Theremin Implementation using Arduino and Ultrasonic Sensor

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Introduction

Statement of Purpose

We live in a world where music is prevalent, and such musical tones are created using physical devices such as musical instruments or via digital devices like MIDI. As the two areas seem quite different and diverged from one another, curiosity of whether merging such different fields of music arose. After some research and unexpected performance during the ISR ceremony one day at lunch, we agreed that theremin would be a perfect way to demonstrate the liminal space between the old and the new way of making music. Theremin is a musical instrument that produces sound by changing the electromagnetic field produced by the two antennas. Recreating the instrument would allow us to really know how capacitance and inductance work. Moreover, compared to the original design by "Thierry" on thereminworld.com, we implemented our own circuit design and make a volume changer using Arduino. Implementation of Arduino in theremin is not present in any of the related works on the internet. In the end it would be very pleasing to display this project to the performer who first introduced this to us at ISR and see their thoughts towards it.

Features and Benefits

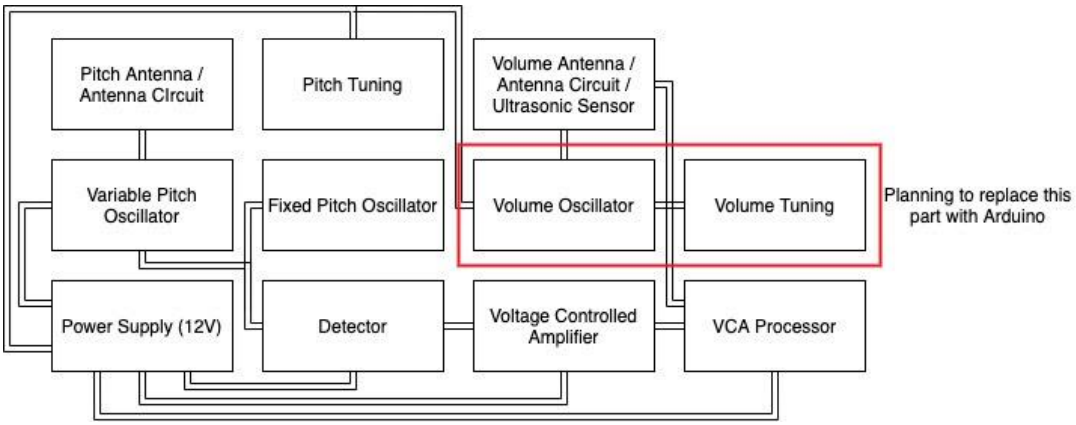
Theremin has two inputs/antennas: one for pitch control and the other for volume control.

1. Pitch Control: For pitch control, we implemented the most common schematic by "Thierry" on thereminworld.com. Using a already proven and widespread implementation allowed us to safely integrate the pitch control feature into our theremin without difficulty.

2. Volume Control: We decided to implement the volume control using Arduino and common ultrasonic sensor. Doing such will allow us to demonstrate that a design that is hardwired can also be implemented in software.

Design

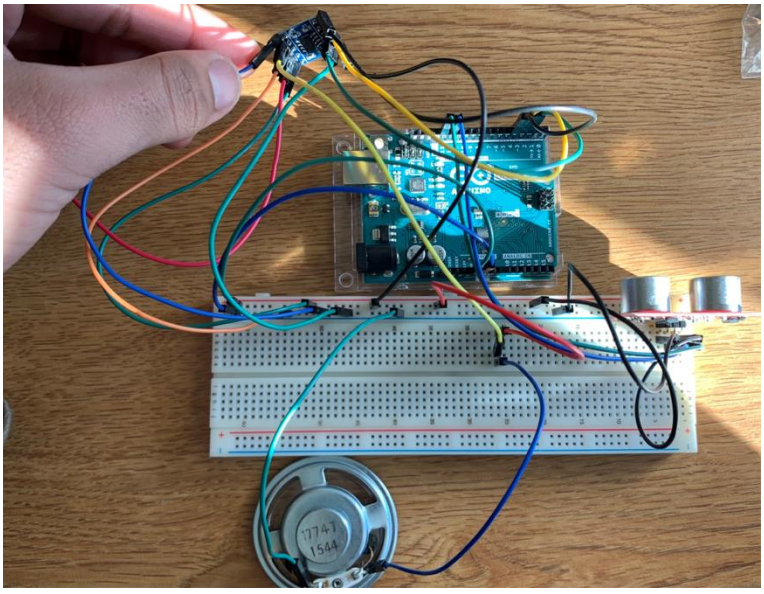
System Overview



The change of capacitance on the pitch antenna would be responsible for the changing in frequency change. The pitch part of the circuit is the most integral to the Theremin since this is the part where capacitors and inductors work together to produce the resonant frequency which is then amplified and played onto a speaker. To make the volume part of the circuit we are planning to use an Arduino and an ultrasonic sensor. The ultrasonic sensor will measure the distance between the hand and the sensor and change the volume of the theremin accordingly. This would be the change part of our lab and would add an innovative touch to it. We would use a regular old speaker to produce the sound and hook it up with the Arduino to change the volume. The power supply would be different for the Arduino, the pitch antenna section, and the amplifier section. We are planning to produce a schematic of the real circuit soon which might be different from the block diagram.

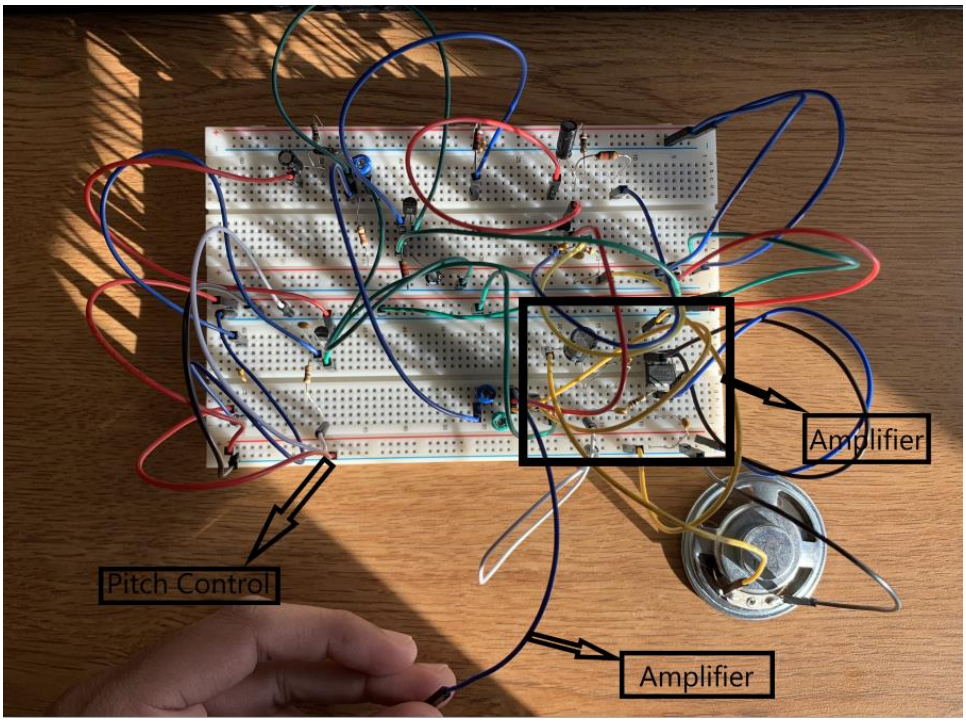
Design Details

I would start with the volume control part of our project. For this part, we used a X9C503 IC which is a digital potentiometer alongside an Arduino and an ultrasonic sensor. The ultrasonic sensor was set up using the Arduino IDE to vary the voltage in the potentiometer thus giving different volume in the speaker. This way without using capacitors and the idea of capacitance that a real theremin would do, for this part of the project we were able to vary the volume through varying the distance of the hand through the ultrasonic sensor.



Now for the pitch control part of the theremin, we used various capacitors, inductors, JFETs and resistors to create the theremin effect i.e. as seen in the theremin world video of the basic physics principles of a theremin and how if produces frequencies within an audible region. We did not have the exact capacitance values for many capacitors, so we had to make them ourselves using series and parallel math of capacitors however when we were unable to achieve those values, we tried to use a variable capacitor which did not finally produce the desired results. Alongside the pitch control part, we also made an amplifier using a LM386N IC. The antenna shown in the

picture below is the controller for the pitch. The human hands or human in general then acts as a capacitor changing capacitance as the distance from the antenna increases or decreases giving us different pitch.



Results

We were quite satisfied with the results produced from the volume control as it varied according to our distance varied from the ultrasonic sensor. However, on the pitch part, due to not having the proper capacitance values, it did not give us the desired results as expected. Overall, the project helped us understand how a theremin really works and how frequencies can be produced as the capacitance changes. The project also got us back in using Arduino.

Problems and Challenges:

Because the capacitor and inductor required were small and not common, we had to either create a capacitance and inductance needed by combining components that were available. Moreover, the variable capacitor, which was an integral part of this project, was delivered extremely late, so we wasted a lot of time just waiting for it to arrive.

Future Plans

One future plan would be building a different shaped antennae and test the change in volume and pitch of the sound outputted. Moreover, we are also considering further improving this build by implementing more sophisticated audio amplifier, alongside with hand-made speaker.

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