# TheorySynth Keyboard

## Project

Modern music synthesizers are be expensive and complicated. Furthermore, music theory can be intimidating to learn when you don't have the right equipment to practice the fundamentals.

TheorySynth offers a solution in the form of an affordable, simple, and easy-to-use synthesizer. Featuring both a 2-octave keyboard and 21-key chord board, TheorySynth is the perfect playground for mastering the fundamentals of modern music theory.



## System Overview
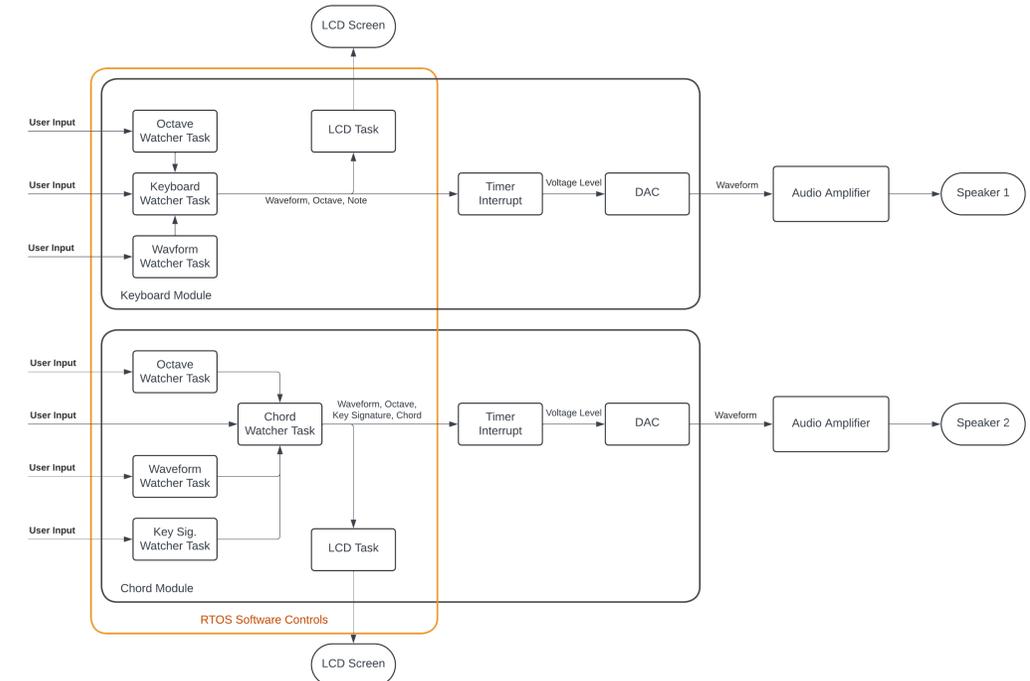


## Methods

- Implemented using FreeRTOS on STM32 development boards
  - One microcontroller for each module allows for greater octave range without conflict
  - FreeRTOS provides efficient handling of various user input simultaneously

- Voltage waveforms created via varying indexing rates through various waveform look-up tables
  - Timer interrupt indexes through the tables with changing increments
  - Voltage levels are then generated through an on-board DAC
  - Common amplifiers ensure the waveforms produce audible music

- Chord generation via combining three varying voltage levels

- Simple designs lead to simple solutions
- Complex designs lead to complex problems

## Conclusion

Results:
- Keyboard module successfully generates on-pitch tones
- Chord module successfully generates triads within a user-chosen key signature
- Octave and Waveform controls successfully modify generated tones
- Chord progressions and melodies may be played simultaneously

Next Steps:
- Implement analog ADSR volume envelope controls
- Software optimizations to allow for multi-key press
- Hardware upgrades to increase the project's capable octave range
- Implement MIDI protocol over USB to enable digital music transcription

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