Beep: Audio and Hypermedia

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This Presentation

- What am I going to cover?
  - Introduction to Audio
  - History Of Audio Machinery
  - Audio In the Digital Domain
  - Operations On Audio
  - Audio and Hypermedia
  - Summary

What is Sound

- Transmitted Compressional / Pressure Waves
- What you hear
- Your brain’s interpretation of the of compressional waves.

What is Audio

- Machine Generated Sound
- Machine Recorded Sound
- Transmitted Sound
- Audible Sound with frequencies from 20hz to 20,000hz

Properties of Sound

- Linear
- Timbre
- Tone
- Amplitude
- Timbre - waveform
- Mention how sound can be decomposed via Fourier transform

Properties of Audio

- Medium
- Fidelity
- Channels
- Mastering

Introduction To History Of Audio

- Phonograph
- Tapes
- Video Tapes
- Digital Recording
- Digital Interactivity
- Digital Distribution
- 1857 Leon Scott’s Phonoautograph
- 1876 Bell Invents Telephone
- 1877 Edison Invents the Phonograph. (uses cylinders)
- 1894 Berliner invents improved Phonograph (uses records)
- 1900 Magnetic Recording on Tape

- 1906 Sound and Film Synchronized
- 1927 Optical Recording on Film
- 1946 Wire Tape Recorder (Consumer)
- 1953 First Video Tape Recorder Invented by RCA
- 1975 Betamax (SONY)
- 1976 VHS (JVC)
- 1977 Atari VCS 2600
- 1982 Compact Discs are created
- 1982 Commodore 64 (Sid Chip)
- 1982 Midi
- 1985 Amiga
- 1987 DAT Tape

- 1989 The Web
- 1992 The first M-bone audio multi-cast on the Net
- 1995 Lucasarts releases games which have adaptive music engines
- 1996 DVD
- 1997 MP3.com
- 1999 Napster
- 1999 Tivo

Phonoautograph

- Leon Scott
- 1857
- Transcribes by scratching waveform into paper.
- There have been recordings of famous people
- Bell improved on the Phonoautograph by using bones from a human ear to help transcribe the audio.
- IEEE Engineers tried to restore the drawn waveform into real audio but due to lack of accuracy of the autograph , they have failed

Phonoautograph Tracing

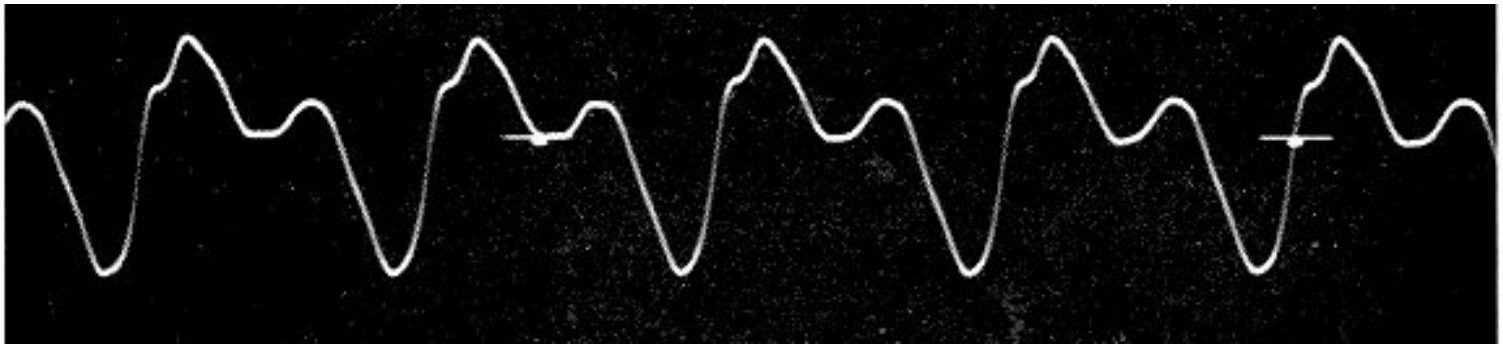

Figure 1: Tracing Of a Phonoautograph [Mor98]

Bell’s Phonoautograph

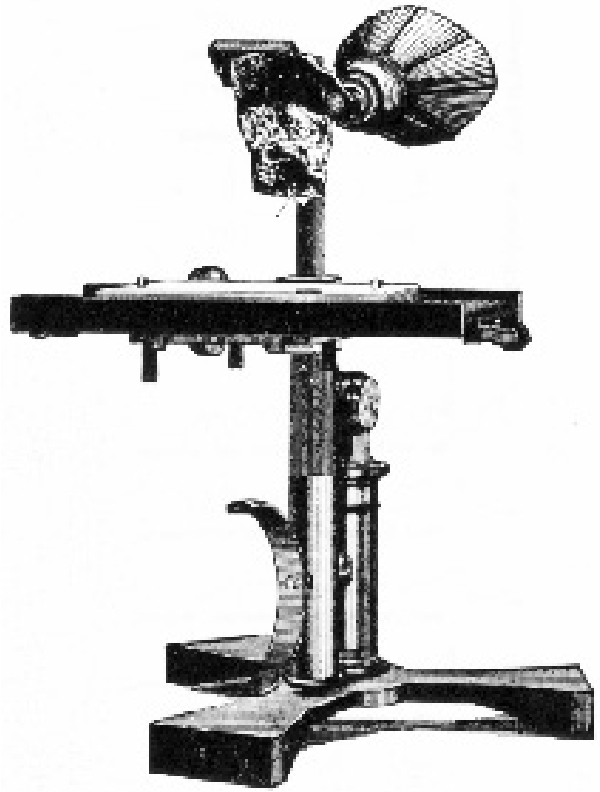

Figure 2: Bell’s Phonoautograph used parts of a human ear salvaged from a cadaver [Mor98]

Telephone

- Alexander Graham Bell
- 1857
- Speaker and Microphone - duplex transmission of audio.
- “Mr. Watson, come here, I want to see you!”
- Bell had split battery acid on himself and no longer was paying attention to the experiment. Watson said he heard every word.
- Bell Experimented w/ phonoautograph. He used the bones from a real human ear to transcribe the audio onto paper. [Mor98]

Phonograph

- Thomas Edison
- Audio transcribed onto tin foil cylinders.
- Vertical transcription of waveform
- Intended for office dictation.
- 1894 Berliner invents improved Phonograph (uses records and sideways transcription)
- It records audio onto tin foil then uses a pin to read the audio.
- It was intended for office dictation, that never flew.
- Pacific Phonograph Company made a wildly successful venture using the phonograph as a one song juke box

Edison’s Phonograph

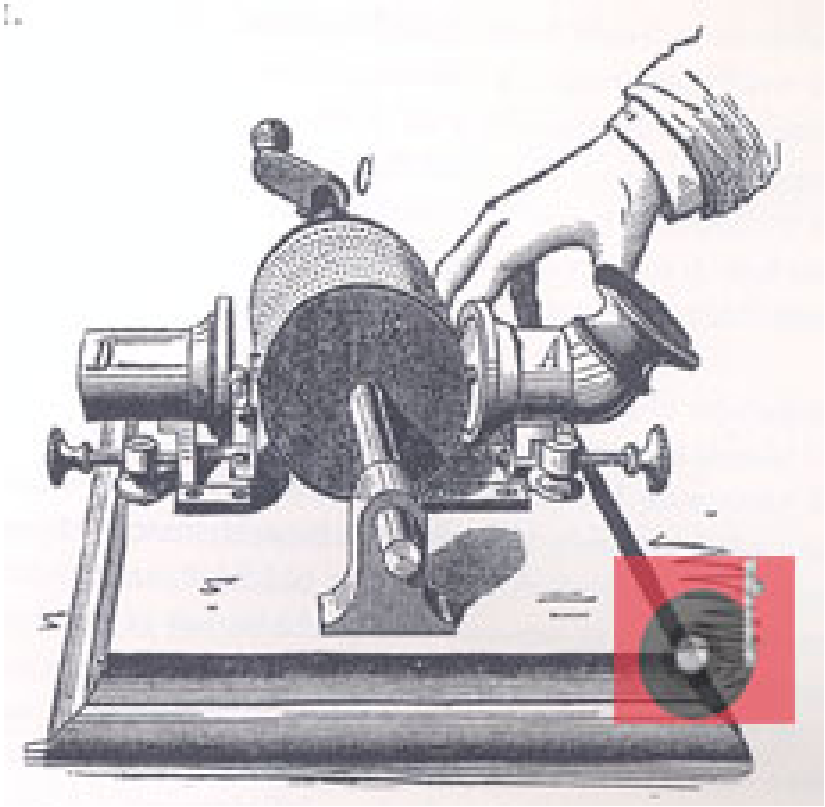

Figure 3: Edison’s initial Phonograph - hand cranked [Mor98]

Magnetic Tape

- 1900 Telegraphone - the world's first answering machine - is invented [Mor00]
- 1946 Wire Tape Recorder (Consumer)
- 1947 Plastic tape coated with oxide used. (Just wire before).
- 1965 Ford, Motorola, RCA and Mercury introduce the 8 track.. many 8 track cassettes are later **F**ound **O**n **R**oad **D**ead.

Sound and Film

- 1906 Sound and Film Synchronized - using a record and film. Poor Synchronization.
- 1927 Optical Recording on Film - much better synchronization, hard to work with. Audio transcribed onto film.
- Still used today, SONY SDDS (Highest Quality Digital Format)

SDDS On Film

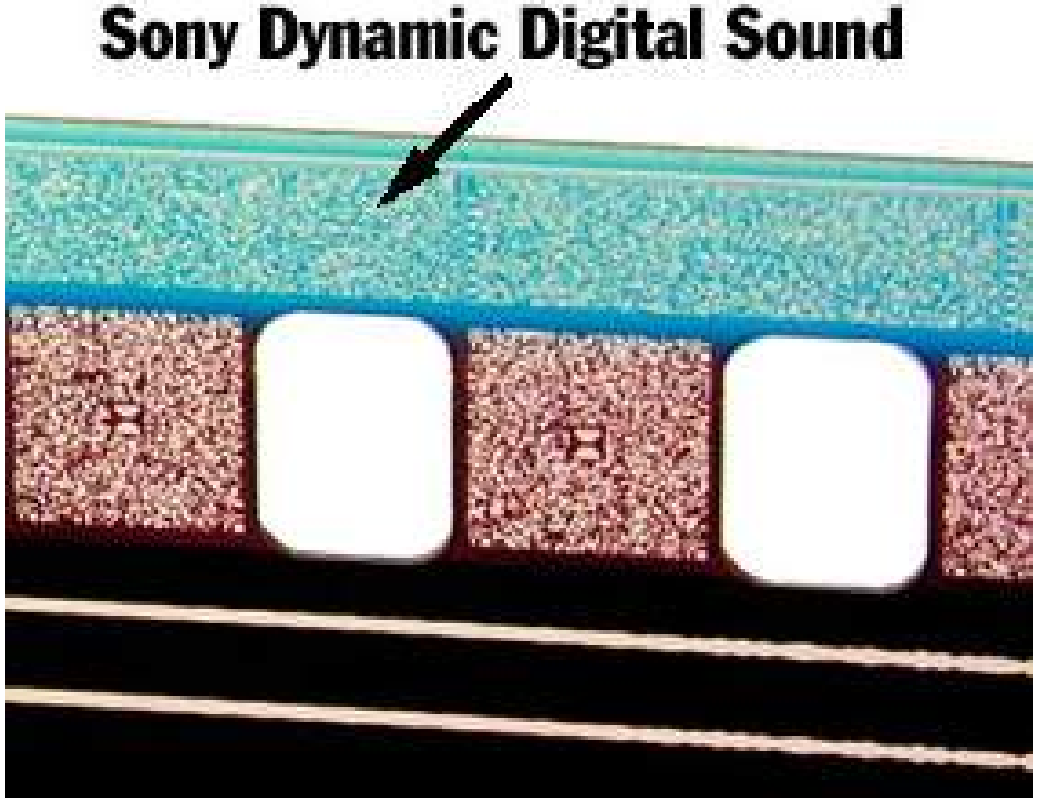

Figure 4: Notice how the digital audio is optically encoded. Dolby (Red) is encoded below the SDDS (Blue). Under that is the conventional stereo sound signal [Tys00]

Radio

- Invented in 1895 by Nikola Tesla, patented filed in 1897 [tes00]
- Marconi was awarded an English patent in 1896.
- Dec 12, 1901 Marconi transmits a cross Atlantic radio transmission.
- 1915 Voice transmitted over Atlantic
- 1923 Photo transmitted over radio
- Late 1910s commercial radio propagated.

Television

- Invented in 1927 By Philo Farnsworth [Far02]
- Farnsworth hated most television programming as well.
- After WWII TV became common in North American households.
- What was the first image transmitted by television? Dollar Sign.

Video on Magnetic Tape

- 1953 First Video Tape Recorder Invented by RCA
- 1975 Betamax (SONY)
- 1976 VHS (JVC)
- Video and Audio combined on a magnetic media
- Transcription of Television Signal onto tape.

Video-Games

- 1977 Atari VCS 2600
- Dolphin - game based on sound.
- Sound associated with events.
- Interactive music
- 1990s Lucasarts releases Indiana Jones: Search For Atlantis
  - Uses adaptive music, the setting of the game or the action dictates the music

Audio On Computer

- Apple I
- TRS-80
- VIC-20
- Commodore 64 (Sid Chip)
- Amiga
- Atari 400/800
- PC Sound Cards (Adlib, Soundblaster, GUS, ...)
- Play some old music, C64, TSR-80

MIDI

- 1982 - Musical Instrument Digital Interface
- Musical Event Based System
- Integrate Music Devices w/ Computer
- MIDI can come in and go out.
- MIDI Networking used on Atari for video-game

DAT

- 1987
- Digital Audio Tape
- Destroyed by the RIAA due to copyright concerns.
- Only used professionally

World Wide Web

- 1989
- Tim Berners Lee
- Allows hyperlinks to files.
- Possible to print scientific knowledge and then link to audio files about the topic.

Internet Audio

- 1992 The first M-bone audio multi-cast on the Net
- Special Audio Protocols such as RTCP/RTSP/RTP meant to transmit audio over networks.
- RealNetworks Real Player
- Windows Media Player
- Nine Inch Nails Perfect Drug bootleg.

DVD

- Uses Dolby AC3 and DTS to encode audio.
- Interactive Menus allowed for crude hypermedia systems.
- DVD Audio - lossy and non lossy.

MP3

- 1997 MP3.com
- 1999 Napster
- 2000 Emusic.com
- Immensely popular and currently quite important.
- Killer App of Broadband

Tivo

- Interactive Video Recorder
- ”Fast Forward” commercials
- Rewind TV broadcasts
- Intelligently record programs you might want to see.

DIVX/MPEG4

- Boom in Internet movie piracy.
- Video is now accessible to broadband users at near DVD quality in 1/4 the space.

PowerPoint

- Enabled combining of media into an essentially linear presentation.
- Allows for embedded media in presentation.
- Allows for mediocre presentations.
- Incredible success in teaching and business world.
- Ever tried to hyperlink into a powerpoint presentation?

Java

- Allowed playing of sounds on the web from interactive pages.
- Cross Platform.

Flash/Shockwave

- Vector Graphics, Animation and Audio combined together
- Immensely popular
- Doesn’t interact well with the web (availability, searchability, etc).
- Currently the defacto multimedia presentation format on the web.

Digital Representation of Audio

- Sampling Rate
- Channels
- Sample Size
- Perfectly reproducible
- Sampling Rate (8000hz, 11025hz, 16000hz, 22050hz, 32khz, 44.1khz, 48khz, 96.2khz)
- Channels (Mono (1), Stereo (2), Quad (4), Surround (5.1), ..)
- Sample Size (4 bit int, 8 bit int, 16 bit int, 24 bit int, 24 bit float, 32 bit float, 64 bit double)

Sampling Rate

- Digital is discrete, analog is continuous. We need to convert between the two.
- DAC and ADC
- We must sample audio at a frequency double the frequency of the maximum frequency of we sound we want to store.
- Telephone allocate 4000hz to speech this requires a sampling rate of 8000hz
- The more samples we take the better sound quality we can achieve
- Sampling Rates: 8000hz, 11025hz, 16000hz, 22050hz, 32khz, 44.1khz, 48khz, 96.2khz
- Aliasing
- Draw diagram of how to sample.

Channels

- Channels are the number of separate sound sources that are encoded and synchronized.
- Often stored in a interlaced form.
- Channels (Mono (1), Stereo (2), Quad (4), Surround (5.1), ..)
- Sub-Channels are not full channels (limited range) (.1 in Surround)
- Often channels are per instrument or groups of instruments.
- Sometimes the channels are shared
- Draw interlacing example on board.

Sample Size

- Sound is quantized into a sample. That is the physical sound is mapped to a discrete numerical domain (integer, floating point numbers).
- A sample has a size: 4 bit int, 8 bit int, 16 bit int, 24 bit int, 24 bit float, 32 bit integer, 32 bit float, 64 bit double.
- Essentially this is the fidelity of the amplitude measurement. This is the number of values a sample can take on. A 16 bit sound sample can have 64K different amplitude values waveform.
- Draw sampling example on the board.

Trade-offs

- Size vs Quality (sampling rate, sample size, channels, compression)
  - Sampling Rate up, size up, quality up
  - Sample Size up, size up, quality up
  - Channel Count up, size up, quality up
  - Lossy Compression Bitrate up, size up, quality up
  - Non-Lossy Compression, size down, quality equal (not much improvement 20% to 50% size reduction in most cases)

Lossy Compression

- MP3 and OGG Vorbis compress audio with some loss.
- These are psychoacoustic models which try to throwout as much data as they can while still sounding as close as possible to the source.
- Bad for noisy samples.
- Can compress sound for a specified size (bitrate).

Discuss

- How do you operate on audio?

Operations on Audio

- 4 basic types of operations:
- – Cropping
  - – Mixing
  - – Filtering
  - – Sequencing

Cropping

- Editing audio
- Removing chunks of audio.

Mixing

- DJ’s on Vinyl and CD
- Layering audio
- Similar to sequencing - joining of multiple channels of audio into one.

Filtering

- Example filters:
- – Reverb
  - Pitch Correction
  - Pitch alteration
  - Ring Modulation
  - Highpass / Lowpass / Bandpass
  - Resonance
  - Synthesis

Sequencing

- Drum machines
- Sequencers
- Repeated Samples - sometimes altered (pitch)
- Realtime Events (keyboard or control parameters)

Discuss

- How have you used audio and hypermedia together?

Audio and Hypermedia

- Audio In Hypermedia
- Audio As Hypermedia

Audio in Hypermedia

- Audio adds to the hypermedia experience.
- Background midi and music files
- User Interface sound cues.
- Links to Audio files to listen to or download.
- Audio in video.

Audio as Hypermedia

- Audio is the hypermedia experience.
- Hyperlinks embedded inside of audio files (mp3s and Winamp)
- Internet radio sending links to website being talked about (available in both Windows Media Player, Winamp and RealPlayer)
- Algorithmic Genetic Music Generators (choose and manipulate your own audio song)
- Audio Manipulation Hypermedia programs
- Non Linear audio editors.

Difficulties Of Audio In Hypermedia

- Audio is inherently linear.
- You can’t skip much without losing context.
- It is hard to navigate audio.
- Not very visual.
- Teleprompters and Speech Synth

Audio On The Web

- Background music
- Audio downloads
- UI cues (mouse overs)

Audio On The Web - Midi

- Awful
- Sounds different on every computer
- Often disabled
- Available on the hokiest and poorest of homepages (angelfire, tripod, geocities)
- Provide Example?

Audio On The Web - Downloads

- Free, Pay and Pirate sites. Simply download mp3s or other compressed music formats.
- Free sites: mp3.com, iuma.com, epitonic.com, ...
- Pay sites have differing levels of Digital Rights Management, none to lots.
- Pay Sites: emusic.com, rhapsody, itunes, ...
- Pirate sites are essentially dead other than p2p.
- Pirate Sites: scour.net, audiogalaxy, kazaa, napster, ...
- Many artists and record companies are very afraid.
- Goto mp3.com, epitonic.com and emusic.com

Audio On The Web - Video

- Live video
- Pirate Video
- Web cams
- Video files
- RealVideo and Windows Media files can have hyperlinks embedded inside of them.

Audio On The Web - Animation

- Macromedia’s Flash and Shockwave are defacto standards.
- SVG will eventually supports similar functionality with SMIL.
- Flash is common and often fun and silly.
- Show fun examples

Example Links

- fiction http://www.digitalfiction.co.uk/digitalfiction/
- games http://www.freshsensation.com/samorost.swf
- moon http://www.rathergood.com/
- badger http://rockape.qgl.org/crap/badger.swf
- Psychadelic http://www.virtualom.com/index4.htm

In Summary

- Audio is recorded or generated sound.
- Audio has really only existed for 150 years.
- Main inventions related to audio are the telephone, the phonograph, the radio, the television, the magnetic tape, the video recorder, the compact disc and the computer.
- Digital Audio is a discrete form of audio recording.
- Audio’s linear quality make it a rough fit for hypermedia.
- Audio is mostly used in hypermedia rather than as hypermedia.

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