EECS 225D Lecture 10 Corrected

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1.0 Stringed Instruments

We first reviewed sources of excitation and resonance in stringed instruments.

1.1 Plucked String

The excitation occurs through an initial condition or pluck. After the initial pluck occurs the string freely vibrates. Acoustic resonance with the wooden body and air inside the body occurs which is what is heard by the listener. The resonances formed are complex air pressure patterns that occur within the body. In an ideal world, the tension, mass density, and length of the strings would fully characterize the frequency produced.

1.2 Bowed Strings

In a bowed string instrument, the player continuously vibrates the string with a saw like waveform. The resulting waves along the string are transverse.

1.3 Struck Strings and the Piano

The piano is an example of a struck string instrument. The first thing to note is that piano use steal strings, because of the enormous tension induced in a piano string. The fact that the string is steel has implications because steal has elasticity. Mathematically the wave equation becomes a fourth order partial differential equation.

A piano has many strings of varying lengths which are mounted to a frame. At one end of the frame are tuning adjusters that modulate the length of the string slightly. Behind the strings is a sound board which resonates the waves produced from the struck string. There is a complex hammer mechanism which has evolved over many years. The hammer mechanism must produce a sharp impulse on the string from a key strike. The hammer can not bounce when struck hard. The mechanism must also support quickly repeated key strokes.

2.0 The Trumpet

The trumpet is an acoustic tube type instrument consisting of a mouthpiece, mouthpipe, cylindrical section, and bell. A user blows air through the mouthpiece to excite the tube. Once excited a feedback loop between the musician and instrument is created. The feedback from the instrument to the musician occurs through the vibrations of the mouthpiece onto the lips. The trumpet player modulates the length of the tube and thus the frequency of music via the valve system.

It has been noticed that there is a time delay between when the low frequency and high frequency components become audible. One theory relates this to the fact that the aoustic tube appears longer to higher frequencies.

3.0 Production models; Where do we go from here?

We wrapped up with a discussion on physically modeling sounds. Most of the models discussed have been based on creating physics based mathematical models of the instrument. A second approach would be to measure the frequency response of the instrument and hardwire that into the system.

We are moving from production to perception over the next few lectures. Next lecture will cover room acoustics to begin that transition.