DEPARTMENT OF MECHANICAL ENGINEERING

Team E6: Chord Crafters

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A. JAMES CLARK SCHOOL OF ENGINEERING

Motivation, Goal, Impact

Motivation:
Ross, a passionate guitarist, experienced a stroke that paralyzed the left side of his body, preventing him from playing the guitar.

Goal:
Design an assistive guitar-playing device capable of holding down strings to form chords using only input from Ross's right leg.

Requirements

Essential Chord Variability: Must be capable of playing at least the following chords — G, D, A, Bm, and A7.

Natural Sound Quality: Produce chord sounds matching those made by a human finger (no buzzing, off-notes).

Quiet Mechanical Operation: Minimal noise compared to the guitar's acoustic output.

Low Latency: Sense users input with little to no delay between input and sound.

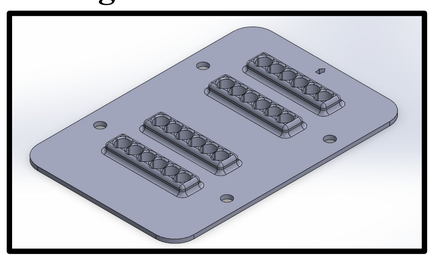
Lightweight Design: Should not add noticeable weight to the guitar or put extra strain on the user.

Long Life: Needs to provide at least 30 minutes of power per session.

Input Device

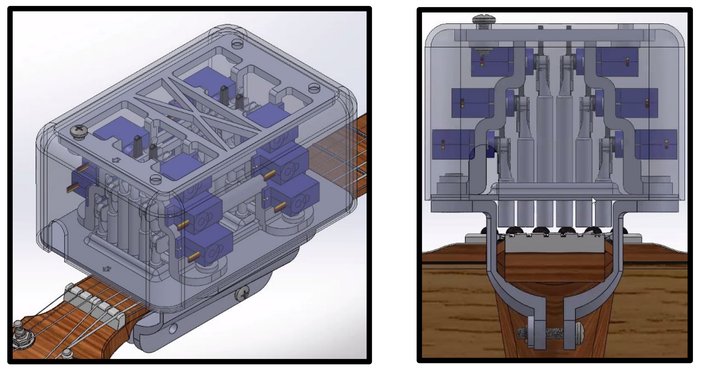
Final design of photoresistor ramp and electronics box

Peg Constraint Sheet



Final Design

Actuator Attachment

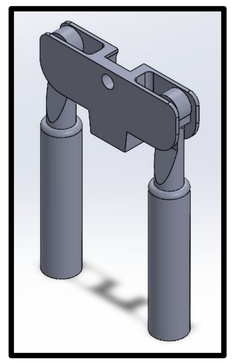


3D CAD of actuator set-up. Features bottom frame, servo housing, 12 servo motors with peg attachments and constraint sheet

Alignment sheet used to ensure pegs are correctly positioned to apply vertical force on the strings

One sided servo horn used to attach peg attachment to motors

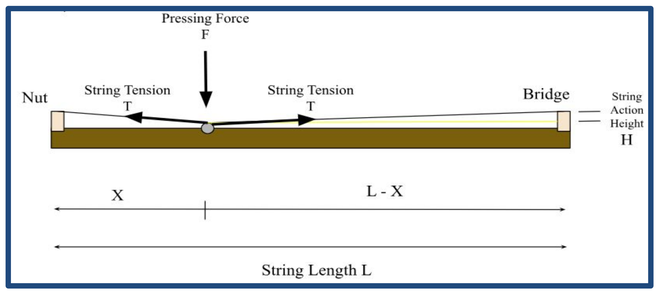
Peg Attachment

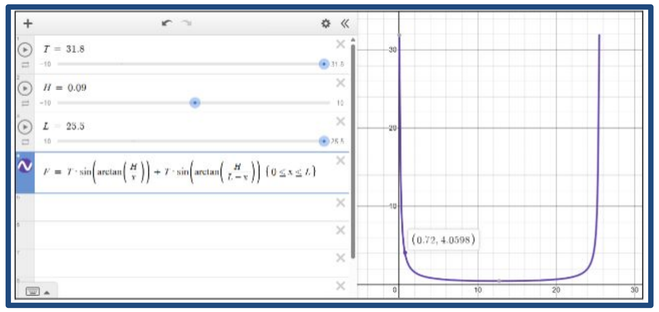


3D CAD of short peg attachment with larger peg diameters

Design Calculations & Decisions

Peg Locations: To locate where our pegs should sit, we measured both how far from off the strings our pegs need to sit to avoid buzzing when the strings are strummed, as well as how far down each fret we need to press to make the right sound. We designed so that our pegs sat 0.23 in. above the fretboard, giving us no buzz, and so that we don't hit the string in the back 25% of the fret, guaranteeing that it makes the proper sound.

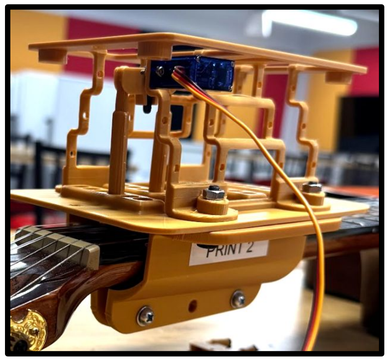




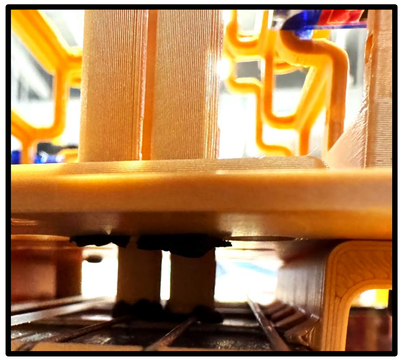
String Pressing Force: To make sure we get enough force to press and hold a string, we calculated the theoretical required force using the string tension and action. We found that we need at least 4 lbs of force to hold down the most difficult string. Our servos can output 2.17 lb*in. of torque, so we made our lever arm 0.5 in. This gives a force output of 4.34 in., which holds down the strings.

Actuation Noise: We measured one servo to be about 46 dB for the guitar player, or 42 dB inside our housing. Twelve servos, by calculation, is 53 dB, which should be much quieter than the guitar.

Prototype & Test Results

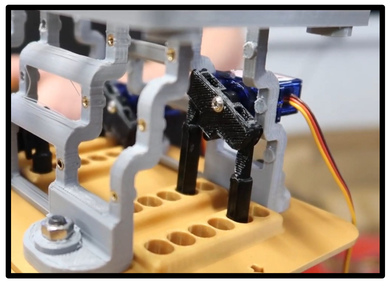


Bottom frame, servo mount, servo with peg attachment

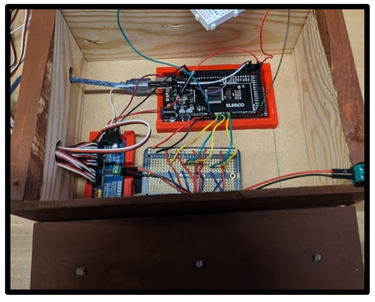


Two servo pegs pushing down strings to generate a chord

Testing photoresistor input with final box design



Calibrating pegs at each position using a potentiometer to determine servo values



User input box showing electronics including Arduino Mega and PCA9685

Test	Bm	D	G	A	A7
1	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓
5	✓	✓	✓	✓	✓

Ran 5 rounds of tests for each chord and our input device worked correctly each time