Automatic Guitar Tuner
EECS 452 Digital Signal Processing Design Lab

Nick Frazier, Dongsuk Jeon, Jaehun Jeong, Maureen Maier, Anirudh Minda, Chris Ranney

Introduction

The purpose of our project is to design a low-cost peripheral device that can automatically tune an acoustic guitar. To make this a marketable product, we had to ensure that the device would tune both accurately and efficiently. Therefore, we used the following specifications:

Tuning accuracy: our pitch detection algorithm is capable of tuning a note within 2 Hz.

Tuning time: a typical user is capable of tuning their guitar in about 30 seconds. Our system can tune a string in under 5 seconds depending on the initial state.

Sensors

Our design uses a disk-type piezoelectric sensor that has been fastened next to the bridge of the guitar. The piezo-electric sensor picks up the vibration from strumming the strings and sends this as an electric signal to the digital signal processor.
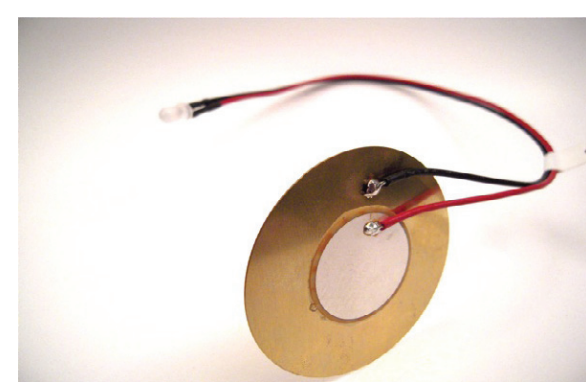

Figure 1: Disc-type piezo-electric sensor

Figure 2: Placement of sensor on guitar, tape removed

Table 1: Frequency of guitar strings (standard tuning)

Guitar String	Note	Frequency (Hertz)
#1	e	329.63
#2	B	246.94
#3	G	196
#4	D	146.83
#5	A	110
#6	E	82.407

Digital Signal Processing

Our system uses the Texas Instruments C5510 Digital Starter Kit for pitch detection and processing. It calculates the FFT of the input signal and applies a Hamming window, and each value goes through a local averaging filter for more stable response. Then our algorithm finds a local maximum point within a specific frequency bin. We compare the result to the desired frequency values and determine whether the string is sharp, flat, or in tune.
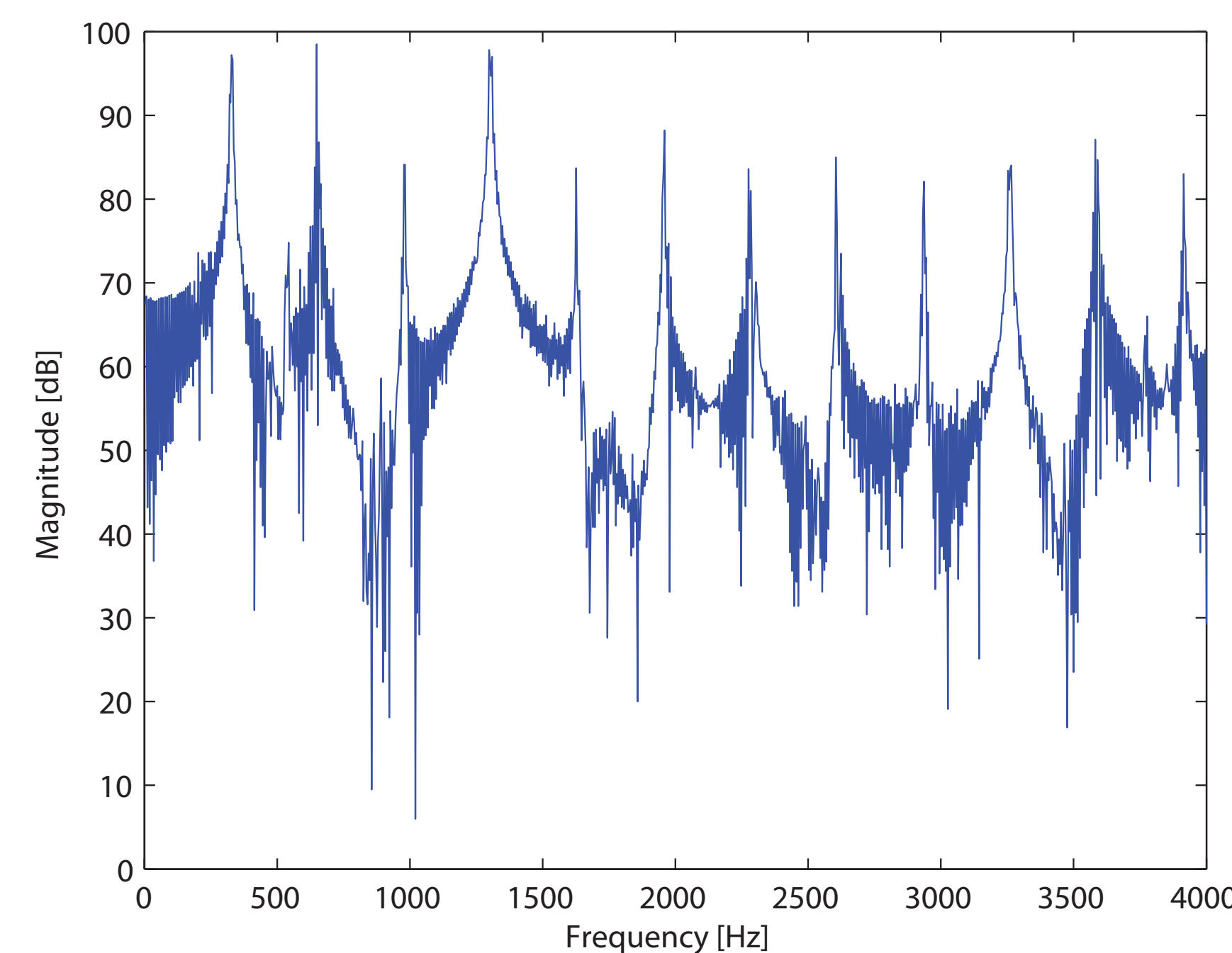

Figure 3: FFT Spectrum of B string (256.94 Hz)

Figure 4: Prototype system tuning 'A' string (110 Hz)

Control System

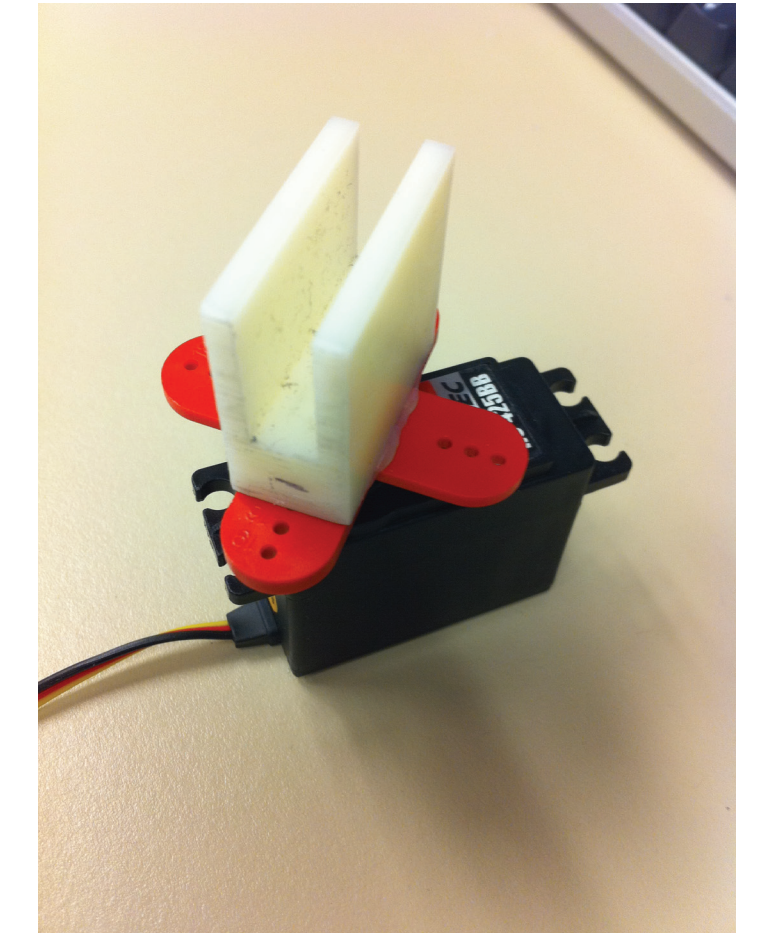Figure 5: Tuning peg interface attached to guitar

Figure 6: Servo with tuning peg interface attached

The program sends a pulse with varying width which controls the position of a servo. The servo is an automatic device that uses error-sensing negative feedback to correct the position of the tuning peg until the string is deemed in tune. We modified a Hitec HS-425BB servo capable of an output torque of 46 oz.in for continuous rotation.

Currently, the program only controls one servo at a time. With more time, our project can be extended to control three or even six servos to tune all the strings simultaneously.

Hardware

We used ABS plastic to design an interface for the servo and the guitar tuning peg. This interface is mounted to the servo with plastic welder epoxy.

The current mounting device is fashioned out of a piece of wood clamped to the table with the servos attached via metal strip. The optimal mounting device would be smaller so that it could be attached directly on the head of the guitar. Additionally, we would like to be able to tune multiple strings at a time, so the servos would be positioned much closer together.

Michigan**Engineering**