

How (not) to build a tuner

PHYS 319 Personal Project

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April 13, 2021



Outline

- 1 Motivation
- 2 High-Level Overview of Functionality
- 3 Brief run-through of components/theory
 - Audio Input and Signal Processing
 - User Controls
 - LCD Display
 - MSP program
- 4 Demo
- 5 Possible Improvements & Outlook

Motivation

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This is
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Demotivation

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- I spent more time building a tuner than actually playing music in the last year.
- 250+ dollar kit worth of parts is outperformed by by brother's 30 dollar device.
- Curse of the physicist: Real life often makes everything you thought would be doable harder.

High-Level Overview of Functionality

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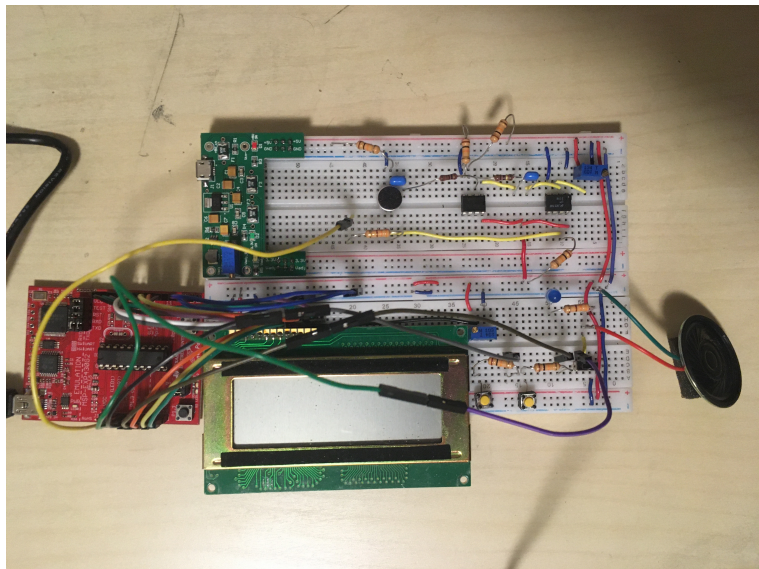
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- Metronome for tempo

High-Level Overview of Functionality

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- Measure the frequency of the played note and return how off it was
- Play the specific frequency for tuning by ear
- Metronome for tempo
- Display & Interface on device itself

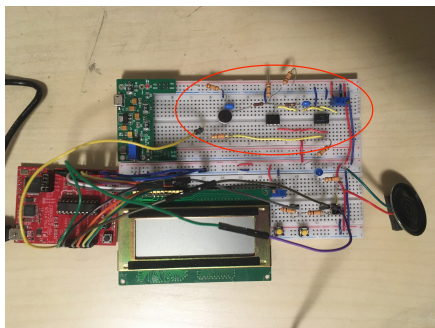
A complicated mess



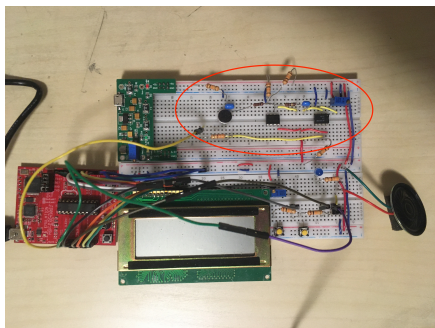
A complicated mess

```
156
157 char* int_to_note_string(int note) {
158     switch(note) {
159         case 16:
160             return "C2";
161
162         case 17:
163             return "C#2";
164
165         case 18:
166             return "D2";
167
168         case 19:
169             return "D#2";
170
171         case 20:
172             return "E2";
173
174         case 21:
175             return "F2";
176
177         case 22:
178             return "F#2";
179
180         case 23:
181             return "G2";
182
183         case 24:
184             return "G#2";
185
186         case 25:
187             return "A2";
```

Audio Input and Signal processing



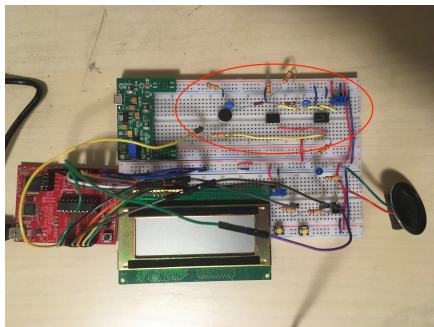
Audio Input and Signal processing



- Electret mic. picks up the signal



Audio Input and Signal processing



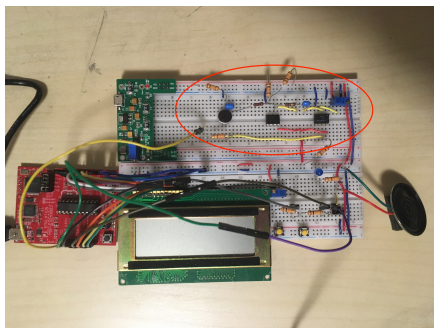
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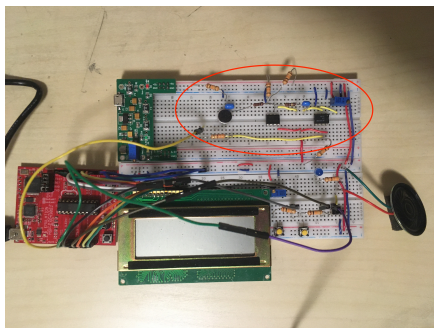




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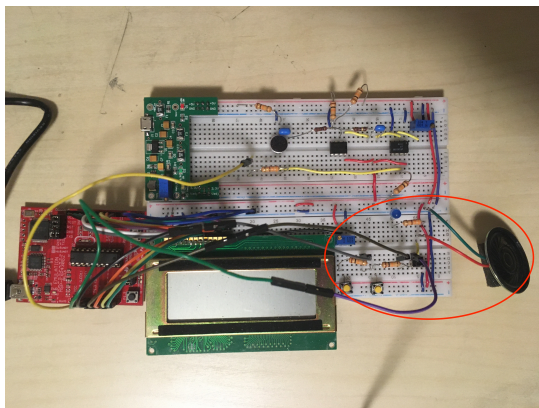
- Comparator converts to square wave

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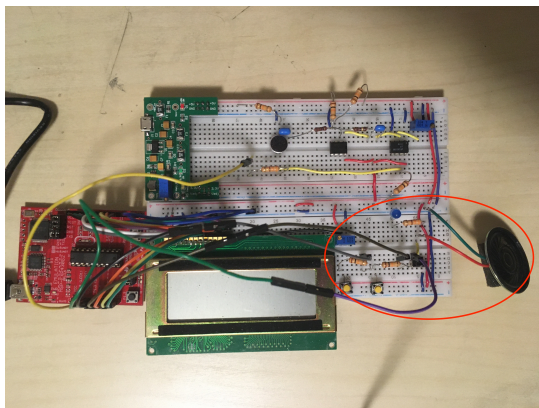


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- Op-Amp amplifies signal 
- Comparator converts to square wave
- Processed Signal gets sent to MSP

User Controls

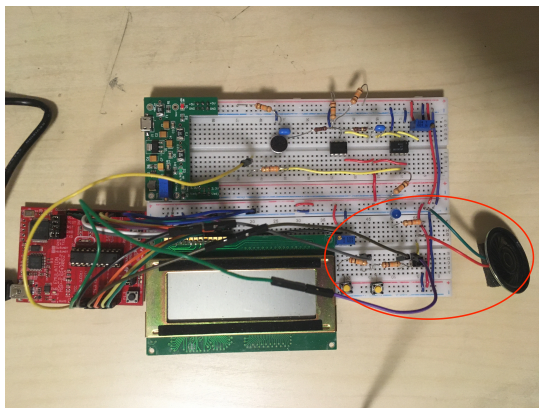


User Controls



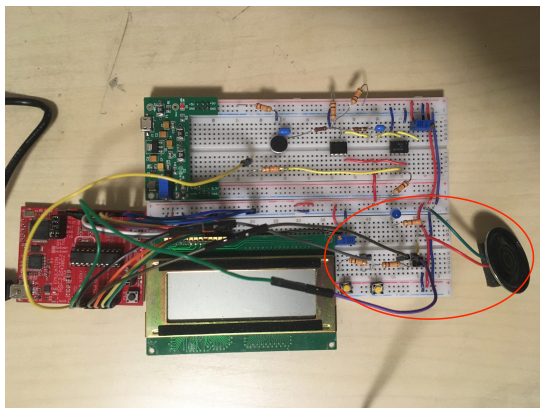
- Buttons to change notes

User Controls



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- Switch to turn speaker on/off

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- Interrupt buttons on MSP to switch tuning/metronome modes

LCD Display



LCD Display



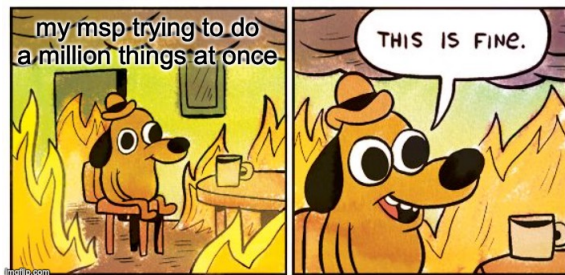
- Potentiometer for screen contrast

LCD Display

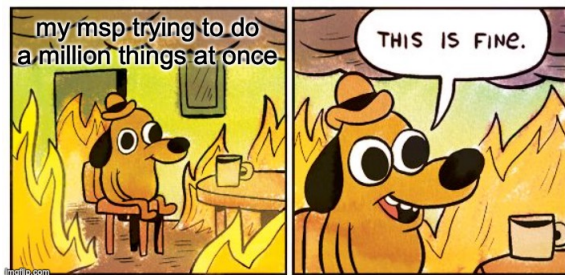


- Potentiometer for screen contrast
- R/S pin, E pin, and 8 data pin inputs from MSP

MSP program

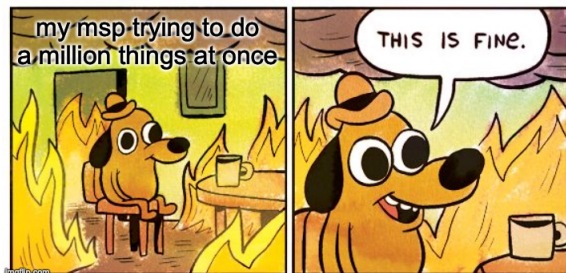


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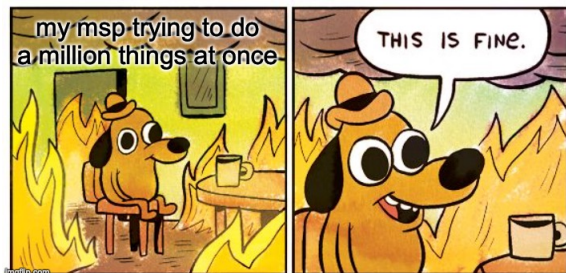
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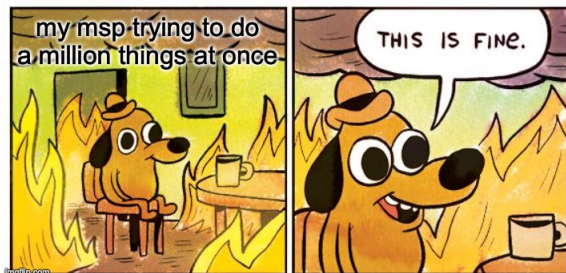
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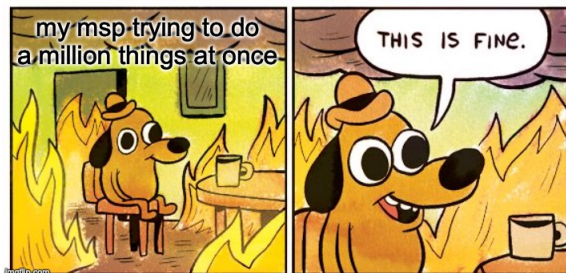
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MSP program



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- PWM output
- Interrupt Handling

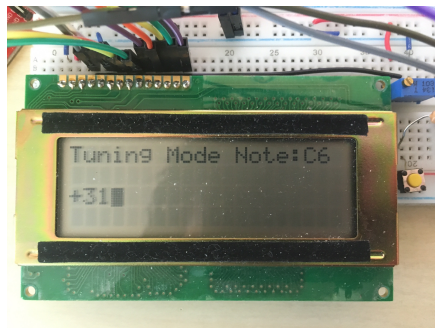
MSP program



- Measuring input signal width
- Outputs to LCD display
- PWM output
- Interrupt Handling
- Internal counter and input handling for bpm/notes



LCD photos as I anticipate it will be impossible to see on camera



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- ② Inconsistencies in measured frequency, difficulty in reading inputs with multiple harmonics
 - ▶ Adjustments in comparator calibration, how the MSP counts the pulse width, implementation of averaging.
- ③ Difficulty in handling tones that are not consistently loud.
 - ▶ Potential stronger amplification, but could be a hardware limitation due to low SNR for quiet signal.

Outlook

