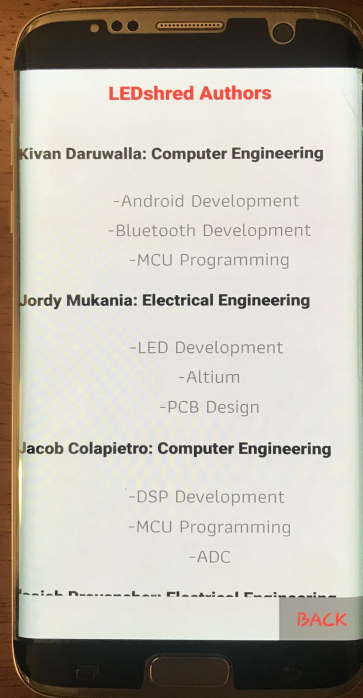
*(First place user is brought when application boots up)*

# Android Application Layout (About/Authors)

## About page with problem statement



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

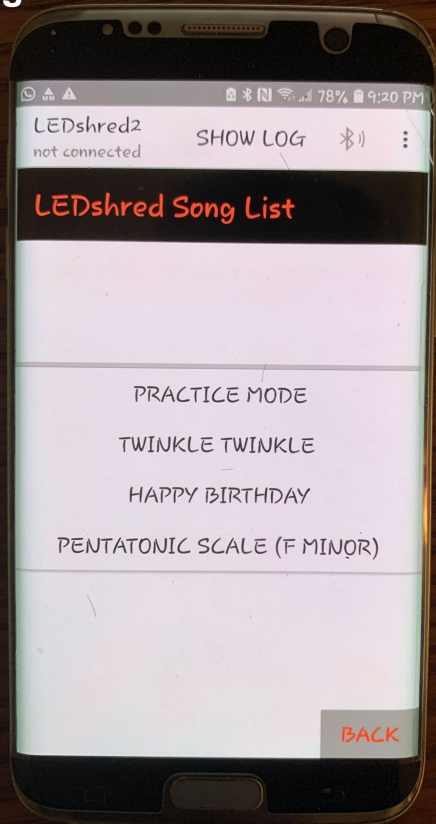


- *Kivan Daruwalla*
- About page providing information about LEDshred.
- Authors page providing background on our roles

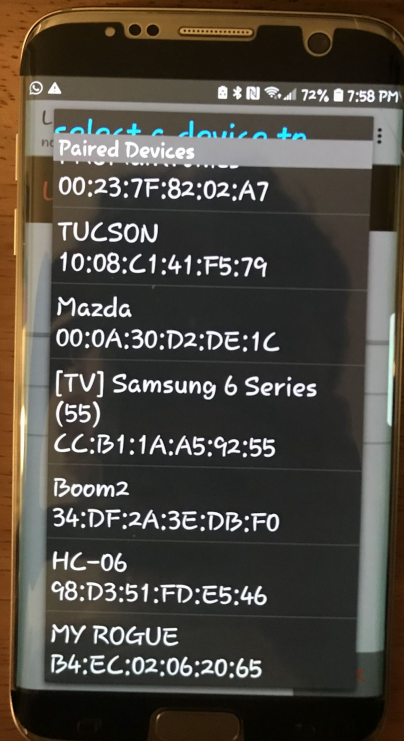
Back Button for Navigation

# Android Application Layout (Songs/Bluetooth)

Song list for user to choose from



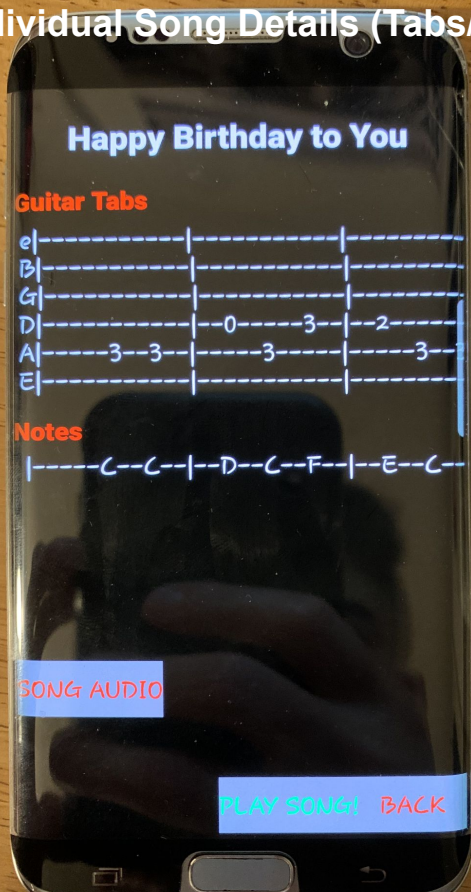
List of devices for user to pair with via Bluetooth



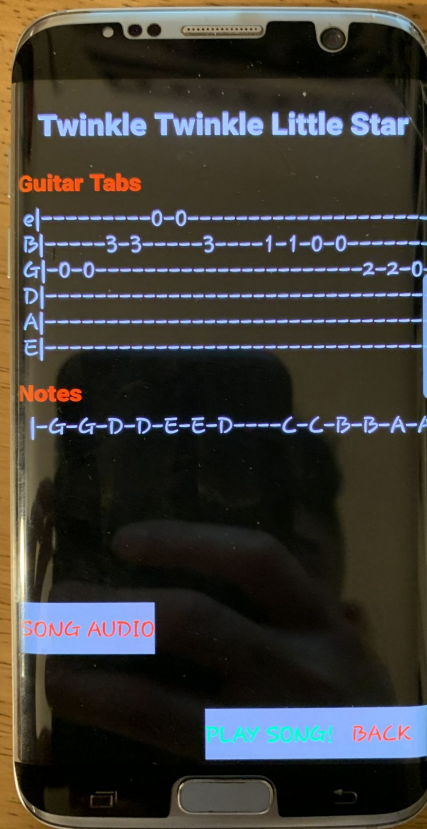
- *Kivan Daruwalla*
- Song list allows users to select which songs to play
- Paired device page allows for bluetooth connection to our system (via HC - 06)

# Android Application Layout (Song Pages)

Individual Song Details (Tabs/Notes)



(Both Tabs/Notes scroll horizontally)

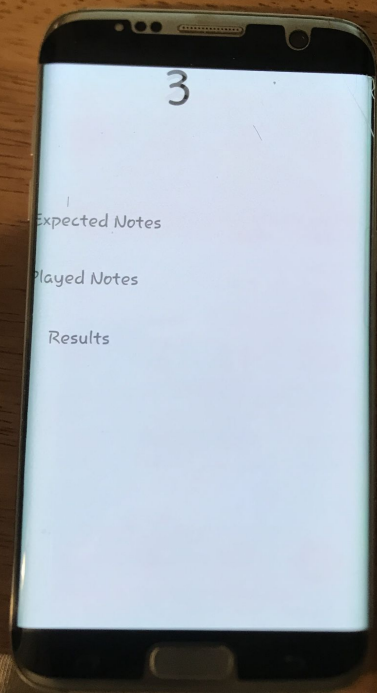


- *Kivan Daruwalla*
- For each song, Tabs and notes
- **Tabs:** show fret position on string for each note in song
- **Notes:** Represent the actual note on A to G scale.
- **Song Audio Button:** Audio recording of songs

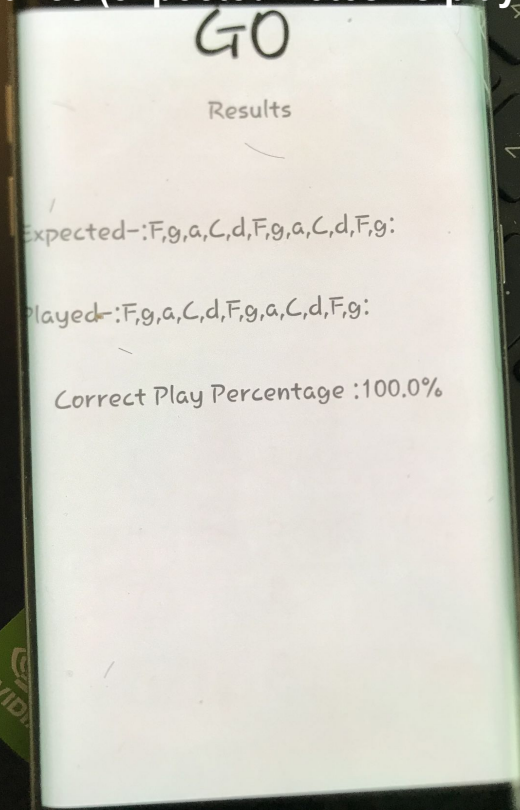
(Allow user to learn song before trying to play)

# 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
- Metronome Countdown



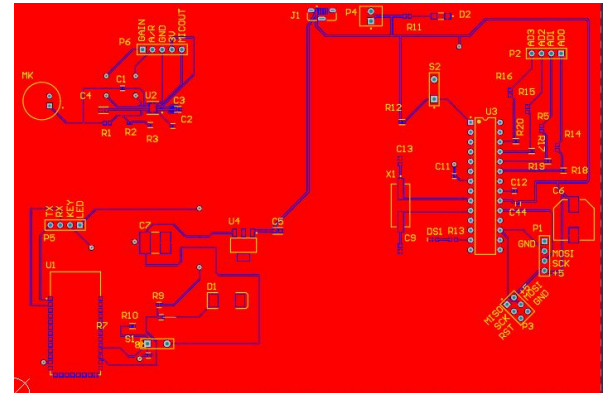
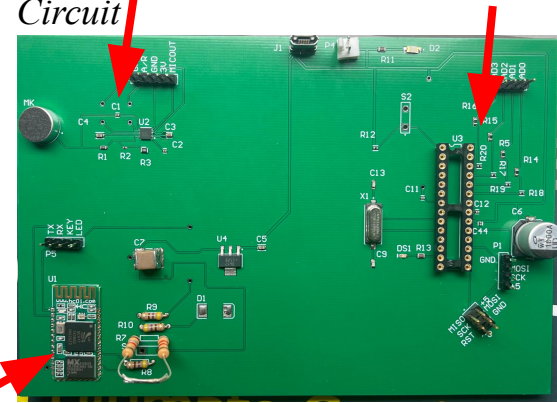
# Custom Hardware PCB (1)

- 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*

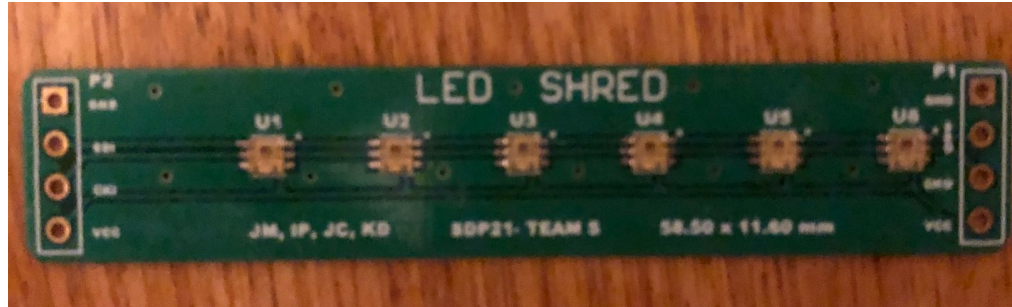
*MCU for LEDs*

*Bluetooth  
Module*





# Custom Hardware PCB (2)



*PCB layout of LEDs and picture*

# Final List of Hardware and Software

## Hardware

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

## Software

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

# Final Project Expenditures

## Total Expenses

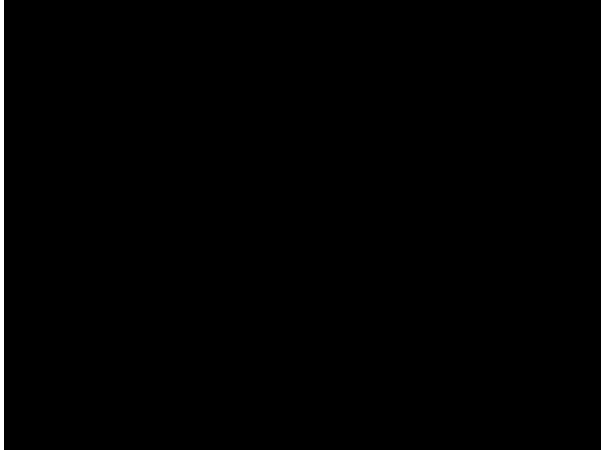
Item	Qty	Cost (\$)
STM32 MCU	2	62.57
Microphone	2	1.97
Dotstar LED (10 pack)	2	13.53
DOTSTAR breakout board (10 pack)	2	13.53
WS2812B Strip	1	20.88
PCBs for LEDs w/ stencil (1)	15	68.25
Micro LEDs for PCB (10 pack)	7	66.67
Acoustic Guitar	1	51.99
Microphone breakout board	1	16.79
Main PCB w/ stencil (1)	10	50.51
PCB parts for main PCB	5	158.25
Revised PCBs for LEDS w/ stencil (1)	10	71.85
		TOTAL: \$596.79

Estimated product cost

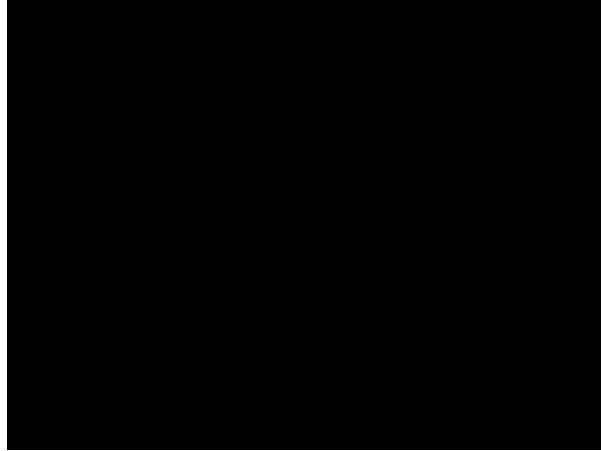
- STM32
- Main PCB with components
- PCB with LED lights

Total: ~\$110

# Final System Demo



*System Overview and  
Pentatonic Scale*



*Happy Birthday Clip*



*Practice Mode  
(All Wrong)*

Thank you

Questions?