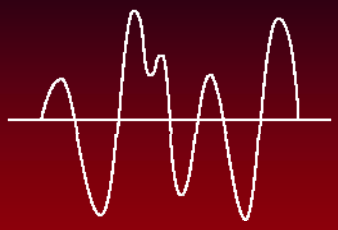
IMGD-1001
The Game Development Process

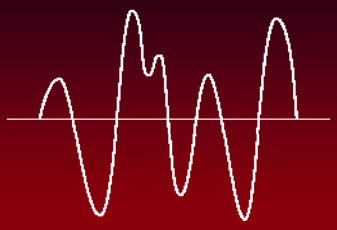
Class 15
Thursday, 24 September 2009

Today's topic:

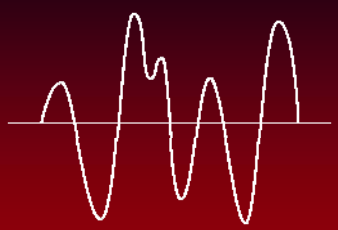
Game Audio



Sound

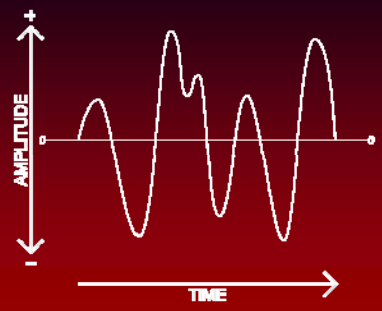


Audible vibration in an elastic medium (usually air)



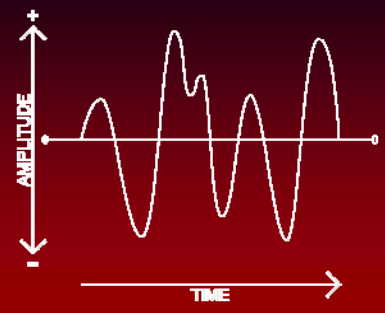
Compression (positive pressure)
Rarefaction (negative pressure)

Amount of pressure change = Amplitude



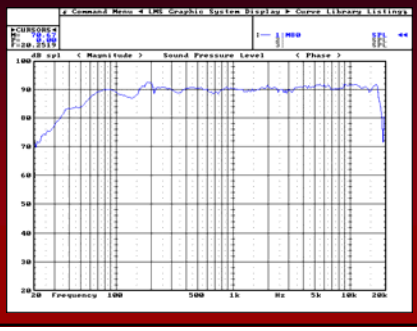
Varies continuously over time

Rate of vibration/pressure change = Frequency



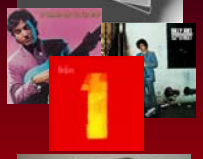
Measured in cycles per second (Hertz or Hz)

Frequency range of human hearing:
Approximately 20 to 20,000 Hz



Analog recording and playback

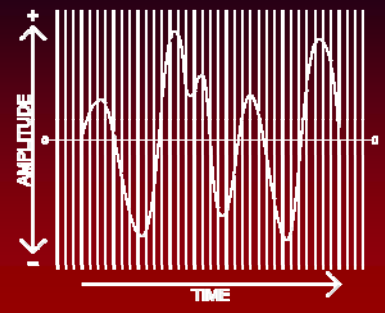
Transducers: Convert one type of energy to another
All transducers introduce distortion



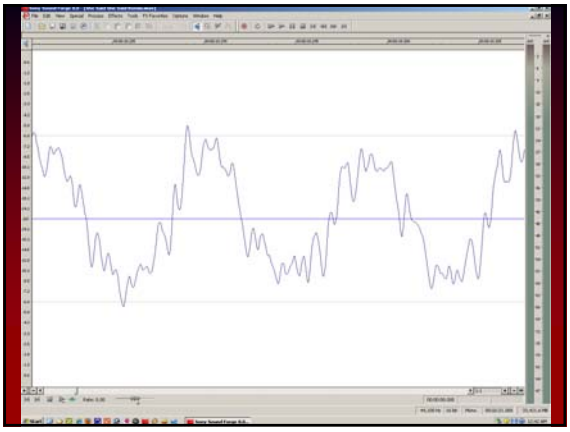
Digital audio

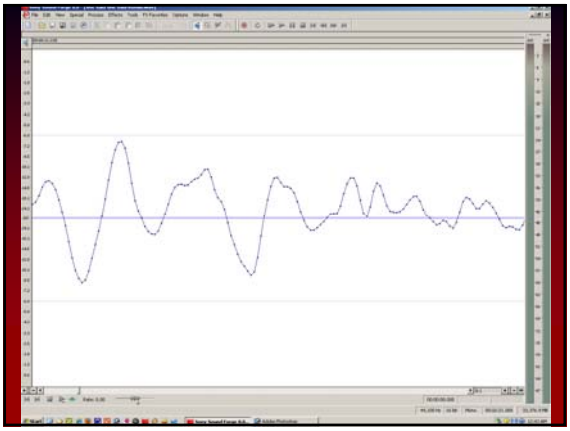
- Experimental recordings: Late '60s
- Jazz/classical: Early 70s
- First symphonic recording: 1976
- First major label recording: 1979
  - Ry Cooder's *Bop Till You Drop*
- Compact Disc
  - Jointly created by Sony/Phillips
  - Introduced October 1, 1982
    - Billy Joel's *52nd Street*
  - Biggest seller
    - Beatles *1* (30M+ copies)

Digital audio based on sampling



Amplitude of signal is measured (and usually recorded)
at precise time intervals, converted to stream of numbers





Digital recording and playback

Extremely accurate, low noise and distortion
Almost immeasurable wow or flutter
Easily edited and manipulated
Essentially perfect replication

Digital sampling ("digitizing")

- Sample rate
  - Number of samples taken per second
  - Also measured in Hertz
- Sample resolution
  - Range of numbers used to describe each sample
  - Measured in binary bits
  - 8 bits = 256 values (± 127)
  - 16 bits = 65,536 values (± 32K)
  - 24 bits = 16,777,216 values

How often to sample?

- Depends on desired frequency range
  - Nyquist frequency = Sample rate required to fully express a signal
  - 2X maximum required frequency
  - 2X 20 kHz = 40 kHz minimum sample rate to represent full human range

How much to sample?

- Depends on desired dynamic range
- Dynamic range = Difference between softest and loudest sounds
  - Measured in decibels (dB); 1 dB = faintest perceptible sound
  - Real-world range: 10-20 dB (anechoic chamber) to 140 dB (beside jet engine)
  - Each bit of sampling resolution approximately doubles dynamic range

Home audio formats

- Compact Disc
  - Sample rate: 44.1 kHz
  - Sample resolution: 16 bits
  - Dynamic range: >90 dB
  - Two channels for stereo
  - "CD quality"

- HD/BluRay DVD
  - Up to 8 channels 96 kHz 24-bit audio
  - Dynamic range: >120 dB

"CD quality" data rate

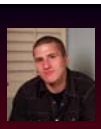
- 44,100 samples per second
- 16 bits (2 bytes) per sample
- 2 channels
- 44,100 x 2 x 2 = 176,400 bytes/sec or 10.584 MB per minute
- Typical pop song 30-40 MB if uncompressed

Compressed digital audio

- Lossless compression
  - Preserves data perfectly
  - Compression ratio: 2:1 typical
- Lossy compression
  - Discards some data to increase compression ratio
  - The trick is: What to throw away?

The game changer: MP3 (1994)

- Lossy compression algorithm based on auditory masking
  - Loud low-frequency sounds can make softer high-frequency sounds inaudible
  - Perceptual coding: Throw away high frequencies that "can't be heard anyway"
  - Compression ratio: 10:1 or better
  - Pop song becomes a 3 MB file

The MP3 Phenomenon

- First Web appearance: Late '94
- Winamp, mp3.com (Summer '97)
- First portable players (Spring '98)
  - 32 MB Eiger MPMan F10, Rio PMP300
- Napster (June '99)
  - Created by Shawn Fanning (19), Northeastern University

Game audio: Early days

- Apple II and PC: Click the speaker
- Atari, C64, early consoles: FM synths
- Macintosh (January 1984)
- AdLib PC sound card (1976)
- Creative Labs Sound Blaster (1989)
  - AdLib with digital audio + game port
- CD-ROM (1985)
- CD-R (1990)
- MIDI/music synthesis

Game audio: Today

- All game audio is digital
  - Music, SFX, VO delivered pre-rendered
- Typical assets
  - .wav (bigger, no decoding)
  - .mp3 (small, decoded, requires license)
  - .ogg (small, decoded, no license)
  - .flac (smaller, decoded)
- Real-time mixing, effects, spatialization

Tonight's assignment:

Continue reading Rollings/Morrs
Continue Project 4

Questions?

Friday:
Game design