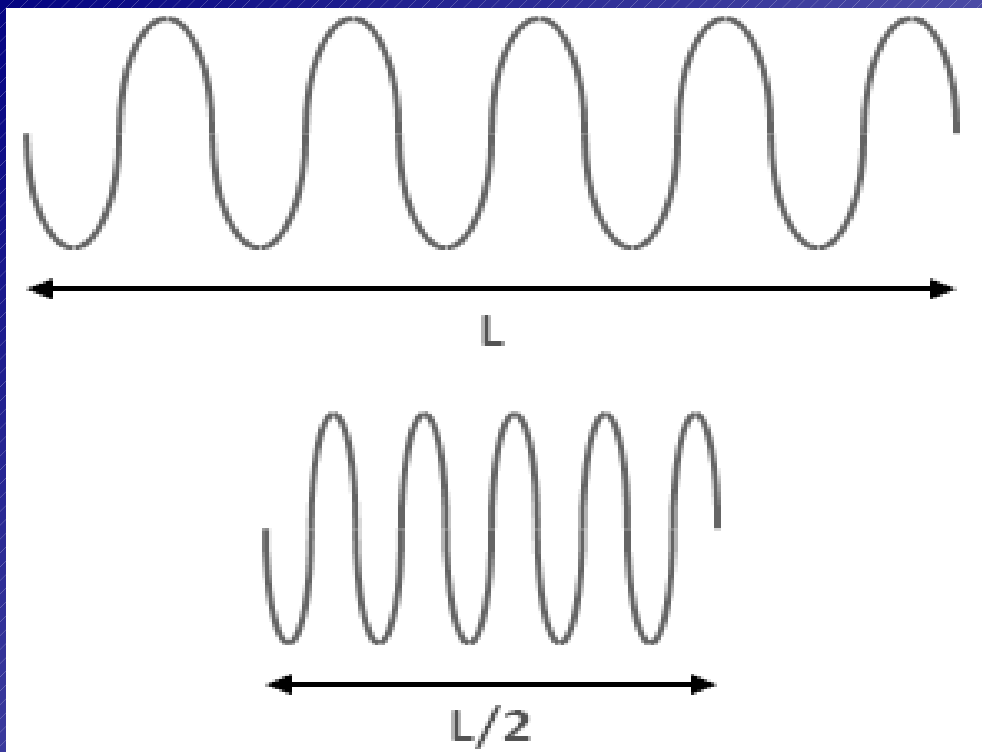


# Real Time Audio Signal Processing in Java

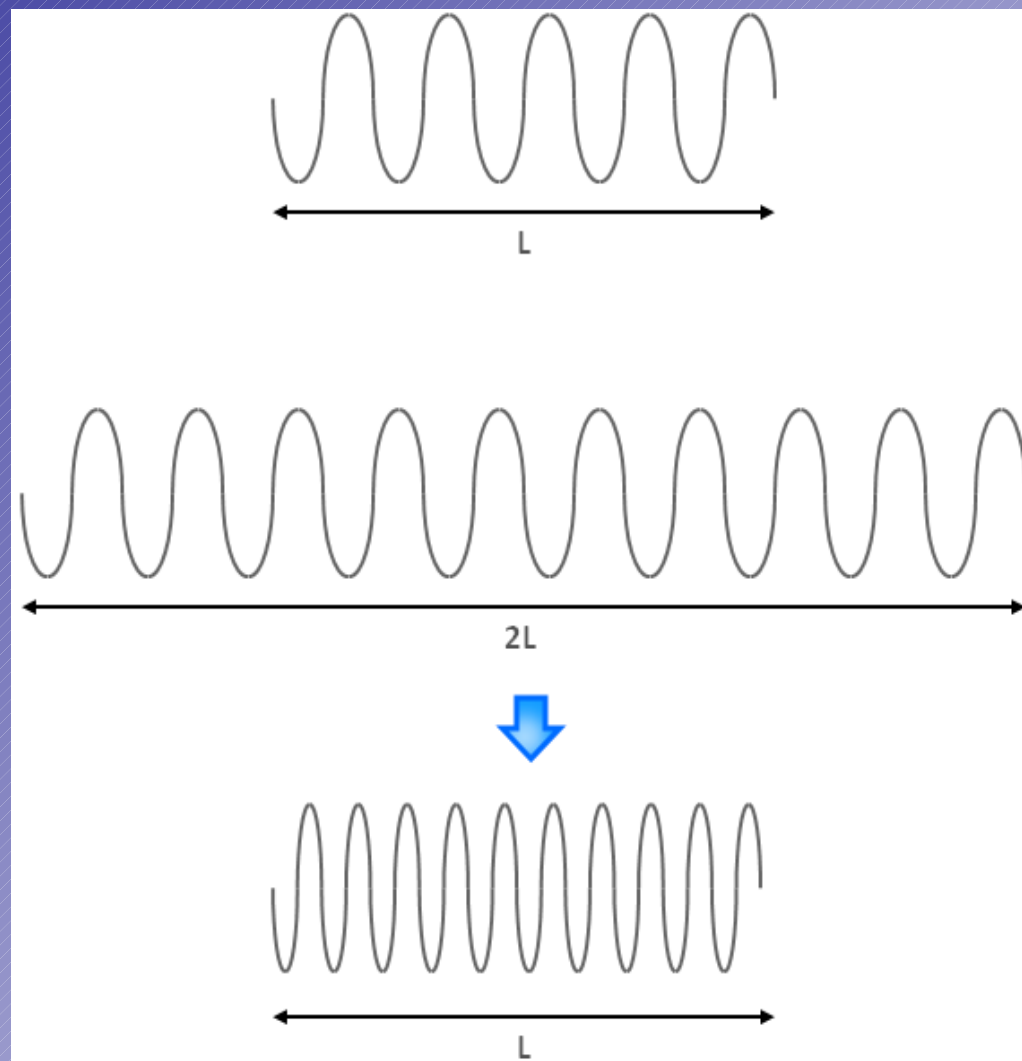
Joshua N. Wurtz

Mentor: Bruce Mechtly,  
Computer Information  
Sciences

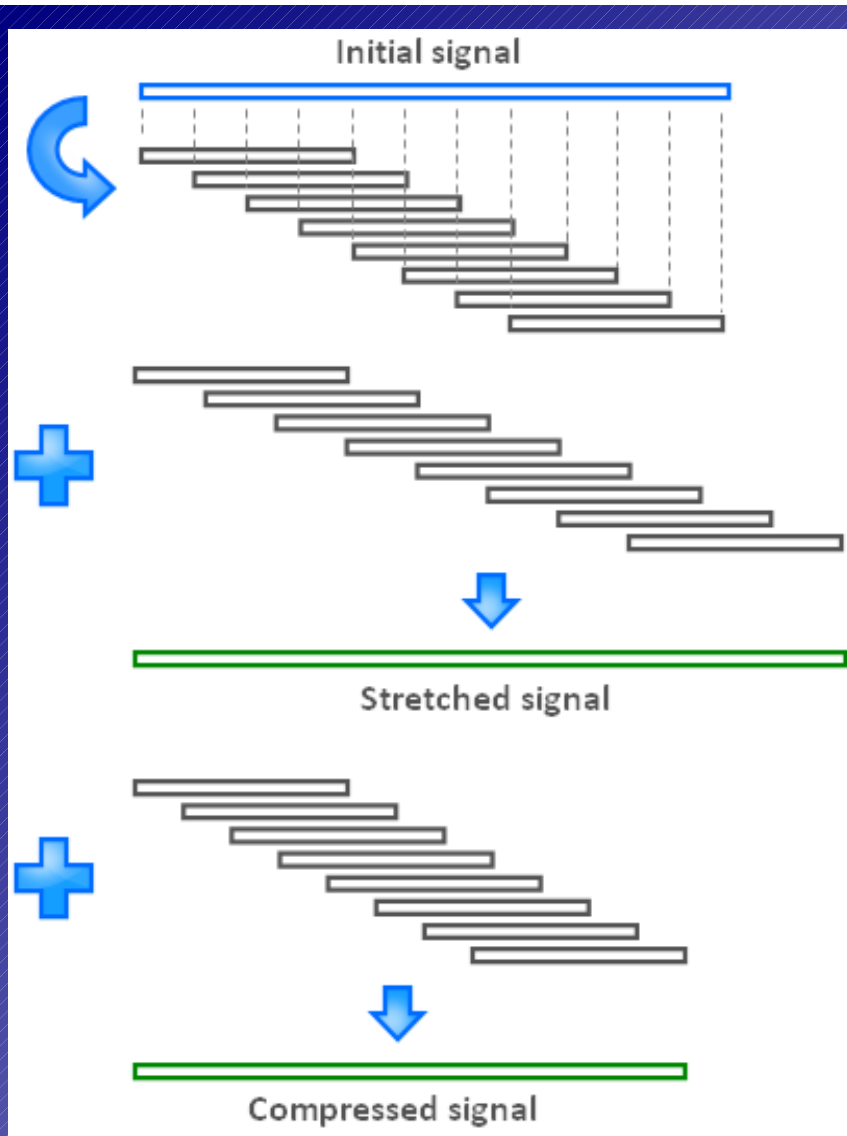
Real time audio signal processing using Java requires consideration of the computational power of the system. A graphical user interface allows users to adjust the window and frames per second to effectively process the audio signal. This window and frame rate adjustment can allow users to perform real time audio signal processing on a greater range of systems. This is demonstrated with echo, flanging, and pitch-shifting on a laptop.



**Pitch-shifting by affecting Duration**  
<http://www.guitarpitchshifter.com/pitchshifting.html>



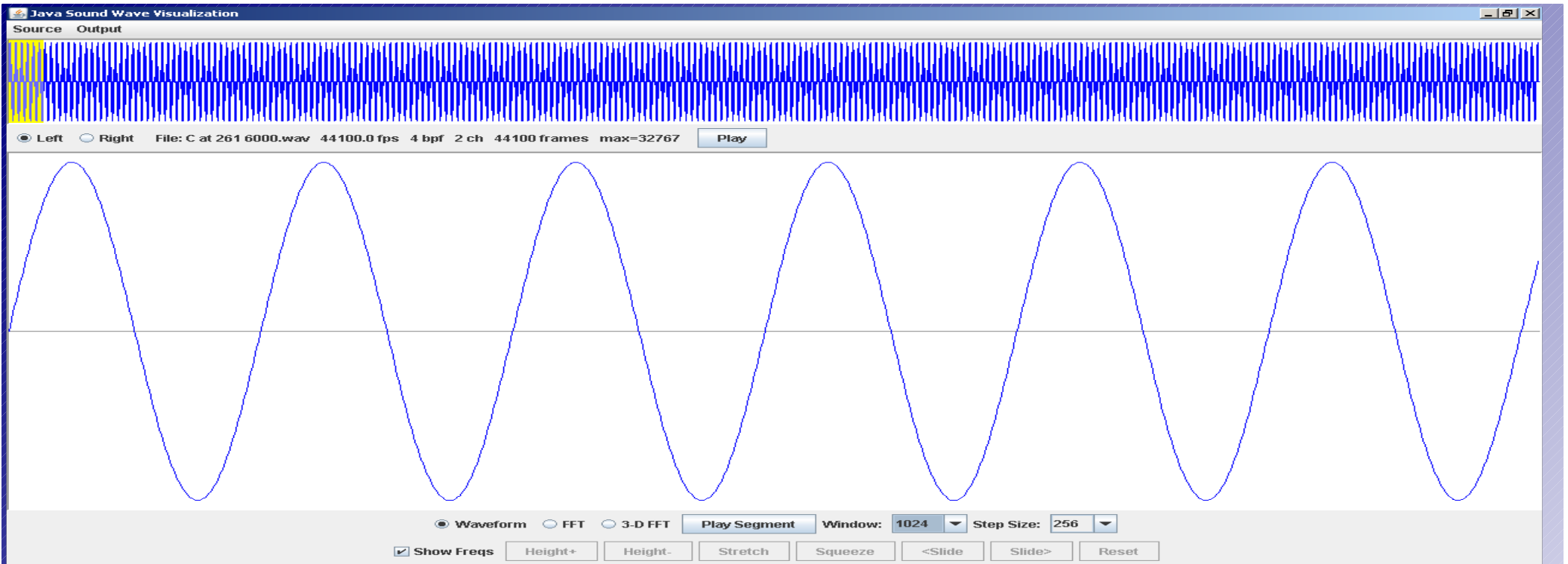
**Pitch-shifting without affecting Duration**  
<http://www.guitarpitchshifter.com/pitchshifting.html>



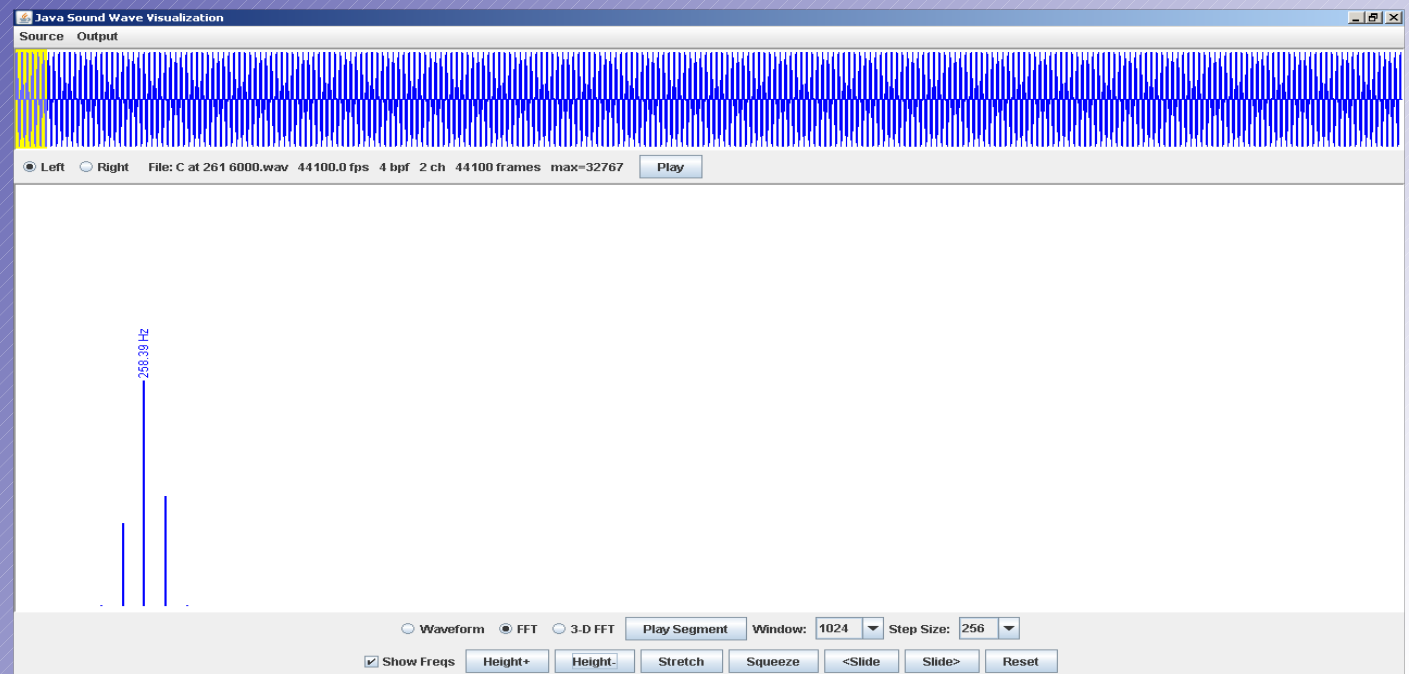
Note	Hz	Note	Hz	Note	Hz	Note	Hz	Note	Hz	Note	Hz	Note	Hz
C1	32.7	C2	65.4	C3	130.8	C4	261.6	C5	523.3	C6	1046.5	C7	2093.0
C#1	34.6	C#2	69.3	C#3	138.6	C#4	277.2	C#5	554.4	C#6	1108.7	C#7	2217.5
D1	36.7	D2	73.4	D3	146.8	D4	293.7	D5	587.3	D6	1174.7	D7	2349.3
D#1	38.9	D#2	77.8	D#3	155.6	D#4	311.1	D#5	622.3	D#6	1244.5	D#7	2489.0
E1	41.2	E2	82.4	E3	164.8	E4	329.6	E5	659.3	E6	1318.5	E7	2637.0
F1	43.7	F2	87.3	F3	174.6	F4	349.2	F5	698.5	F6	1396.9	F7	2793.8
F#1	46.2	F#2	92.5	F#3	185.0	F#4	370.0	F#5	740.0	F#6	1480.0	F#7	2960.0
G1	49.0	G2	98.0	G3	196.0	G4	392.0	G5	784.0	G6	1568.0	G7	3136.0
G#1	51.9	G#2	103.8	G#3	207.7	G#4	415.3	G#5	830.6	G#6	1661.2	G#7	3322.4
A1	55.0	A2	110.0	A3	220.0	A4	440.0	A5	880.0	A6	1760.0	A7	3520.0
A#1	58.3	A#2	116.5	A#3	233.1	A#4	466.2	A#5	932.3	A#6	1864.7	A#7	3729.3
B1	61.7	B2	123.5	B3	246.9	B4	493.9	B5	987.8	B6	1975.5	B7	3951.1

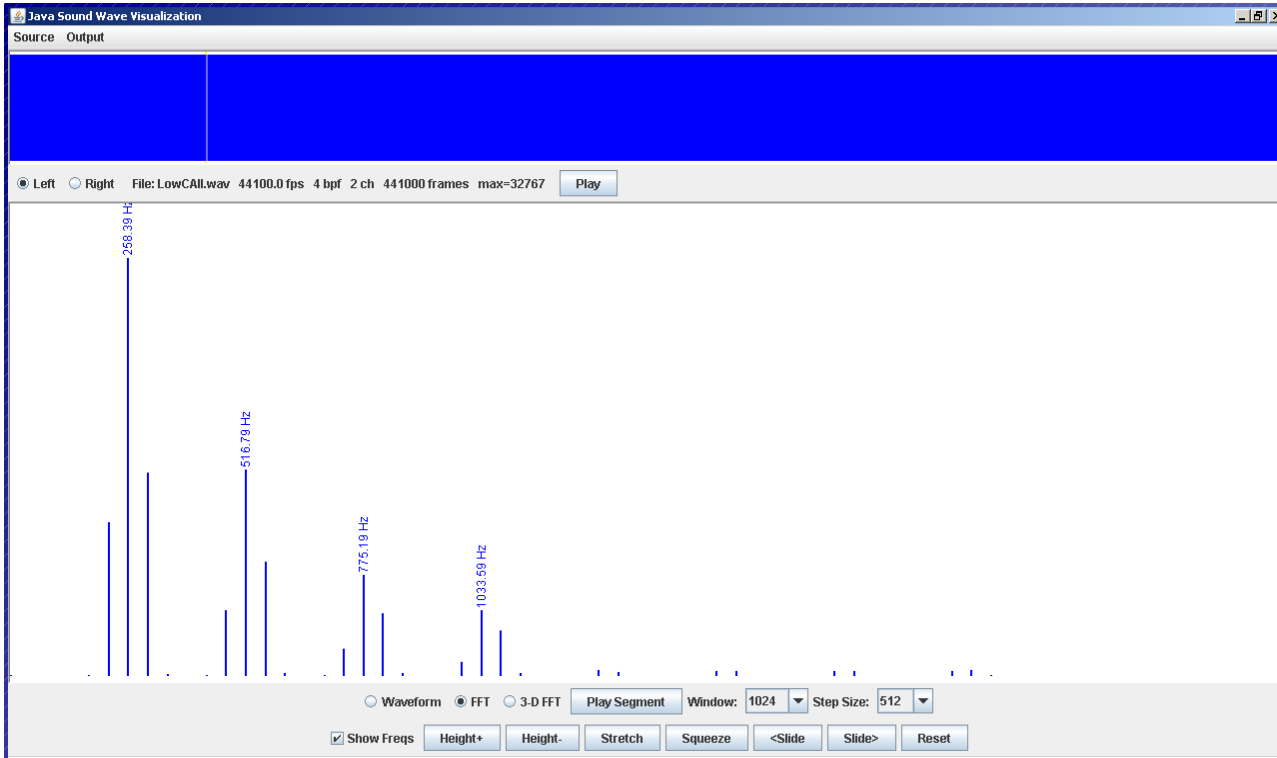
**Notes and their fundamental frequency**  
<http://www.guitarpitchshifter.com/pitchshifting.html>

**Stretching and Compressing the Signal by Frame**  
<http://www.guitarpitchshifter.com/algorithm.html>

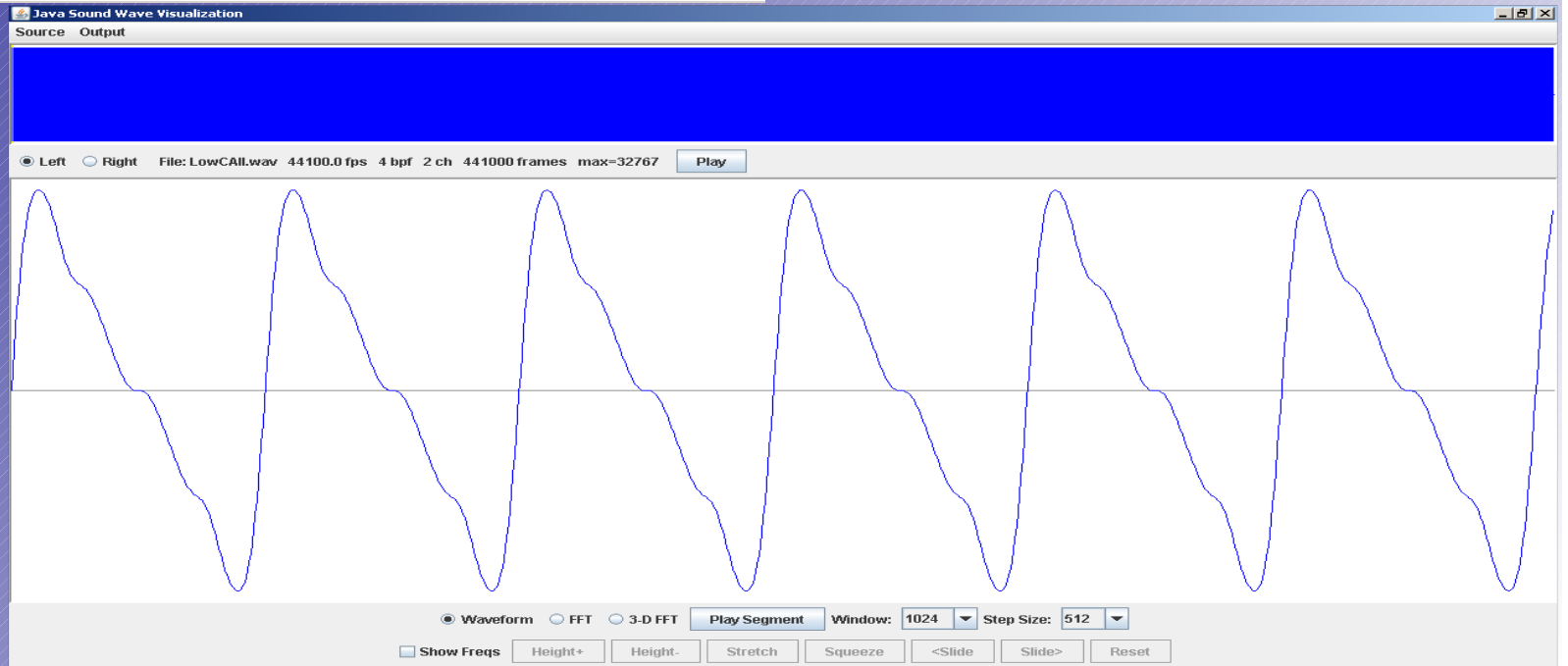


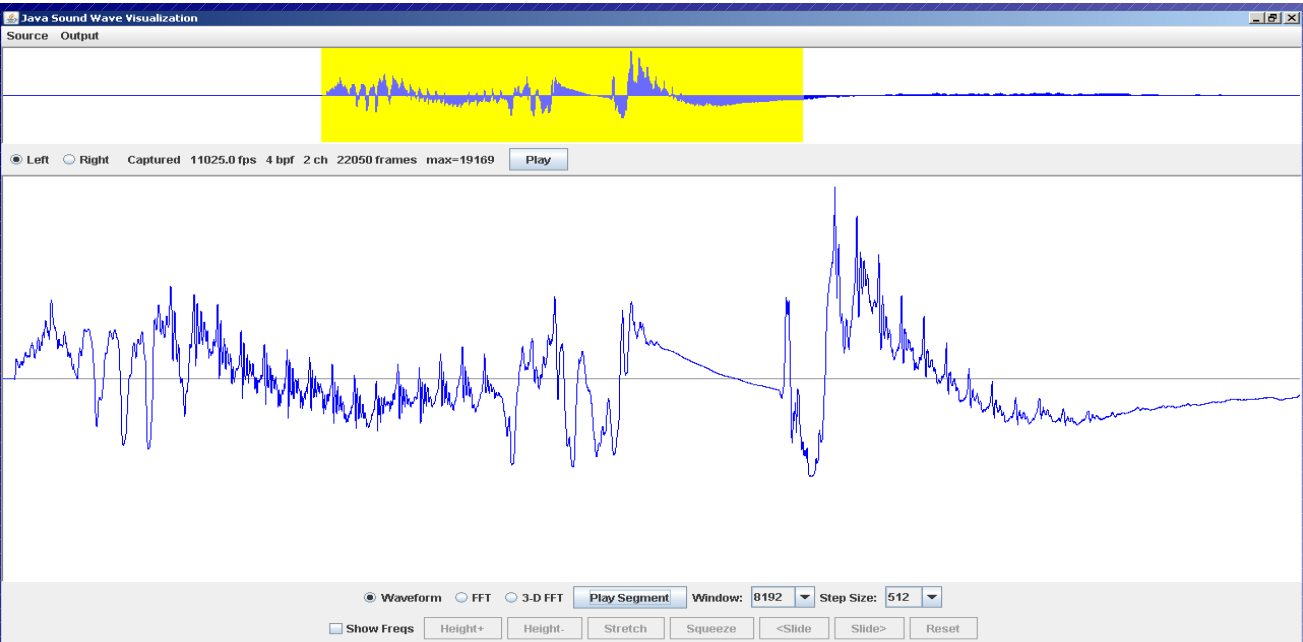
# C4 Sinusoid Wave and Frequency Representations



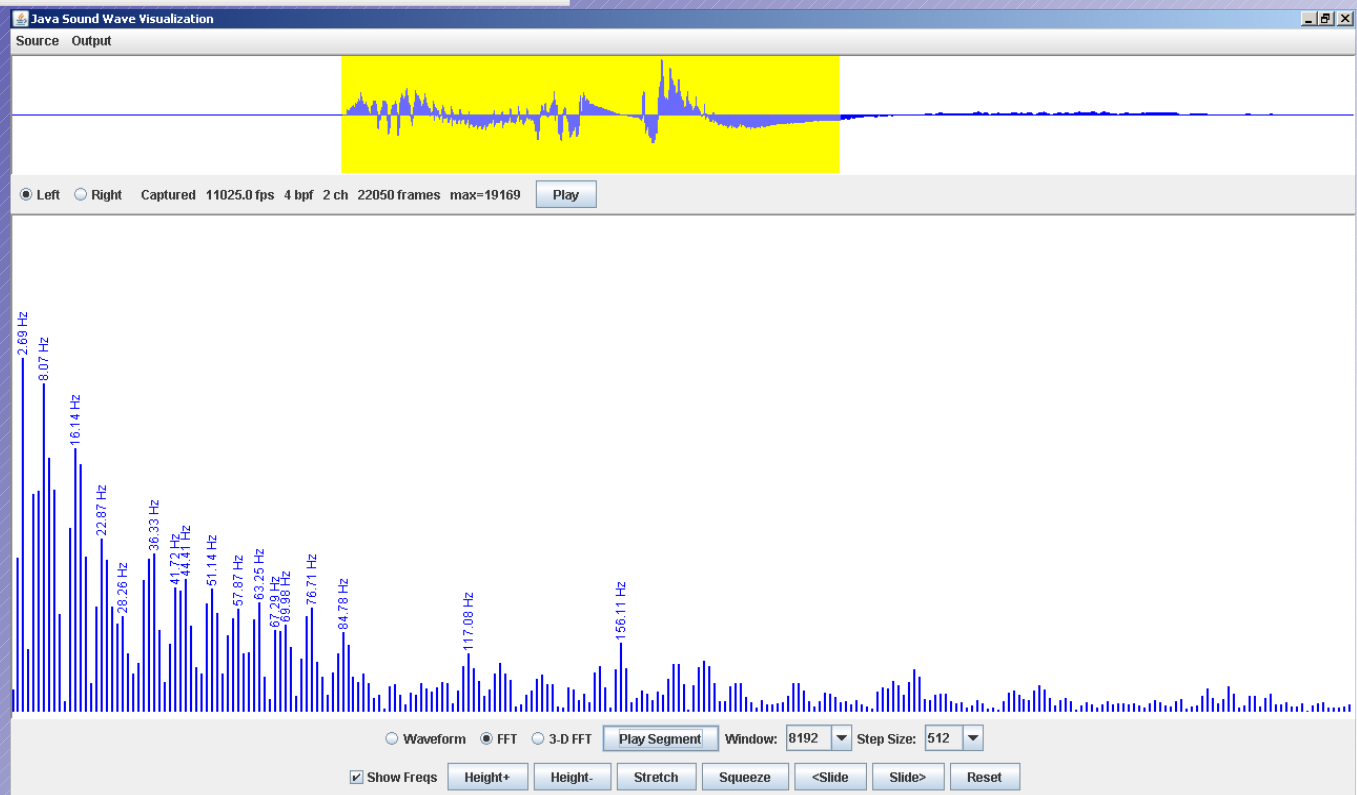


**C4 with  
Harmonics**

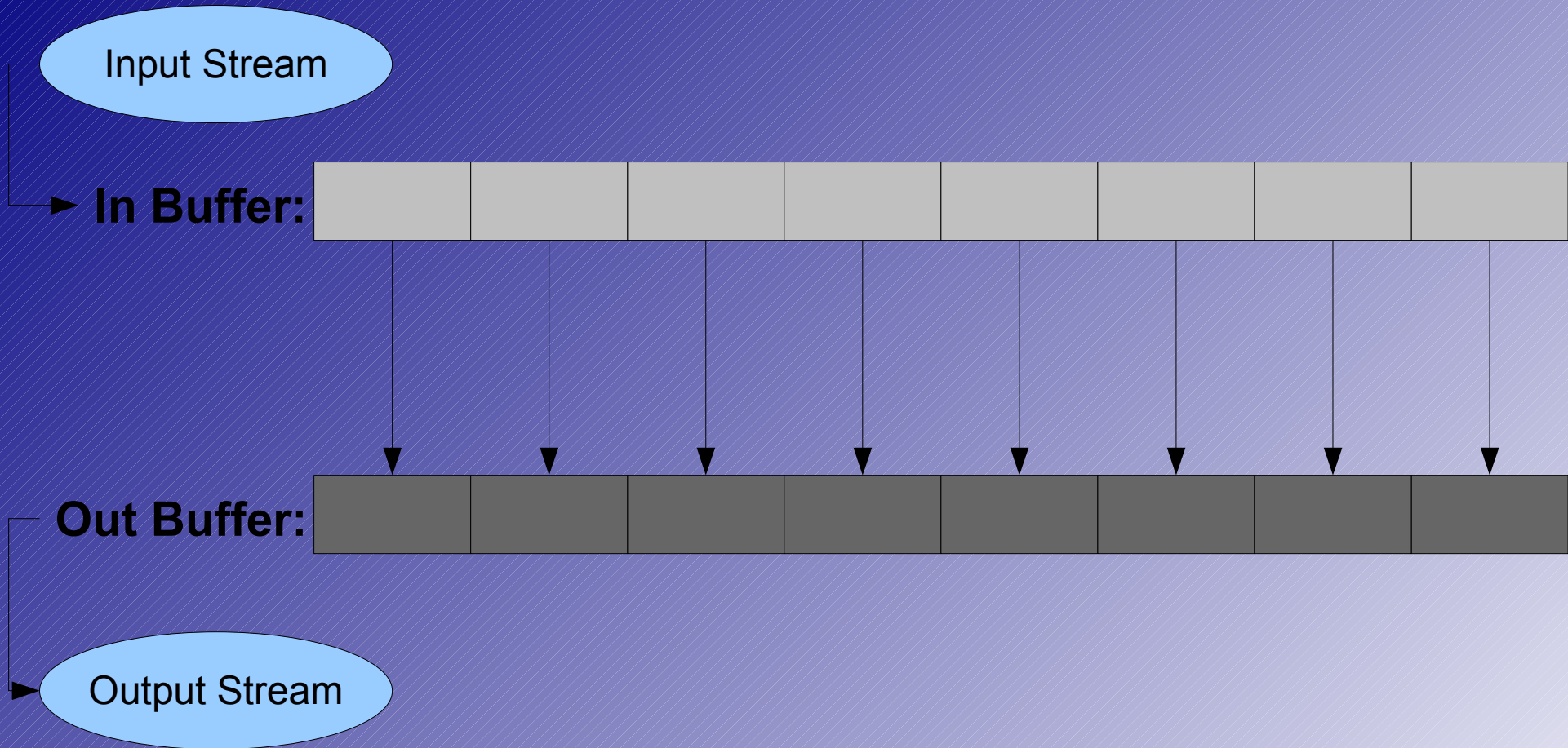




**Sinusoidal wave  
and frequency  
representations of  
the word Washburn.**

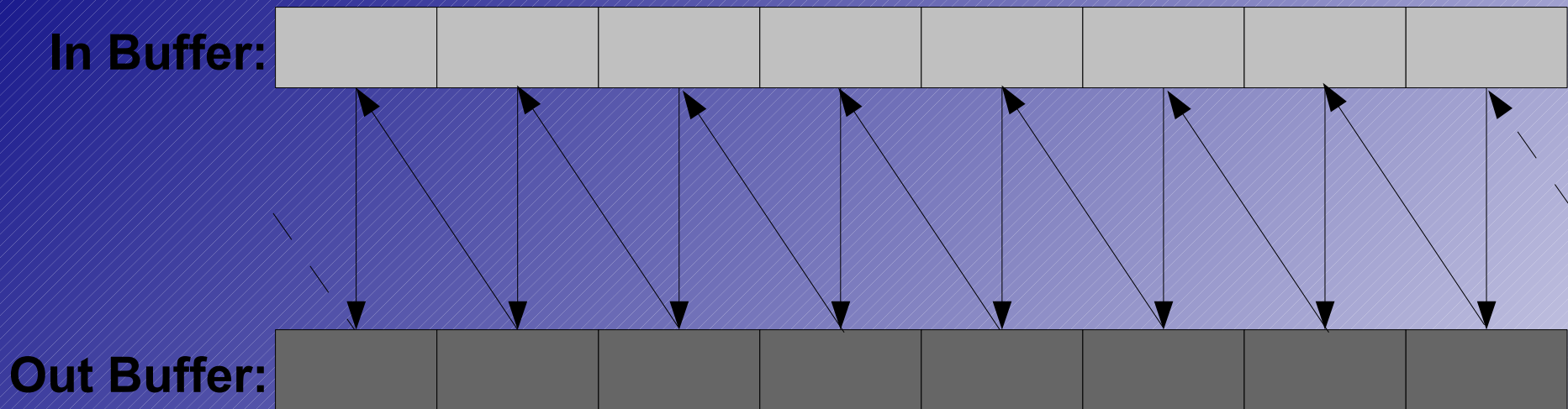


# The Buffer





# Echo



Echo processing places the data from its window into the corresponding and each following window, up to the number of echoes specified. In effect there may be multiple echoes within a window along with original signal.

## Flange

**Flanging produces a comb filter effect on an audio signal. It is the mixing of two identical signals together, with one signal delayed by a small and gradually changing period. This period should be smaller than 20 milliseconds. It produces a swirling effect.**

## Pitch Shift

**When pitch of original signal is raised or lowered. Harmonizer is adding of pitch shifted signal with the original signal.**