The Automatic Guitar Tuner is a smart, motorized device that will aid musicians and music enthusiasts alike in tuning their guitars accurately and efficiently. The primary motivation behind this project was to expand our knowledge and experience with audio signal processing. Our product is connected to an electric guitar via auxiliary cable. When a string is played, the device determines its pitch and compares this to a pre-programmed reference (i.e., the desired value). It then turns the motor (affixed to a tuning peg) the correct amount in order to bring the string to the desired pitch.

**Key Technologies**

- Standard-E tuning - The system is only designed to tune a guitar to standard-E (E,A,D,G,B,e = 82, 110, 147, 196, 247, 330) Hz.
- Ergonomic design - “Gun-shaped” to comfortably fit user’s hand.
- Microcontroller - ESP32 with 240 MHz clock, 600 MIPS, 32-bit registers, and 12-bit ADC.
- Trigger-operated motor - Continuous servo controlled by PWM signals from ESP32.
- Universal nozzle - Designed to fit any tuning peg.
- String-select button - Cycle through strings.
- Input power - 9VDC @ 500mA (max), regulated from 120V mains.

**Signal Processing Firmware**

**Autocorrelation Algorithm:**

1. Input signal is sampled over a small time interval at t=0.
2. A copy of sample is incrementally compared with original signal, being shifted one sample each time.
3. A ‘correlation’ value is assigned to each comparison, indicating the similarity between sampled and original signals with respect to the amount of time shifted.
4. Plotting correlation values against time produces a sinusoidal trace where high values = high correlation and low values = low correlation.
5. Frequency of this trace = fundamental frequency of original signal.

**Enclosure Manufacturing Process**

Designed in Fusion360, our enclosure is 3D printed using PLA filaments.