Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Team 28: Guitar Entertainment System

Bi-Weekly Update 5

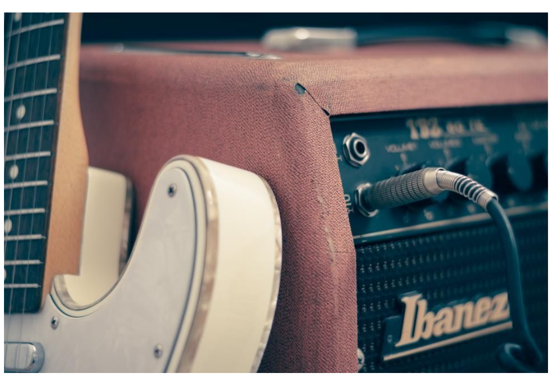
Rishabh Ruikar, Monte Martin III, Rawan Ibraheem
Sponsor: Souryendu Das (TA)

Dwight Look College of ENGINEERING TEXAS A&M UNIVERSITY

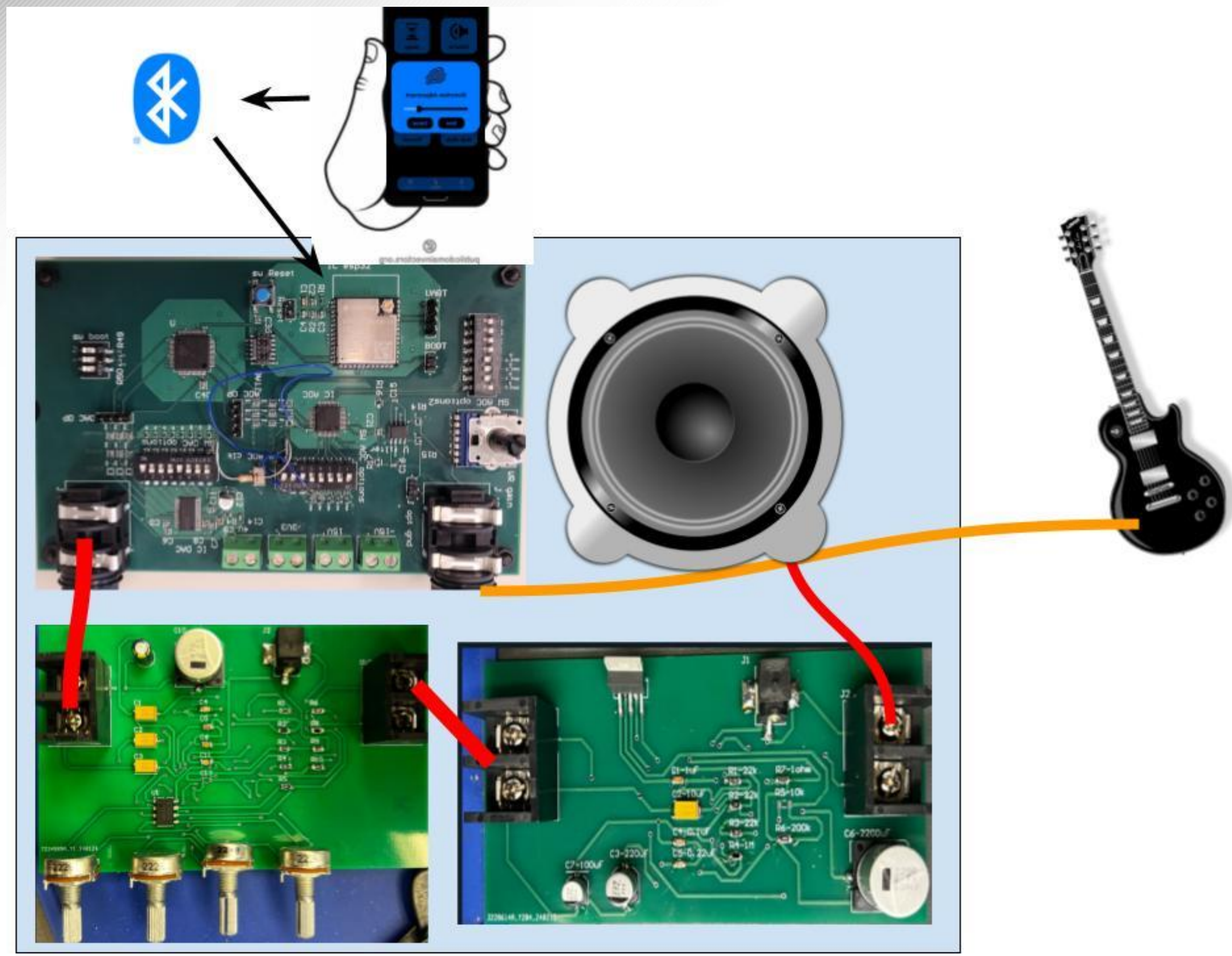
Project Summary

- Problem Statement: Current guitar amplifiers and effects systems often present a steep learning curve, deterring those with limited technical experience from fully exploring their sound potential.

- Solution proposal: Developing a user-centric guitar sound system, combining an amp, pedals, and a Bluetooth-connected app. This system simplifies sound customization through intuitive controls and presets, making advanced sound manipulation accessible to all skill levels.



Integrated System Diagram



Project Timeline

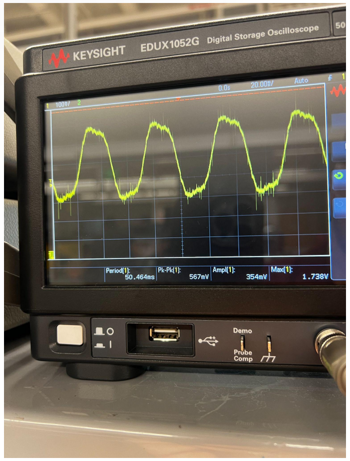
Preamplifier validation (completed 3/23)	Pedal and app integration (completed 2/15)	Pedal and amplifier integration(to be complete by 4/7)	Final Integration (to complete by 4/10)	System Test (to complete by 4/10)	Validation and report (to complete by 4/17)

Rishabh Ruikar: Amplifier

Accomplishments since last update 28 hrs of effort	Ongoing progress/problems and plans until the next presentation
• Validated Preamplifier according to the 3 main signal types coming from a guitar: 20Hz (low frequency), 1kHz (mid), 20kHz (high-end of audible spectrum) • Replaced 50k ohm gain pot with a 10k gain pot to ensure impedance matching and achieve gain factor necessary for I/O voltage ratio • Solved the chip heat issue on the amplifier board	• Found an issue with the amplifier board concerning a resistor that consistently burns out (Meeting with Dr. Lusher on 3/28 to diagnose and solve this)

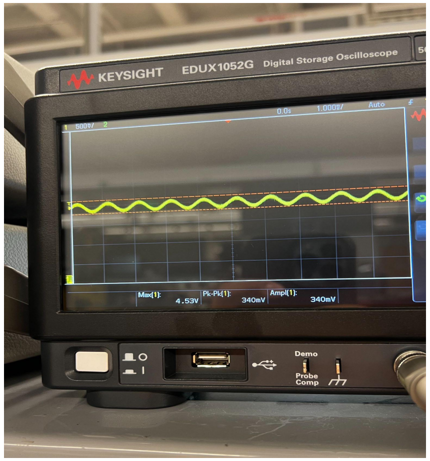
Rishabh Ruikar: Amplifier (cont.)

20Hz@500mV



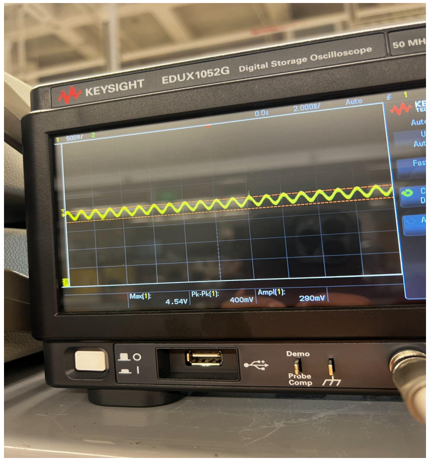
- P2P: 567 mV
- Max: 1.73V

1kHz@500mV



- P2P: 340mV
- Max: 4.02V

2kHz@500mV



- P2P: 400mV
- Max: 4.21V

Monte Martin: Pedals

Accomplishments since last update 65 hrs of effort	Ongoing progress/problems and plans until the next presentation
• Validated the ADC and DAC can generate their own bit clock and word select • Validated that the STM32 can be programmed •	• Debug the DAC, figure out why the DAC isn't sending out a signal • Ensure that the ESP32 can be flashed and communicates with the STM32 • Determine if the effects will be on the ESP32 or the STM32 • Fix loss of head of packet/stopped serial stream on ESP32

Monte Martin: Pedal System Cont.

ADC data, bit select, and word select in master mode; DAC bit select and word select in master mode.

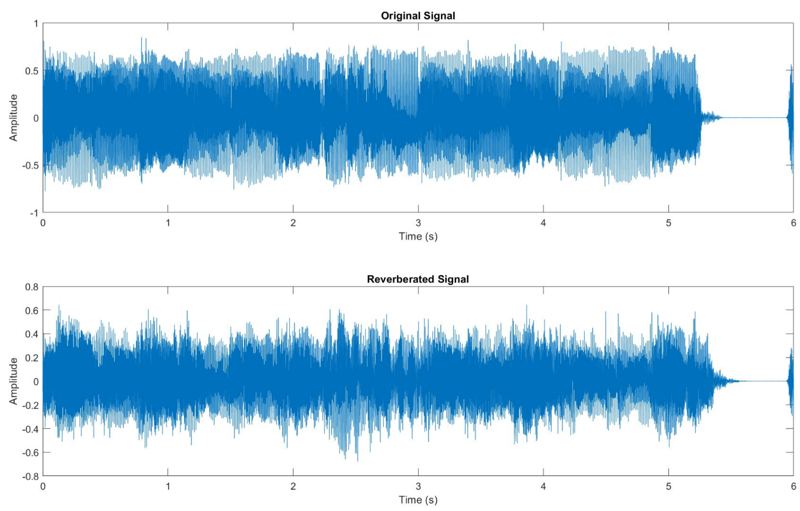
Rawan Ibraheem: Bluetooth App

Accomplishments since last update 26 hrs of effort	Ongoing progress/problems and plans until the next presentation
• Prepared MATLAB programs for validation of pedal PCB • Programmed UART communication on STM32 on Pedal PCB	• Error when programming ESP32 on pedal PCB caused by “serial noise or corruption”. • Validate the sound effects using an audio jack breakout board and an oscilloscope.

Rawan Ibraheem: Bluetooth App

Validation Plan for Sound Effects on Pedal PCB

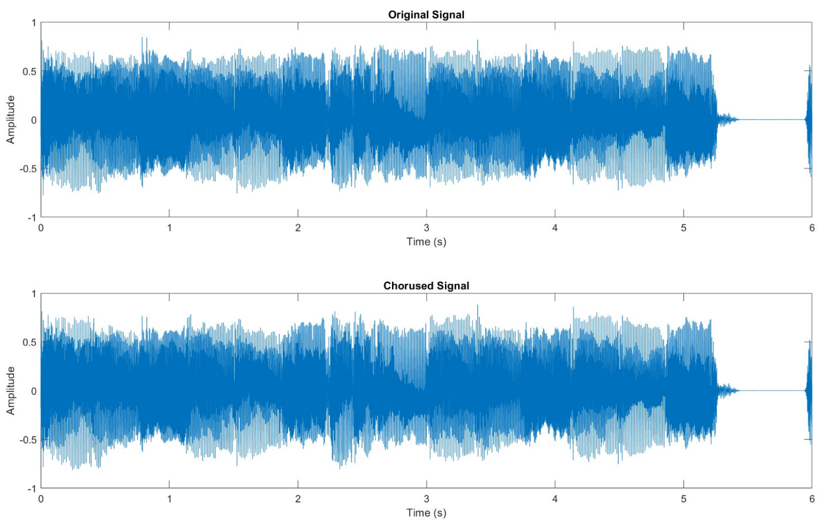
The sound effects will be validated using an audio jack breakout connected to the analog input of the pedal PCB, and the oscilloscope will measure the analog output signal, which will be written to a csv file and characterized in MATLAB.



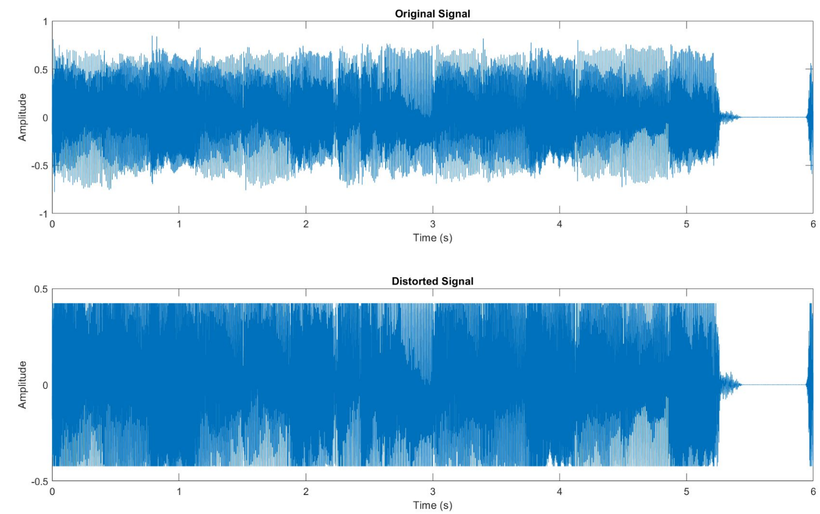
Example processed reverberated signal.

Rawan Ibraheem: Bluetooth App

Validation Plan for Sound Effects on Pedal PCB



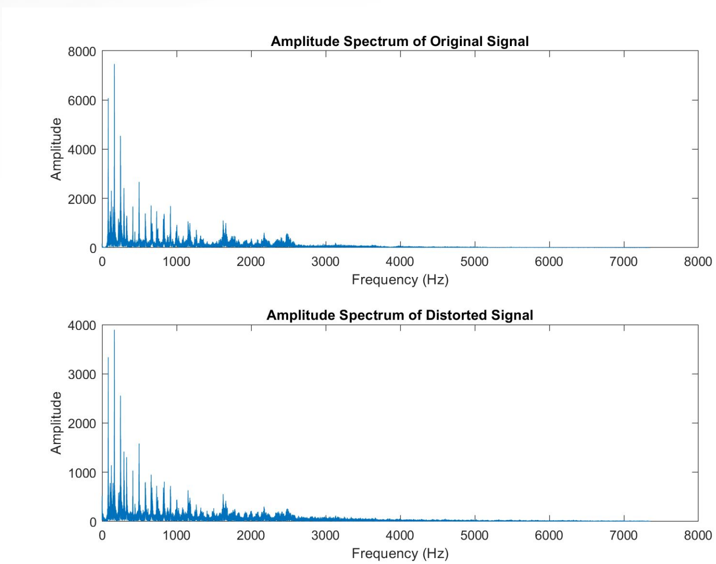
Signal with chorus applied.



Signal with distortion applied.

Rawan Ibraheem: Bluetooth App

Validation Plan for Sound Effects on Pedal PCB



Amplitude spectrum of distorted signal.

```
>> Validation
Playing Original Signal...
Playing Reverberated Signal...
RT60 for Original Signal: 0.011375 seconds
RT60 for Reverberated Signal: 0.0165 seconds
SNR: 2.9122 dB
```

RT60 and SNR computation for reverberated signal.

All: System

Accomplishments since last update 10 hrs of effort	Ongoing progress/problems and plans until the next presentation
• Programmed the UART connection on the STM32	• Complete System Integration and testing by 4/8 • Complete validation by 4/12

Execution Plan

Task	Owner	1/22	1/29	2/5	2/12	2/19	2/26	3/4	3/11	3/18	3/25	4/1	4/8	4/15		
Send out new pre-amplifier and amplifier PCBs for manufacturing.	Rishabh															In Progress
Solder parts onto amplifier PCBs	Rishabh															Not Started
Utilize a signal generator to produce sine waves, square waves, and pink noise for testing the amplifier's signal integrity and frequency response, aiming for a flat response within ±0.5 dB across 20 Hz to 20 kHz.	Rishabh															Completed
Conduct dynamic range measurements, aiming for a dynamic range of over 75 dB to capture the full spectrum of audio without distortion or noise intrusion.	Rishabh															Behind schedule
Execute thermal management tests, ensuring the amplifier maintains operational temperatures below 50°C under full load conditions to guarantee long-term stability.	Rishabh															
Test pedal PCB and redesign.	Monte															
Send out pedal PCB for manufacturing.	Monte															
Solder parts onto pedal PCB	Monte															
Test and Validate PCB	Monte															
Ensure that there isnt any signal loss when transfering to amplifier	Monte															
Test the Pedal PCB with the application and ensure there is sound output	Monte															
Ensure that ESP32 can send signals to STM32 to adjust sound effects	Rawan															
Code each sound effect in STM32 using development board and function generator	Rawan															
Program each sound effect onto STM32 on Pedal PCB																
Begin designing housing	All															
House all parts	All															

Validation Plan

MCU & Application	3.2.1.5	ESP32 can communicate with STM32	Terminal COM port connected to STM32 displays the applied sound effects	Rawan	Completed	2/15/2024
MCU & Application	3.2.1.5	STM32 can apply each sound effect (volume, distortion, reverb, chorus, delay, wah-wah)	Use a function generator and an osciliscope to test input and output signal when sound effect applied and process input and output data through USB connection to computer	Rawan	Incomplete	
MCU & Application	3.2.1.4	Application reports errors connecting to ESP32 or STM32	Implement pop-up window that displays warnings in Android application	Rawan	Incomplete	
MCU & Application	3.2.1.4	MCU can send signal to STM32 within 1 second	Use oscilloscope to measure the input and output signal	Rawan	Incomplete	
ADC/DAC, DSP	3.2.1.2	Practical Filter eliminates noise and creates a differential signal	Use oscilloscope to provide an input signal and the output signal	Monte	Completed	1/15/2024
ADC/DAC, DSP	3.2.1.2	STM32 communicates with the ESP32 with less then 10 ns of delay	Check data readouts from STM32 and ESP32	Monte	Incomplete	
ADC/DAC, DSP	3.2.1.2	All effects work as intended, with outputs within 5 dB of calculated values	Use oscilloscope to provide an input signal and the output signal	Monte	Incomplete	
ADC/DAC, DSP	3.2.1.2	have less than 10 ns of delay between signal input and output	Use an oscilloscope to measure delay between input and output signals	Monte	Incomplete	
ADC/DAC, DSP	3.2.1.2	The delay function can create up to 2 seconds of delay without loss of signal quality	Use a timer and oscilloscope to measure delay and signal quality	Monte	Incomplete	
ADC/DAC, DSP	3.2.1.2	ADC, DAC, and DSP all can communicate within 10 ns of delay when tested seperately	Osciliscope to send and recieve analog, ESP32 dev to send and recieve digital through i2S	Monte	Incomplete	
ADC/DAC, DSP	3.2.1.2	The system can take in up to 2.1 V rms signals and output them without any clipping or loss of signal quality	Oscilloscope and function generator	Monte	Incomplete	
Amplifier	3.2.3.3	Preamplifier is able to create at least a 10dB gain from 3 types of sine waves- 50Hz(bass), 1kHz (mid), 5kHz (treble)	For each frequency test (50 Hz, 1 kHz, 5 kHz), apply a constant-level sine wave, measure the preamp's output, and analyze the amplitude and harmonic content to evaluate its frequency response and distortion characteristics.	Rishabh	Completed	3/3
Amplifier	3.2.3.3	Validate the frequency response curve by comparing it against the amplifier's specified performance criteria, ensuring it meets the expected flatness within ±0.5 dB across the 20 Hz to 20 kHz range, using calibrated measurement equipment for accuracy.	Using software-based audio signal generators, generate a frequency sweep from 20 Hz to 20 kHz to test audio equipment.	Rishabh	Incomplete	
Amplifier	3.2.3.3	Aim for a flat response within ±0.5 dB across 20 Hz to 20 kHz	Using a signal generator to produce sine waves, square waves, and pink noise for testing the amplifier's signal integrity and frequency response,	Rishabh	Incomplete	
Amplifier	3.2.3.1	Aim for a dynamic range of over 120 dB to capture the full spectrum of audio without distortion or noise intrusion.	Generate 1 kHz sine, measure output and noise, calculate dynamic range.	Rishabh	Incomplete	
Amplifier	3.2.3.2	Ensure the amplifier maintains operational temperatures below 100°C under full load conditions to guarantee long-term stability.	Load testing, send peak sine waves constantly for about 30 minutes	Rishabh	Incomplete	
All	N/A	User can adjust sound effect signal multiple consecutive times.	One user will repeatedly adjust sound effects in one minute as another user plays the guitar, to ensure system operates as intended.	All	Incomplete	

Validation Plan (cont.)

All	N/A	User can play the guitar while adjusting the sound effect.	One user will control the mobile application while another plays the guitar.	All	Incomplete	
All	N/A	System experiences no failure when tested outdoors.	Fully integrated system is taken outside into an open and windy area, each sound effect is tested.	All	Incomplete	
All	N/A	User can plug in an active and passive pickup guitar.	Function generator to simulate active and passive pickups and oscilloscope will be used to see the readings.	All	Incomplete	
All	N/A	System experiences no failure when tested in a place with high signal noise pollution.	System will be tested in the FEDC where other teams are working on Bluetooth-based projects.	All	Incomplete	
All	N/A	SNR of calculated delay sound effect vs Pedal PCB output waveform is a minimum of 25 dB	Matlab will be used to compute the desired effect from the input waveform measured by the oscilloscope. Ouput of pedal PCB will be saved to a csv file and the data will be compared in Matlab.	All	Incomplete	
All	N/A	SNR of calculated chorus sound effect vs Pedal PCB output waveform is a minimum of 25 dB	Matlab will be used to compute the desired effect from the input waveform measured by the oscilloscope. Ouput of pedal PCB will be saved to a csv file and the data will be compared in Matlab.	All	Incomplete	
All	N/A	SNR of calculated distortion sound effect vs Pedal PCB output waveform is a minimum of 25 dB	Matlab will be used to compute the desired effect from the input waveform measured by the oscilloscope. Ouput of pedal PCB will be saved to a csv file and the data will be compared in Matlab.	All	Incomplete	
All	N/A	SNR of calculated wah-wah sound effect vs Pedal PCB output waveform is a minimum of 25 dB	Matlab will be used to compute the desired effect from the input waveform measured by the oscilloscope. Ouput of pedal PCB will be saved to a csv file and the data will be compared in Matlab.	All	Incomplete	
All	N/A	SNR of calculated reverb sound effect vs Pedal PCB output waveform is a minimum of 25 dB	Matlab will be used to compute the desired effect from the input waveform measured by the oscilloscope. Ouput of pedal PCB will be saved to a csv file and the data will be compared in Matlab.	All	Incomplete	

Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Thank you!