1. PROBLEM

The theremin is the first electronic musical instrument ever created, but is also one of the least used or well known. It has traditionally been a difficult instrument to learn because it lacks any physical reference for the performers, forcing them to rely heavily on their ears in determining what notes they are playing [1]. Most novice musicians' ears are not very well developed, leading to a frustrating experience for those trying to learn to play the theremin, discouraging casual players who are not sorely determined to learn, from taking it up. Those beginners that do choose to endure these difficulties are hindered by the inherent problems in self-study caused by the aforementioned limitations: that is, with no tactile or visual reference and a less-than-perfect sense of pitch, the students may have difficulty in ascertaining whether their performance is in tune or otherwise acceptable without guidance from a teacher. This is an unfortunate problem, because the fact that the theremin is such a rarely played instrument leads to difficulty in finding teachers, making self-instruction an all but necessary element in learning.

Our group proposes to address these problems by building a display into the theremin that would show what note is being played and to make the theremin MIDI compatible. The display provides visual feedback to the performers, giving them a more reliable reference than their ears as to the accuracy of their performance. The MIDI compatibility will allow thereminists to interface the instrument with a computer, allowing them to study the instrument using software we will write that will be used to evaluate and rate their playing, according to exercises specified in the software. This software is what will set the theremin apart from other MIDI theremin models. The software will be designed such that exercises can be added to it as needed, allowing for greater challenges to be introduced as the user's playing ability grows.

These improvements will make the theremin an easier instrument to play and improve the quality and effectiveness of theremin pedagogy in general, making the theremin more accessible and attractive to a broader group of musicians. In addition to these improvements, the theremin will be designed for a lower cost than currently available models, which can typically range from $370 to $3500, further widening the prospective user-base by making it more attractive to casual users. These changes may allow the theremin to finally obtain the popularity and mainstream acceptance that have eluded it for almost the entire eighty years of its existence.

References

[1] S. J. Aldrich, "The History and Significance of the Theremin", http:/ www.stanford.edu/~aigeanta/theremin/, Stanford University, 2000.

2. OBJECTIVES

The three main issues that we intend to focus on in designing our theremin are ease of use, ease of learning, and cost. In order for it to be accessible to a broader range of people, the theremin will need to be easy to set up and play. Along with making it easy to use, the cost of the theremin will need to be minimized by making certain considerations in its design. These include reducing the octave range and choosing the lowest costing components as possible. In order to make the theremin easy to learn, computer software will be created that is compatible across a broad range of PC's along, and an onboard LCD interface will be included to display the pitch being played. The following is a list of what will be needed to accomplish our objectives.

1. **MIDI compatibility**: The product will be able to connect to the computer for use with the learning software. A MIDI signal output will be used for this purpose.

2. **3-octave range**: The theremin's musical range will be three octaves. These octaves will be:
    a. 1st octave: from 130.81 Hz to 246.94 Hz
    b. 2nd octave: from 261.63 Hz to 493.88 Hz
    c. 3rd octave: from 523.25 Hz to 987.77 Hz

3. **Pitch detection**: The theremin will be able to detect the pitch being played. The accuracy will be within 5% of actual note as defined by:

    a. 1st octave:

C3	130.81 Hz
C#3/Db3	138.59 Hz
D3	146.83 Hz
D#3/Eb3	155.56 Hz
E3	164.81 Hz
F3	174.61 Hz
F#3/Gb3	185.00 Hz
G3	196.00 Hz
G#3/Ab3	207.65 Hz
A3	220.00 Hz
A#3/Bb3	233.08 Hz
B3	246.94 Hz

    b. 2nd octave:

C4	261.63 Hz
C#4/Db4	277.18 Hz
D4	293.66 Hz
D#4/Eb4	311.13 Hz

E4	329.63 Hz
F4	349.23 Hz
F#4/Gb4	369.99 Hz
G4	392.00 Hz
G#4/Ab4	415.30 Hz
A4	440.00 Hz
A#4/Bb4	466.16 Hz
B4	493.88 Hz

c. 3rd octave:

C5	523.25 Hz
C#5/Db5	554.37 Hz
D5	587.33 Hz
D#5/Eb5	622.25 Hz
E5	659.26 Hz
F5	698.46 Hz
F#5/Gb5	739.99 Hz
G5	783.99 Hz
G#5/Ab5	830.61 Hz
A5	880.00 Hz
A#5/Bb5	932.33 Hz
B5	987.77 Hz

4. **Audio specifications**: The theremin will have a preamp voltage of 2V and a pitch drift of at most 2% of the expected pitch.

5. **Power supply**: The power will be supplied externally.

6. **Speaker jack**: There will be standard 3.5mm jack to be used by external speakers.

7. **Teaching Software**: The software will have lessons for Beginner, Intermediate, and Advanced Musicians and will be developed for the Windows API. It will be compatible with Windows 98® or higher and the Sound Blaster® sound card.

8. **Weight**: The theremin will weigh less than 15 lb.

9. **Cost**: The theremin will cost less than $200.

10. **Interface**: An LCD screen will be used as an interface.

11. **Size**: The theremin will be no larger than 1.5 ft by 1 ft by .5 ft.

12. **Power consumption**: The theremin will consume under 50W of power.

Low cost, easy setup, and PC software will make our theremin more appealing than current designs. Meeting these objectives will improve the marketability of our theremin. We hope to create a design that will allow a broad range of players to enjoy the theremin