Automatic Guitar Tuner

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Initial Project Document and Group Identification
Divide and Conquer

Group F

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Automatic Guitar Tuner

Project Narrative

The Automatic Guitar Tuner will be a handheld device with the ability to tune a guitar. This product will aid people who are unable to or have difficulty tuning a guitar by hand. It will also help the musician calibrate their “ear” in order to hear if the guitar is in tune or not. It will be easy and intuitive to use, no matter the skill level of the user.

The tuner will have a mechanism that allows it to pick up the frequency produced when the guitar string is plucked. The mechanism will then send this information to the microcontroller unit (MCU). The MCU will communicate with a phone application designed for this purpose. The application will provide the MCU with the desired in-tune note. The MCU would then use this information and the frequency feedback to spin the servo and in turn tune the guitar.

The application will be the user interface for the device itself. It will allow the user to designate which note they want tuned, while also providing the user with a history of previous tuning measurements. The measurement history could be used to train the human ear into hearing if a note is out of tune or not. The application will also allow the user to completely unstring or restring the guitar without hassle, by using a series of button presses. The guitar tuner will also have an organic light emitting diode display (OLED) which will allow the user to forgo the phone application and perform all basic functions.

An example usage case would be this: The musician decides to restring their guitar. They open the application on their phone and set the device to the “Remove String” option. The device is held against the tuning knob and a button on the tuner will be pressed and held down. The device will continuously rotate the knob, loosening the string until it can be removed. The musician then changes the setting in the application to “Install String” option. The musician places the new string in the correct position and presses the button again. This time, however, it will spin only a certain number of rotations. This will ensure that the device does not over tighten the string and damage the guitar. Once it stops rotating, the application will automatically set itself into tuning mode and request input for which setting the guitar should be tuned to. Once chosen, the guitarist will then pluck the string and the Automatic Guitar Tuner will tune the guitar.

The device will be handheld due to the multiple configurations of guitar headstocks. It will decrease the risk of damage to the guitar and the risk of affecting the sound quality of the guitar itself. This also allows the device to be smaller and lighter.

This device is essentially 3 devices in one: a tuner, a guitar peg winder, and a teaching tool. It will allow people of all ages to continue enjoying their hobby without the hassle and pain of restringing and tuning their guitars. It will also help musicians who are interested in developing their “ear” in order to hear if their guitar is in tune or not.

Requirements Specifications

Weight: The device will weigh no more than 0.5 kg.
Durability: The device will be capable of surviving a 1 m drop.
Reliability: The device will have a service life ≥ 1 year
Affordability: The device will cost no more than 75 dollars
Torque: The device will use a continuous rotation servo with enough torque to tune ≥ 95% of all guitars.
Low Noise: The device will have a low Signal-to-noise-Ratio (SnR) microphone
Accuracy: The device will have a precision of tune of ±2 percent
Thermal Management: The tuner will be capable of continuous operation without risk of overheating at room temperature (25°C)
Calibration: The tuner will maintain calibration for duration of ≥ 1 year.
Speed: The tuner will complete tuning cycle in ≤ 5 sec.
Dimensions: The tuner shall fit in a package ≤15x7.5x5cm.
Memory: The tuner will have onboard flash storage to save previous tuning frequencies.
Charge Time: The battery will be capable of charging from 10% to 90% in two hours.
Battery Protection: The battery circuit will prevent over-draining of battery cells.
Power Source Standard: The battery will be capable of charging off a common 5V micro USB power supply.
Display Brightness: The LED display will have a brightness of greater than or equal to 250nits.
LED Power Consumption: The LED display will consume no more than 0.1W.
LED Resolution: The LED display resolution will be no less than 90ppi.
Leakage Current: The tuner will produce a leakage current of no more than 0.75mA.
Range: The tuner will be wireless accessible via Bluetooth to within 50 meters.
Latency: Communication between the tuner and Android application will have an average latency of no more than 225ms.
Application Response Time: The application's response time to touch input will be no longer than 200ms.

House of Quality

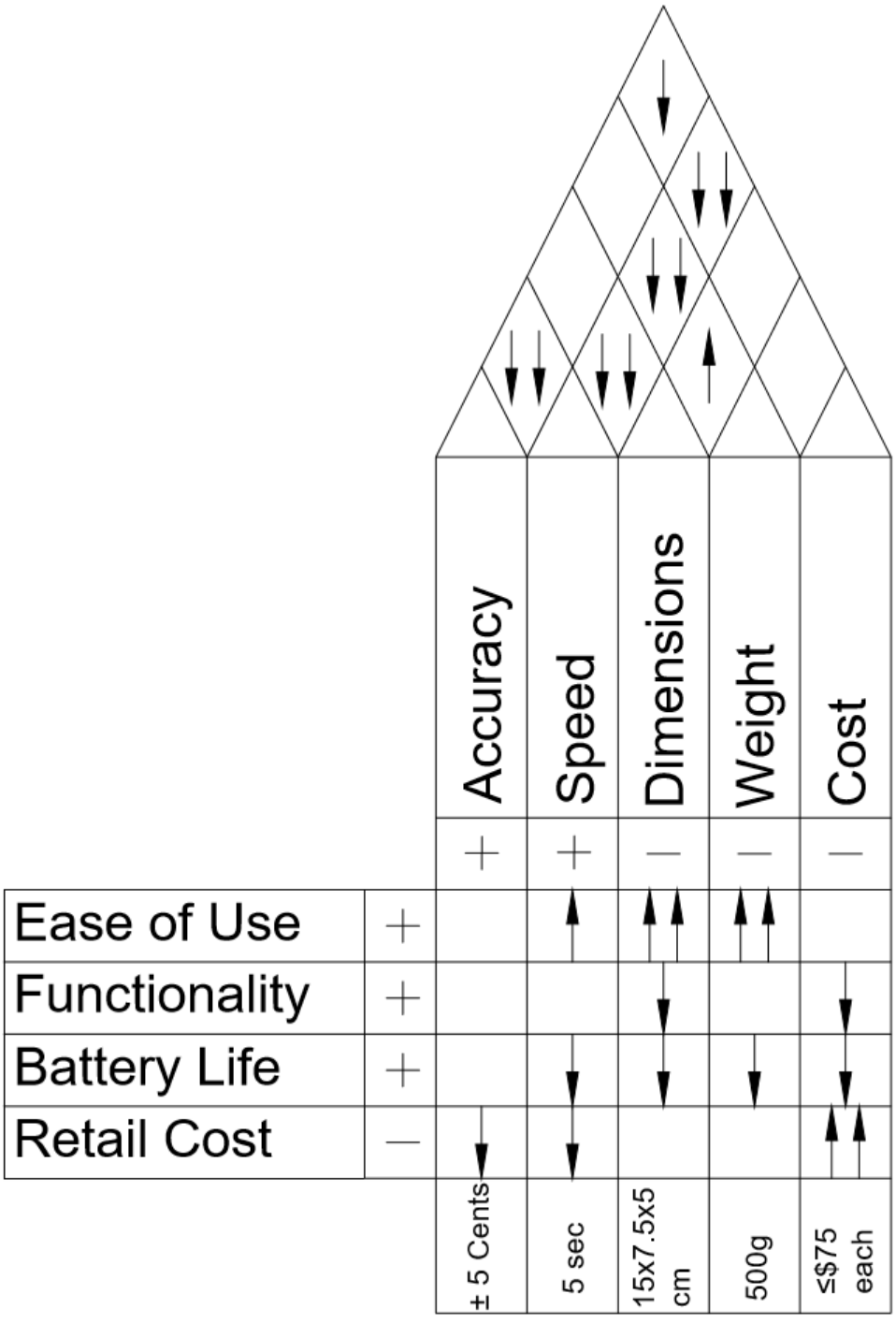

Figure 1: House of Quality

Block Diagrams

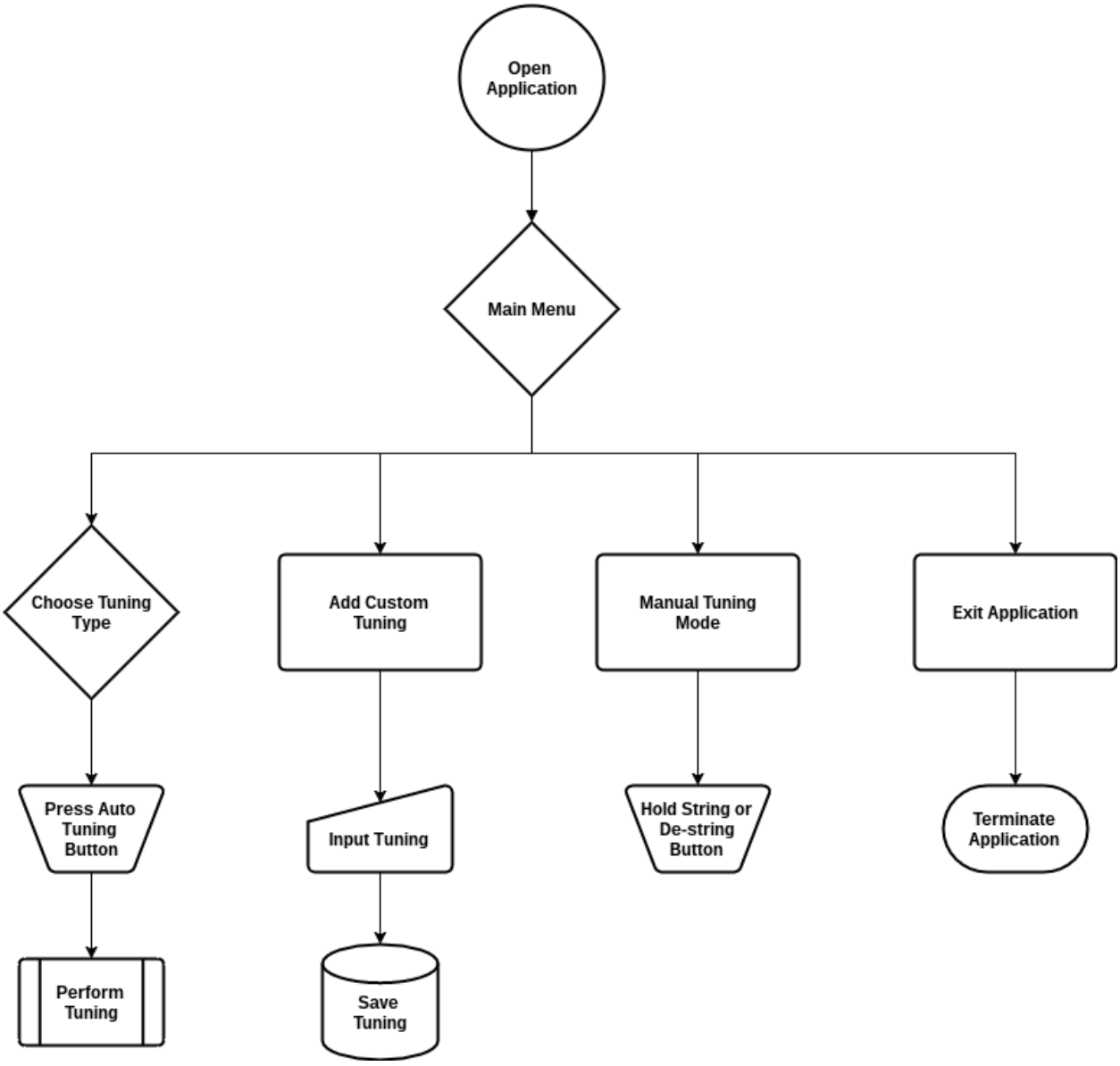

Figure 2: Software Block Diagram

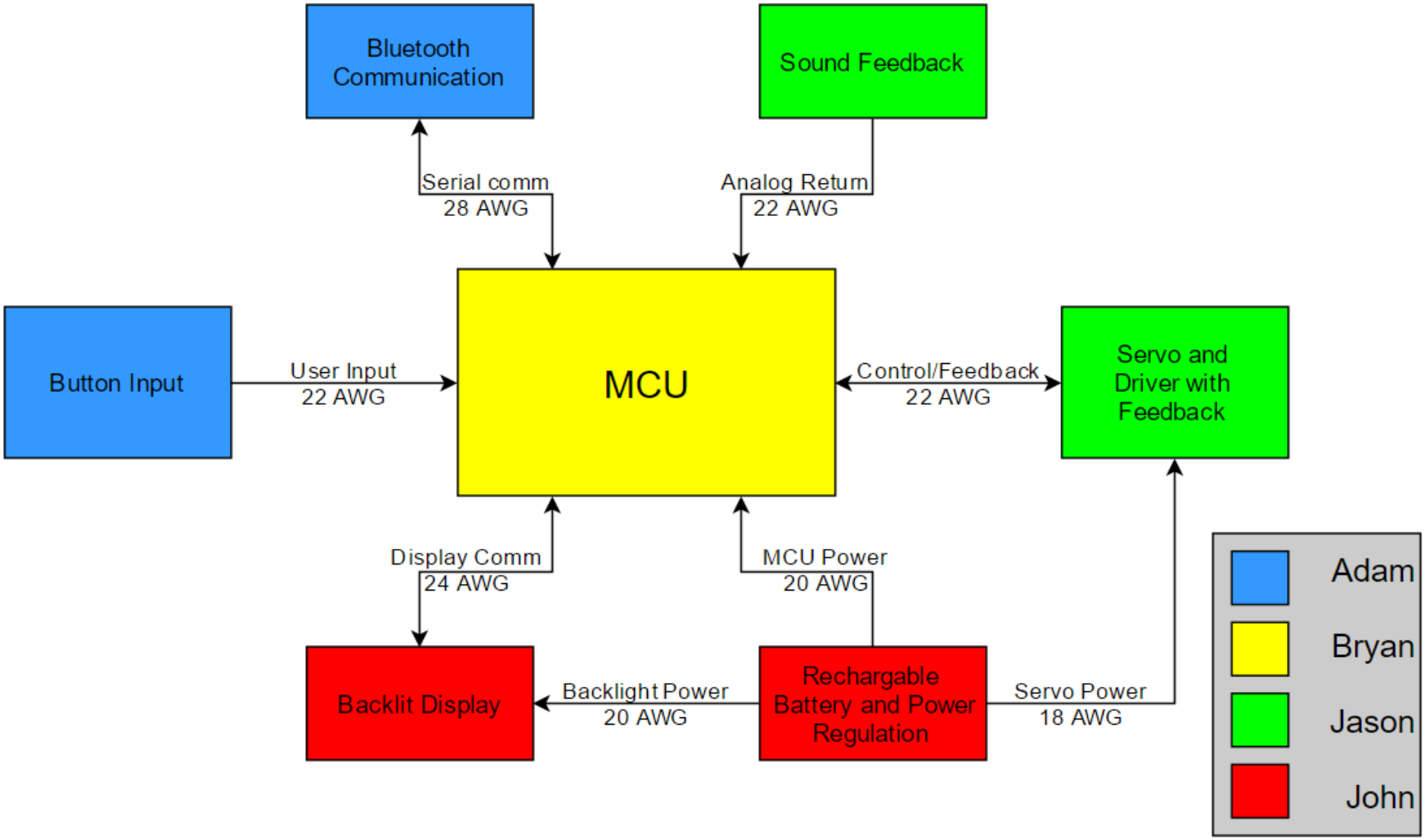

Figure 3: Hardware Block Diagram

Budget

Component	Cost
Board Development Cost	$50
Servo	$40
Casing	$10
Microphone	$20
Rechargeable Battery	$20
Battery Charging Circuit	$20
Charger	$5
Unforeseen Costs	$150
OLED Display	$5
Total Development Budget	**$320**

Table 1: Budget

Milestones

Number	Task	Start	End	Status
Senior Design 1				
1	**Ideas**	1/9/2017	1/13/2017	Complete
2	**Project Selection & Role Assignments**	1/16/2017	2/7/2017	Complete
	Project Report			
3	Initial Document - Divide & Conquer	1/16/2017	2/3/2017	Complete
4	Update Divide & Conquer document	2/4/2017	2/17/2017	Complete
5	Table of Contents	3/13/2017	3/24/2017	In Progress
6	30 Pages	2/20/2017	3/10/2017	In Progress
7	60 Page Draft	2/20/2017	3/31/2017	In Progress
8	90 Pages	2/20/2017	4/14/2017	In Progress
9	Final Document(120 pages)	2/20/2017	4/27/2017	In Progress
10	**Research, Documentation & Design**	2/3/2017	4/27/2017	In Progress
11	Final Hardware Decisions	2/20/2017	3/24/2017	In Progress
Senior Design II				
12	**Order and test parts**	8/21/2017	8/28/2017	
13	**Build Prototype**	8/21/2017	9/4/2017	
14	**Testing & Redesign**	9/4/2017	9/30/2017	
15	**Successful tests & Finalized design**	10/1/2017	10/31/2017	
16	**Peer presentation**	TBA	TBA	
17	**Final Report**	TBA	TBA	
18	**Presentation**	TBA	TBA	
19	**Senior Design Showcase**	TBA	TBA	

Figure 4: Milestones