Theremin Project

Ben Glick, Sean Richardson, Jerome Regovich

Introduction

For our final project, our goal is to construct and operate a theremin. A theremin is an electronic instrument named after the english transliteration of the name of its inventor, Leon Термéн. We find the project of constructing a theremin intriguing, for the instrument is unique in that it is played without physical contact. It is also generally recognized as the first electronic instrument. Its distinct sound is often used in science fiction film and television scores, although it also has been used in orchestral music, most notably by Dimitri Shostakovich in many of his film scores. Theremin players can change the volume and pitch of the instrument they are playing by moving their hands closer and farther from two "antennas" in the instrument.

In building a theremin, we hope to solidify our understanding of some of the circuits and techniques we have learned throughout the year. Constructing an operational theremin requires incorporating a voltage oscillator, a low pass filter, and an amplifier -- all circuits we have learned in experimental methods. Additionally, a theremin is a good project to see how small circuit elements fit together in working towards a bigger goal.

A theremin project is big enough to practice some more general engineering skills. We will have to carefully plan out the construction process in order to have it working by the end. We will also have to practice the ageless engineering skill of building something functional while minimizing the cost. And in going through the construction process for a larger project, we will likely get to experience the process of underestimating how long small parts of the project will end up taking.

Operating Principles

The basic “black box” diagram of the theremin is shown in Fig. 1. The thereminist stands in front

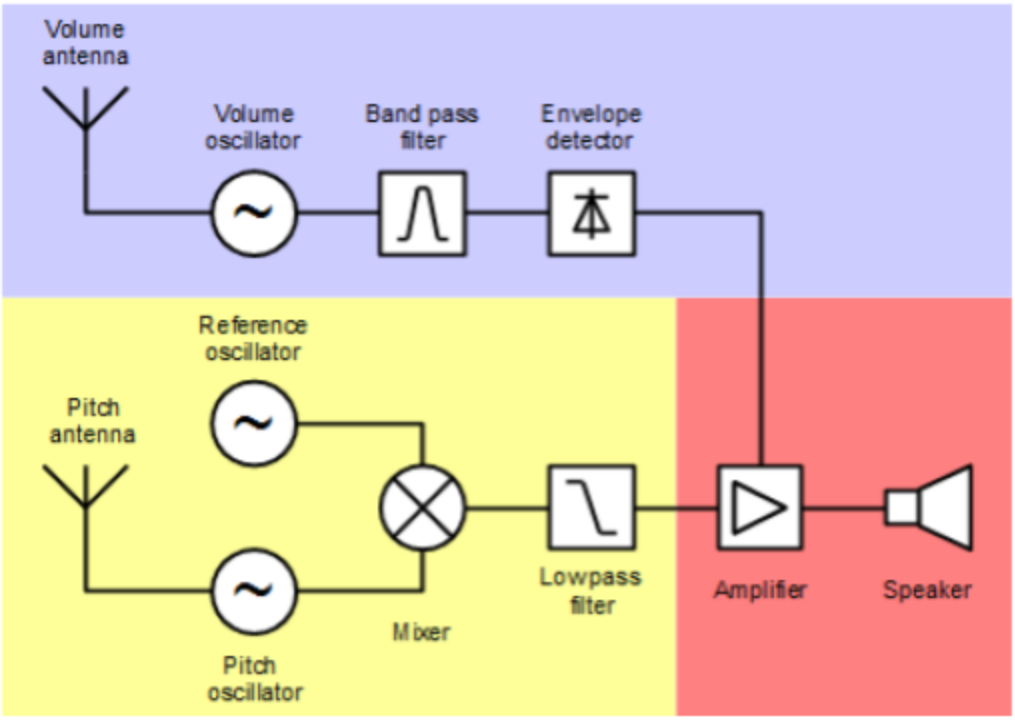

Fig. 1. Block diagram of a Theremin

of the instrument and moves his or her hands near two metal antennas. The distance from one antenna determines frequency of the output sound, and the distance from the other controls amplitude, or volume. Higher notes are played by moving the hand closer to the pitch antenna, while louder notes are played by moving the hand away from the volume antenna. Though they are commonly called antennas, they are not used for receiving or broadcasting radio waves, but instead act as plates of capacitors.

The theremin uses the heterodyne principle to generate an audio signal, using a heterodyne

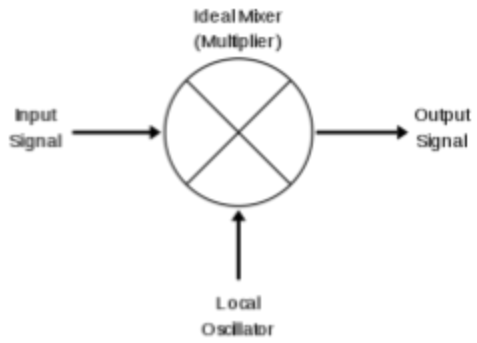

Fig. 2. Behavior of a heterodyne mixer.

mixer. The mixer takes two oscillating inputs, and returns the result of multiplying the incoming waves together. The structure of a heterodyne mixer is shown in Fig. 2. The Theremin's pitch circuitry includes two oscillators. One oscillator operates at a fixed frequency. The frequency of the other oscillator is almost identical, and is controlled by the performer's distance from the pitch control antenna.

The performer's hand acts as the grounded plate (the performer's body being the connection to ground) of a variable capacitor in an L-C circuit, which is part of the oscillator and determines its frequency. This signal is then passed through a band-pass filter before being fed into the mixer so that stray frequencies are not incorporated into the sound. The mixer produces the audio-range difference between the frequencies of the two oscillators (volume and pitch) at each moment, which is the tone that is then amplified and sent to a loudspeaker.

Apparatus

Our theremin would follow the block diagram in Fig. 1.

Each individual part would not be too complicated to build, and if time constraints us, we can simply throw in a premade part if necessary.
We will use a series of breadboards and digital software to build each individual part. All circuit components we plan to use from the lab except for a couple of integrated circuits which will need to be purchased specially from a supplier. They are fairly common ICs and are not difficult to find.

Equipment, Supplies, and Budget

Because we are building our theremin mostly from scratch, we have nearly all the required supplies available in the lab. We have ordered all of the required parts, but are still searching for a particular op amp.

Timeline

Week 1

- Order/Obtain kit with parts
- Start building some of the simpler circuit chunks (Such as the low pass filter and envelope detector)
- Determine which parts are too time consuming to build ourselves (probably will be the mixer and speaker)

Week 2

- Build the antenna interface
- Begin adding parts together
- Produce some sort of sound we can control

Week 3

- Connect final parts
- Operational theremin

Bibliography

http://www.strangeapparatus.com/Theremin.html
After looking through many other pages, this tutorial is the one we have chosen to follow. It gives detailed circuit diagrams for each of the seven different components required to complete the build.

https://www.popsci.com/diy/article/2008-04/build-pocket-theremin-cheap
http://www.thereminworld.com/files/Pages/28/files/Kustom.pdf
http://www.instructables.com/id/The-Tight-Light-Theremin/
http://www.instructables.com/id/555-Square-Wave-Theremin/
http://www.seventransistorlabs.com/Theremin/
https://www.cs.nmsu.edu/~rth/EMTheremin.pf
http://www.edutek.ltd.uk/Circuit_Pages/Theremin.html
http://www.theremin.info/index.php?module=-&type=file&func=get&tid=15&fid=image&pid=54