Automatic Guitar Tuner

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BACKGROUND

Tuning a guitar is a very difficult task to accomplish for most entry level players. The reason for this is because it requires an ear for the specific notes and knowledge of tunings. Most products on the market that seek to solve this problem still require you to turn the pegs yourself, and the solutions that didn't were bloated and had extra features that would bump up the costs.
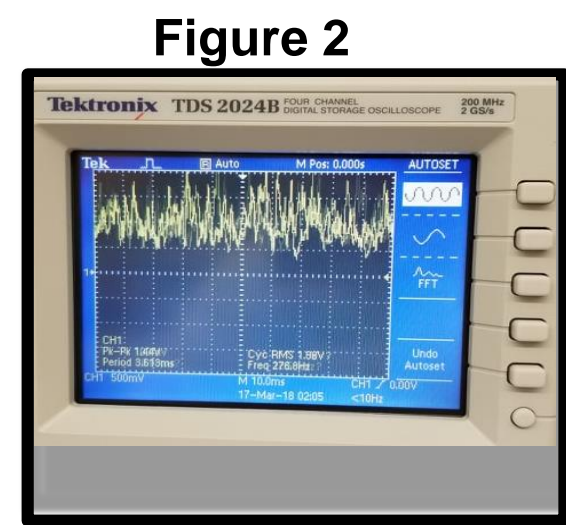
Figure 1

Figure 2

Standard Microphone Input
A typical electret microphone connected to +5V and a 22kΩ resistor will output a frequency when sound is applied to it. However, the output that is shown (Figure 2) is not very clear. In this case an electret microphone cannot just be hooked into an Arduino UNO for a clear input. It must go through amplification and filtering to get the most precise frequency value.
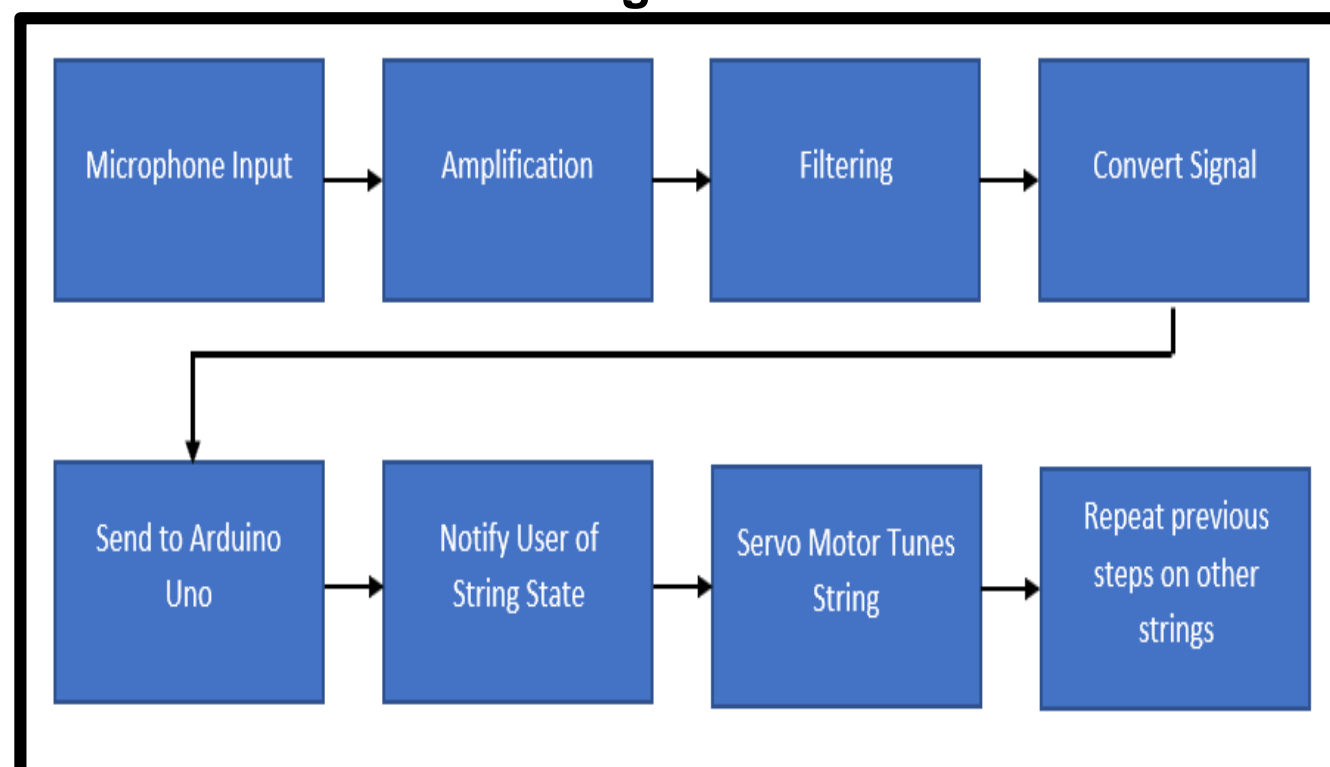
From Beginner To Professional Guitarists
Tuning a guitar is something any guitarist should first learn how to do correctly. Manual tuning requires skill and patience where as having something automatic would save time and be more precise.

PROPOSED SOLUTION

We proposed a solution (Figure 3) where a microphone (Figure 4) picks up the signal from the guitar and a microprocessor uses that signal to control a servo motor. The motor then turns the guitar pegs in the appropriate direction until the proper frequency is achieved. In between, the signal goes through filtering (Figure 4) and modulation (Figure 5) to convert the signal into a form that the microcontroller (Figure 6) can utilize.

Figure 3

Microphone Input	→	Amplification	→	Filtering	→	Convert Signal

Send to Arduino Uno	←	Notify User of String State	←	Servo Motor Tunes String	←	Repeat previous steps on other strings

SYSTEM DESIGN

Sound Input
An electret microphone was used to listen to the input frequency. It is connected to a 1µF capacitor, a 4.7kΩ resistor, and a 1k Ω resistor which then leads into an operational amplifier.

Figure 4

Microphone Input

Amplify The Microphone
A LTC1056CN8 Operational Amplifier IC [3] was used to amplify the range of the electret microphone. This allowed the microphone to be used further away instead of just up close to the sound input.

Figure 4

Low Pass Filter

Schmitt Trigger and Level Shifter
This circuit converts the sine wave from the low pass filter into a square wave. It uses two operational amplifiers, one with a input in the positive terminal and the other with an input in the negative terminal. Each op amp has a variety of resistors and two Zener diodes [1] in order to convert the sine wave into a square wave. The output of the Schmitt Trigger is then connected to pin 7 on the Arduino Uno and displays a clear frequency [2].

Figure 5

Schmitt Trigger and Level Shifter

Low Pass Filter
An LTC1064-2CN IC is a switch capacitor low pass filter. It is connected from the microphone input circuit to pin 2. This part of the circuit will allow a more clear and less static tone which comes from the microphone. It is also hooked up to the voltage-to-frequency converter to control its cutoff frequency.

Cutoff Frequency Circuit
An AD654 IC [5] is used to set the cutoff frequency from the low pass filter. It is connected from 11 of the LTC1064 (Low Pass Filter) IC, which is the fclk output, to pin 1 of the AD654 IC.

Figure 6

Microcontroller

Microcontroller and Other Peripherals
An Arduino Uno is used as a microcontroller for the whole project. It supplies power (+5V) and GND to the breadboard and has an input from the microphone circuit and output to a high torque servo motor with a 3D printed fitting. 3 LEDS (two red and one green) also notify the user if the string is tuned or not.

FUTURE DIRECTION

- Add button functionality for additional tunings
- Integrate our circuit into a PCB and create a casing for the project
- The Arduino Uno didn't have enough inputs for us to include an LCD display. A future design would include a microprocessor with more inputs so we can include it
- Design a phone app that controls the device

ACKNOWLEDGEMENTS

REFERENCES

[1] D. Nedelkovski, "What is Schmitt Trigger | How It Works," *HowToMechatronics*, 25-Feb-2018.
[2] A. Kumar, "How does a level shifter work in an op amp?," 05-Feb-2017.
[3] "LT1055/LT1056 ," *Precision, High Speed, JFET Input Operational Amplifiers*.
[4] "LTC1064," *Low Noise, Fast, Quad Universal Filter Building Block*.
[5] "AD654," *Low Cost Monolithic Voltage-to-Frequency Converter*.

CONTACT INFORMATION

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