Computer-based interfaces for applications in music education

Brian Dolhansky, Electrical & Computer Engineering, Drexel University • Advisor: Youngmoo E. Kim

Abstract

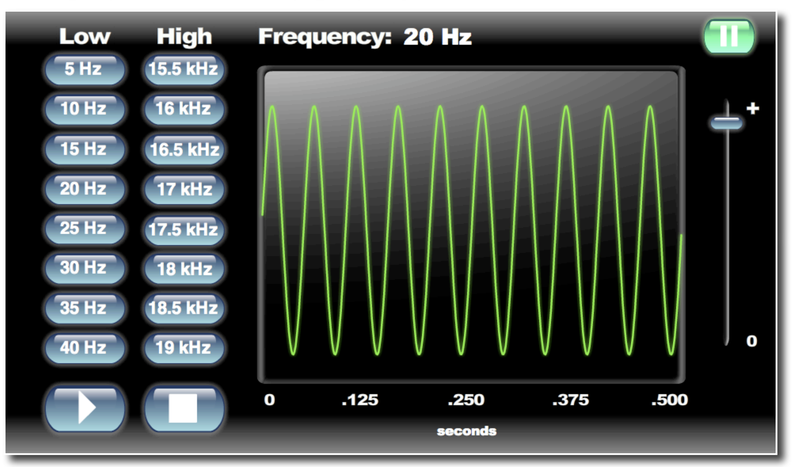
With computers becoming increasingly affordable and ubiquitous, their role in education is becoming more important. Because many public education facilities cannot afford the complicated equipment needed to produce and analyze musical signals, a less expensive alternative is required. Software-based solutions provide an accessible and low-cost option for educators. Most schools today have access to computers with the hardware capabilities to access a web page and run a simple web-based application that could simulate complex electrical equipment. In addition, new hardware interfaces can communicate abstract ideas in an intuitive and concrete form.

Developing Educational Applications

Adobe Flash provides a simple development environment for creating educational musical applications. The only software needed to run a Flash application is the Adobe Flash Player and an internet browser capable of running Flash. Flash programs do not require expensive hardware. These factors contribute to an effective development tool to create low-cost teaching tools.

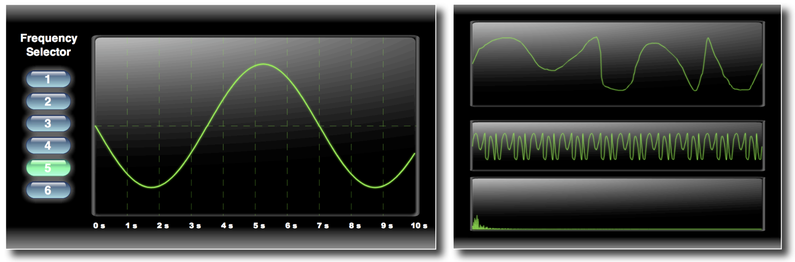
Hearing Test with Waveform Display

- The normal range of human hearing is from 20 to 20 kHz.
- Tests the user's hearing range, which decreases with age.
- Displays the currently playing waveform.



Draw Sound and Frequency Quiz

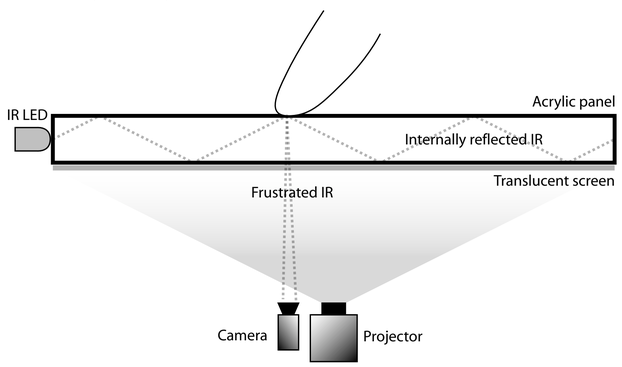
- In Draw Sound (bottom left), students can draw a waveform in the top window.
- Waveform is repeated on the second screen.
- An FFT is taken of the drawn wave, and the wave's frequency spectrum is displayed in the lower window.



- In Frequency Quiz (top right), a waveform is drawn across 10 seconds of time.
- Students can use displayed gridlines to determine the exact frequency of the displayed waveform.

Multi-touch Display

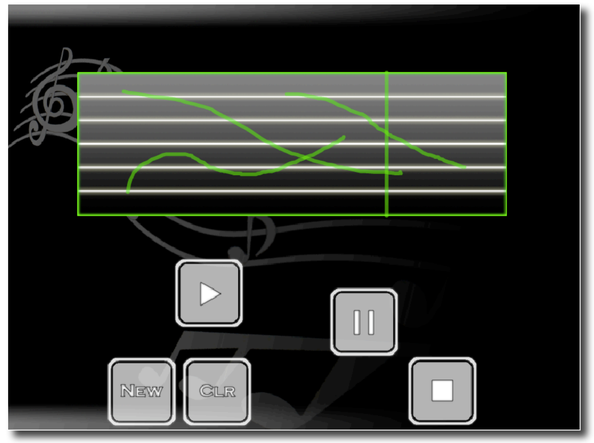
- Provides an intuitive way for students to interact with music education programs.
- Touch points are tracked through Frustrated Total Internal Reflection (FTIR):



- Points of reflected infrared light are followed by the tracking computer.
- Point data is sent to application via TCP connection.
- Packets sent by tracker are parsed by software and relevant events are shown on the display.

Musical Paint

- An application that utilizes the MTD.
- Students can draw a number of notes on a 12 note scale that ranges from A_3 (220 Hz) to A_4 (440 Hz).
- In addition, there are various play controls that the user can move and resize:



- In order to derive the correct frequency from the drawn note, the raw y-values of the line are converted to a discrete frequency value:

$$d(y) = 220 \times 2^{\frac{y}{12 y_{max}}}$$

- This frequency was then passed to a sine function that generated a sound wave:

$$f(x) = \sin\left(\frac{x}{f_s} \times 2\pi \times f_o\right)$$

Conclusion

Software-based simulations of complicated electronic systems can help provide musical education to schools with limited funding. Complex devices can be coded to operate like their physical counterparts. In addition, new types of hardware interfaces provide an intuitive way for students to interact with physical simulations. Instruments can be synthesized or entirely new sounds can be created. Using these tools, computer-based music instruction can be an effective low-cost way to teach musical ideas and concepts.