eGuitar

A low-cost, high-utility learning system adaptable to any standard guitar

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Contributors/Sponsors:

Other than the properly cited usage of open source software, the group members will be the only contributors to this project. While the group members will attempt to procure sample parts to save money, this project will be funded "out-of-pocket" with no official sponsors.

Motivation:

This project idea was conceived and motivated by the struggle that many would-be musicians undergo when trying to familiarize themselves with a guitar for the first time. There is a significant learning curve involved with any new instrument but the aim of the eGuitar is to minimize this learning curve and make guitar tablature more tactile and natural. A person who decides they want to learn guitar should be able to learn quickly and receive feedback about their performance without the definitive need for a guitar instructor. With the help of the eGuitar, honing of coordination and speed should be accelerated beyond the standard experience of learning an instrument.

Goals and Objectives:

The eGuitar system should be more affordable than a paid instructor and the sum of the leading individual products whose feature set is included in the system. It should also have unique features that make it attractive to a learning guitarist.

The eGuitar ecosystem should provide the user with a convenient means of learning alongside recorded tablature. The guitarist should have visual cues for which frets need to be played, audible feedback for the tempo of the song (metronome), accompaniment, and/or the current pitch to be played, and an on-board chromatic tuner (with audible reference pitches) for tuning their guitar.

In terms of special features, the guitarist will have the ability to loop certain portions of the song with increasing tempo (speed-training). The guitarist will also receive constructive feedback metrics about their performance and accuracy in playing the right notes at the right times.

Project Function:

It is expected that the user of the eGuitar can load pre-made tablature onto the microSD card for playback and training. An example "typical user experience" might be this:

- (Optional) Create or procure additional compatible tablature on the user's PC.
    - Transfer the tablature to the eGuitar's microSD card
- Power-on the eGuitar system
- Tune guitar using on-board chromatic tuner
- Load desired tab/lesson from SD card
- Choose portion of song to learn along to, optionally modifying tempo, optionally enabling metronome and reference pitches

Project Specifications and Requirements:

LED Indicator Specifications

- For LED placement under each string:
  - Height of LEDs must be less than 1 mm.
  - Width of LEDs must be less than 3 mm.
  - Combined resin enclosure for wires and LEDs must remain under 1 mm.
  - If it is found that using PCBs allows easier management of components:
    - Height of PCB must be less than 1 mm.
    - Width of PCB must be less than 20 mm.
    - Length of PCB must be less than 42 mm.
  - Common ground line against top of guitar neck.
- For LED placement on top of guitar neck:
  - LEDs are embedded in line on custom PCB.
    - Height of PCB must be less than 4 mm.
    - Width of PCB must be less than 20 mm.
    - Length of PCB must be at least 150 mm long.
  - For 6 frets, total of 36 LEDs must be included.
  - Custom printed enclosure will be used to easily read which numbered LED is on, as well as hide connections.
    - Height of enclosure should be less than 8 mm.
    - Width must be less than 20 mm.
    - Length must be at least 150 mm long.
  - All data lines will be connected to the main control board via ribbon cable to prevent large bundles of wires.
    - Thickness of ribbon cables must be less than 5 mm.
    - Length of ribbon cables must be at least 2 ft. long to connect to Control Board at the base of the guitar.

DSP paired with Polyphonic (Hexaphonic) Pickup:

- DSP chip must be able to handle 6 individual signal inputs from polyphonic pickup
  - 6 individual piezoelectric pickups that encode note played into a signal.
  - Each individual pickup must be sensitive enough to not receive “data” from other strings being played.
  - Support frequencies between 50 Hz and 2000 Hz with accuracy of 0.1Hz.
- DSP chip would also be source of LED control.
  - I2C I/O Expanders for control of at least 36 LEDs.
- DSP must be able to communicate via RS232 /USB to host PC.
- DSP can communicate over I2C to external display.
  - 128x64 LCD.
- Potentiometers used for user input.
  - Rotary potentiometer – 10k Ohm, Linear.
- Push buttons used for user input.
- Size of PCB with DSP chip and other components must be no larger than 100x100 mm.

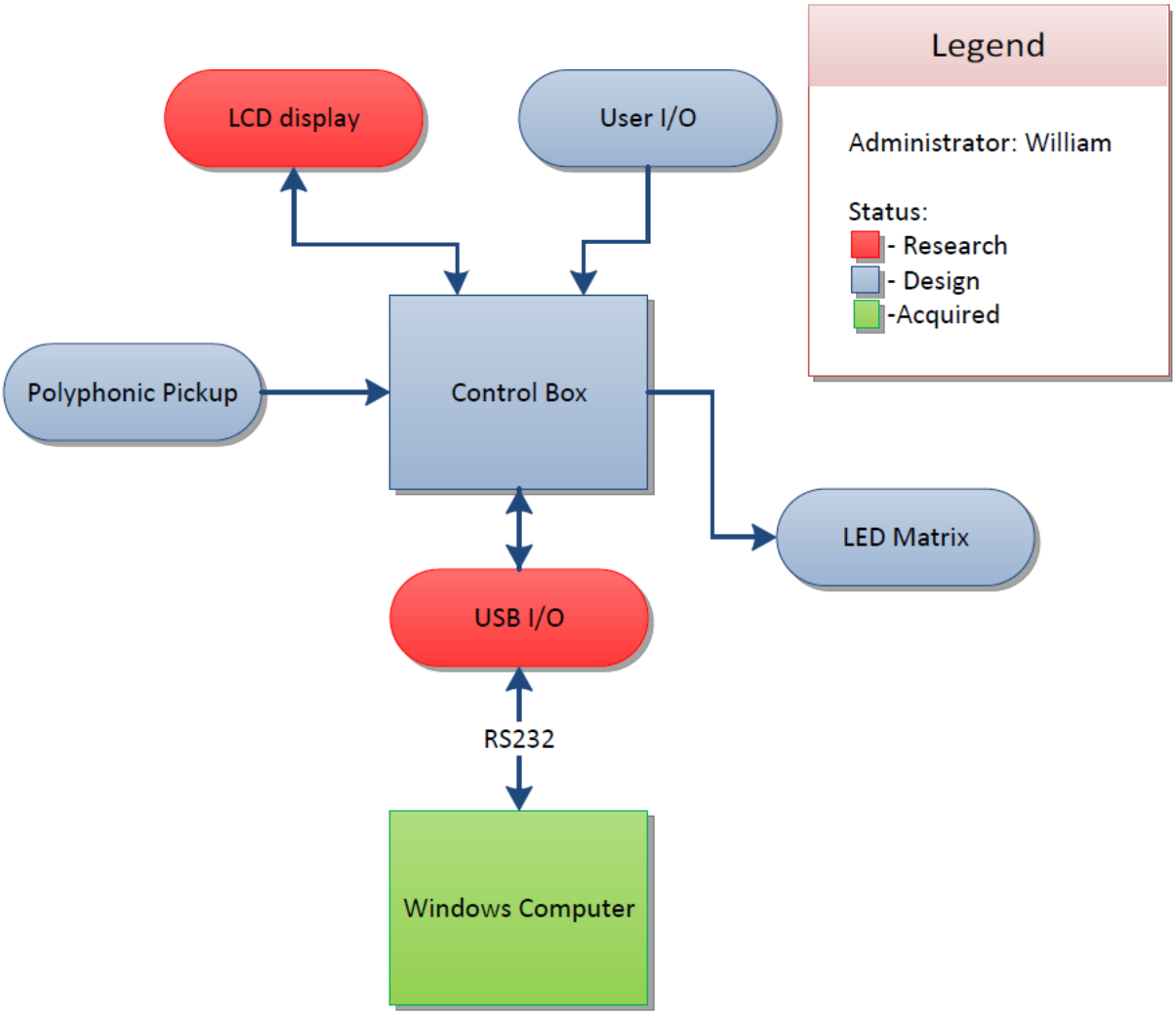
Power for Control Board:

- Rechargeable 5V battery.
  - Powers control board and all I/O connections.
  - Rechargeable via USB connection to PC or proper wall adapter

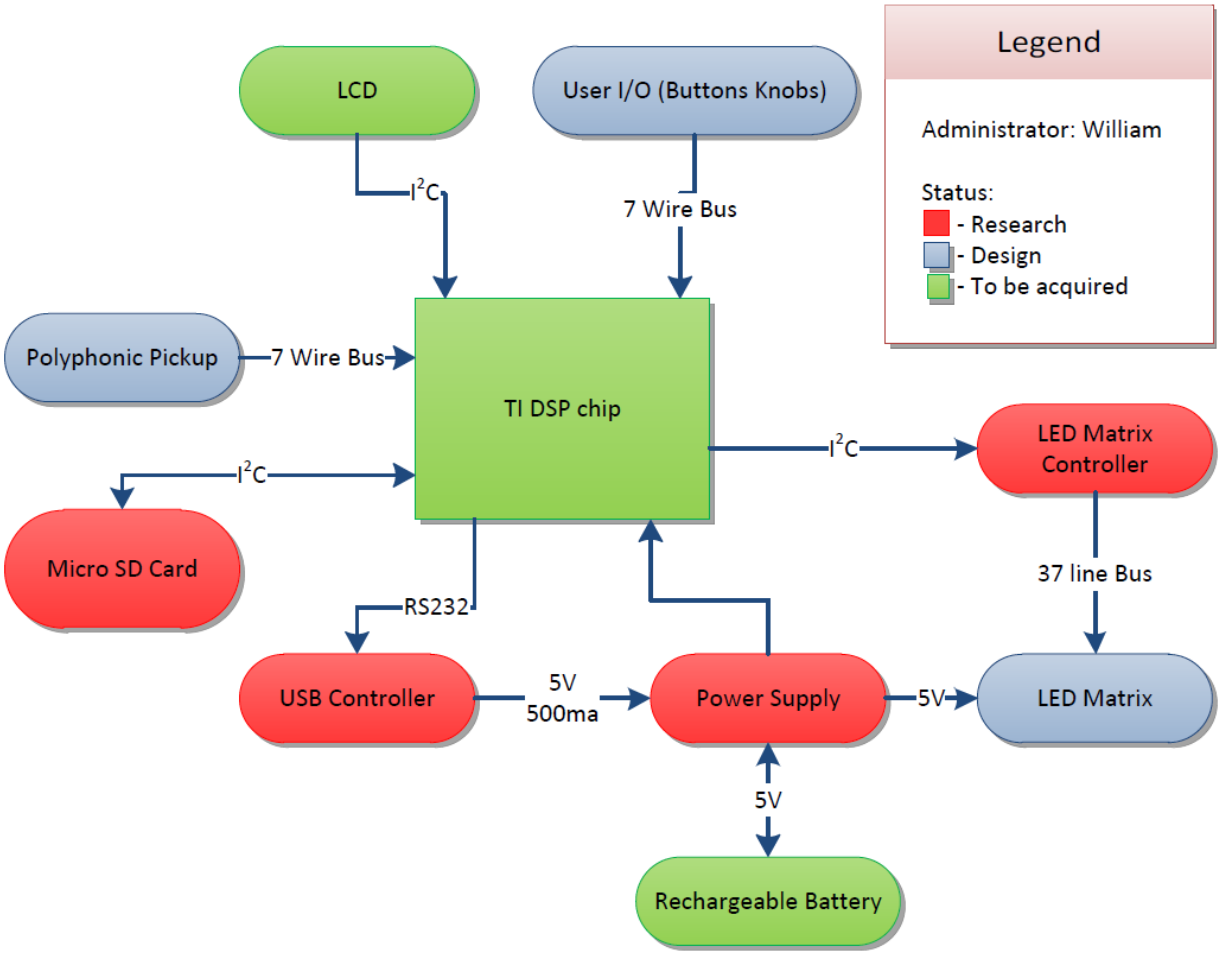
Hardware Block Diagrams:

Below are several block diagrams showing the group's best educated guess at the logical structure of the eGuitar Project.

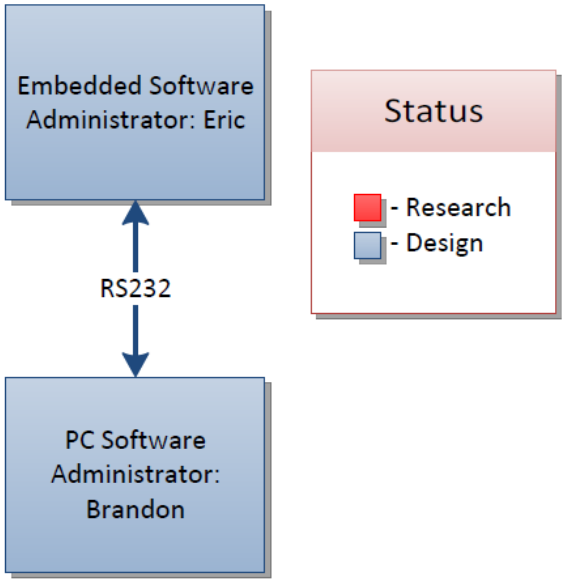
Hardware (High-Level)



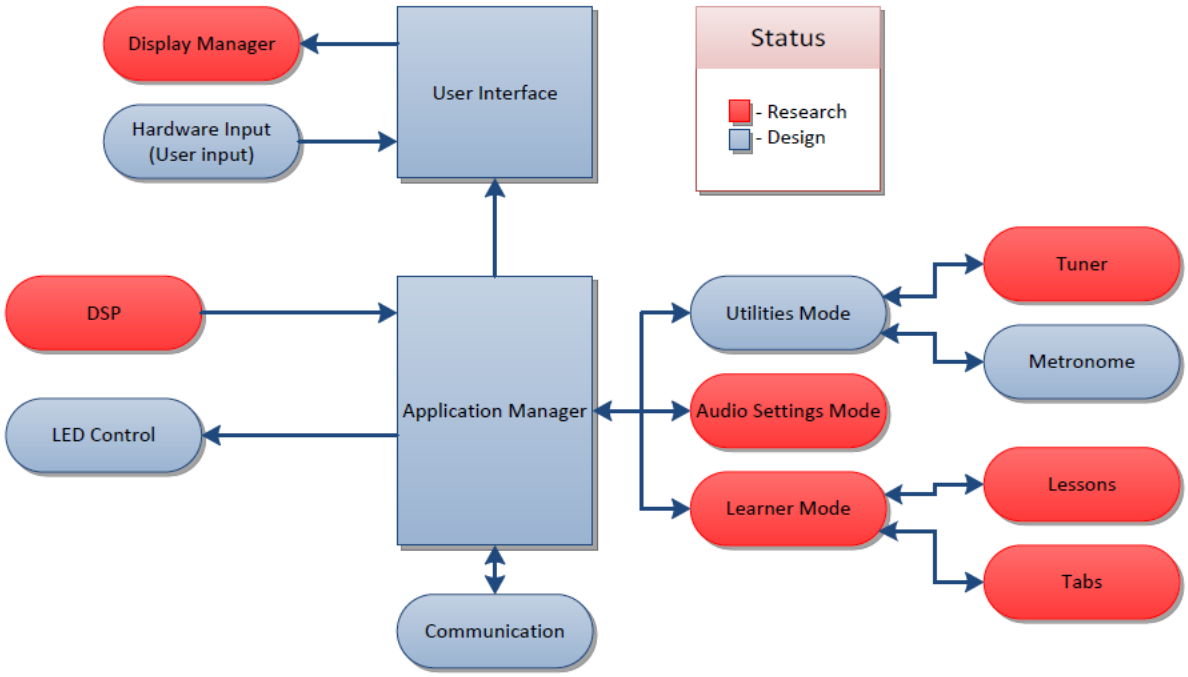
On-Board Hardware (Detail)



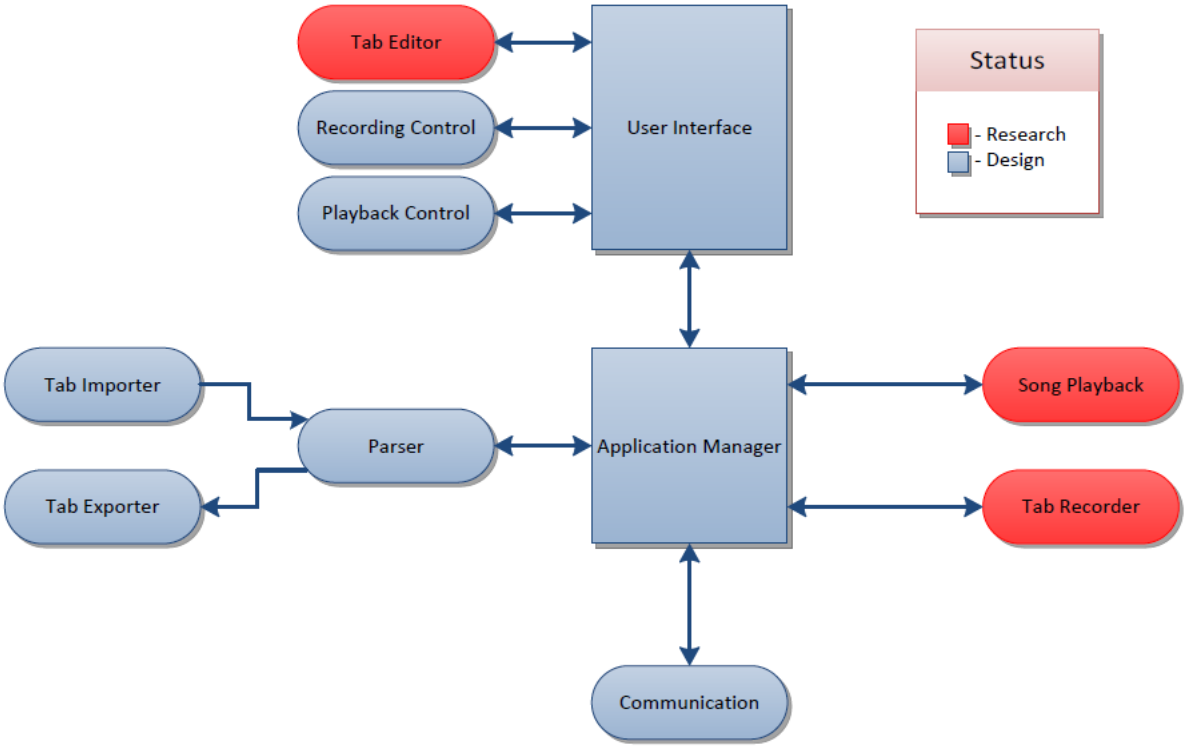
Software (High-Level)



Software (On-Board)



Software (PC)



Project Budget and Financing:

As this project is not sponsored, the group will attempt to collect sample parts where possible. Below is a table listing out anticipated cost for each component alongside our hopeful maximum budget.

Component/Description	Anticipated Price (USD)	Maximum Budget (USD)
Custom PCBs: Control board w/ DSP and I/O	100.00	$200.00
I^2C I/O Expander	10.00	$20.00
TI Fixed-Point Digital Signal Processor	20.00	$50.00
LED Matrix Enclosure	5.00	$10.00
Ribbon Cabling	90.00	$150.00
9V Lithium Ion Rechargeable Battery – 350 mAh	4.95	$15.00
9V Battery Holder	2.95	$5.00
Battery Charger	7.00	$10.00
Alnico 2 Polepiece Magnets	15.00	$30.00
42 Gauge Copper Wire	30.00	$50.00
Polyphonic Pickup Structural Components	5.00	$10.00
LCD Display	14.00	$20.00
Rotary Potentiometer – 10kOhm	2.00	$6.00
Pushbuttons	1.00	$2.00
TI ezDSP Board	0	$150.00
MicroSD Card – 2Gb	5.00	$10.00
Total Cost	**$311.90**	**$738.00**

Project Milestones:

While the course of the next two semesters is indeterminate, the group does hope to prototype a good portion of the subsystems required for the eGuitar in the first semester while keeping up with course-required documentation. Ultimately (by the end of the second semester) the eGuitar should function well enough to allow for the user experience mentioned in *Project Function*. Below is a table detailing the group's minimum and ideal milestones for both semesters.

	Minimum milestones	Hopeful milestones
First semester	Course-required documentation	Prototyped LED control
	Procurement of viable parts for building final system	Prototyped software (parser)
Second semester	Single-note DSP	Polyphonic DSP
	On-board tuner	Tablature recording
	On-board metronome	Lessons playback
	Tablature playback	Additional fret LED coverage
	On-board LED control	Motorized tuning (unlikely)