Introduction to Multimedia Computing

Audio Media Type

Topics

- Properties of Audio Media
- Audio Data Compression
  - Motivation
  - Redundancy
  - Redundant Audio Data
  - MPEG Layer 3 (mp3) standard

Digital Audio

- What is Sound?

  Sound is the brain's interpretation of electrical impulses being sent by the inner ear through the nervous system.

- Audio is sound within the acoustic range available to humans.

- An audio is an alternating signal with frequency (AF) within the 20 to 20,000 hertz (cycles per second) range.

Sound Categories

- ## Content Sound

  Content sound provides information to audiences, for example, dialogs in movies or

  theater.

- ## Ambient Sound

  Ambient sound consists of an array of background and sound effects.

Content Sound Types

- **Narration:** Narration provides information about an animation that is playing on the screen.
- **Testimonials:** These could be auditory or video sound tracks used in presentations or movies.
- **Voice-overs:** These are used for short instructions, for example, to navigate the multimedia application.
- **Music:** Music may be used to communicate (as in a song).

Ambient Sound Types

- **Message reinforcement:** The background sounds you hear in real life, such as the crowds at a ball game, can be used to reinforce the message that you wish to communicate.

- **Background music:** Set the mood for the audience to receive and process information by starting and ending a presentation with music.

- **Sound effects:** Sound effects are used in presentations to liven up the mood and add effects to your presentations, such as sound attached to bulleted lists.

Properties of Sound

- The **amplitude** measures the relative loudness of the sound, which is the distance between a valley and a crest.
- The **amplitude** determines the volume of the sound.
- The unit of measurement of volume is a **decibel**.

Sample Sound Amplitudes

Source	Intensity Level
Threshold of Hearing (TOH)	0 dB
Rustling Leaves	10 dB
Whisper	20 dB
Normal Conversation	60 dB
Busy Street Traffic	70 dB
Vacuum Cleaner	80 dB
Large Orchestra	98 dB
Walkman at Maximum Level	100 dB
Front Rows of Rock Concert	110 dB
Threshold of Pain	130 dB
Military Jet Takeoff	140 dB
Instant Perforation of Eardrum	160 dB

Properties of Sound (Cont.)

- **Frequency:** The number of peaks that happen in one second is the frequency.

- Another term associated with frequency is **pitch**. If an object oscillates rapidly (high frequency), it creates a "**high-pitched**" sound (treble).

- A low-frequency sound on the other hand is produced by an object that vibrates slowly, such as the thicker strings of a piano or guitar (bass).

Properties of Sound (Cont.)

- **Wavelength:** Wavelength is the distance from the midpoint of one crest to the midpoint of the next crest.
- Wavelength is represented by the symbol λ

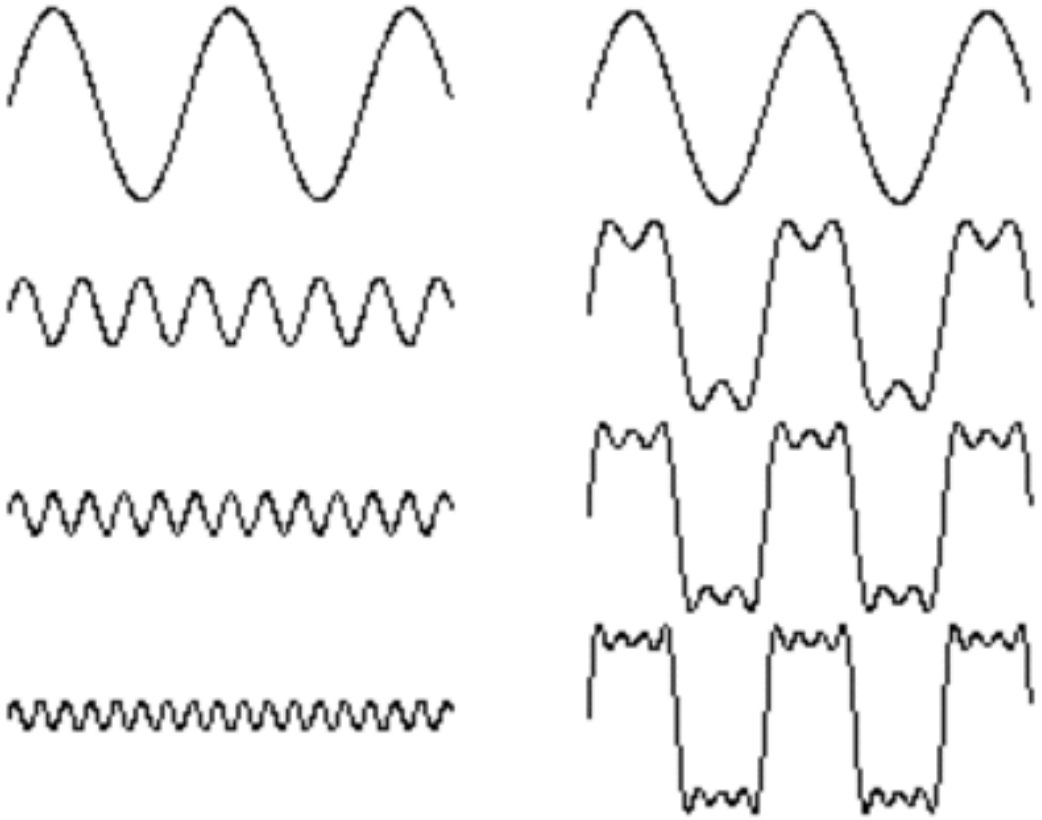
- **Bandwidth:** Bandwidth is defined as the difference between the highest and the lowest frequency contained in a signal.
- A signal which spans the range of 200-3200 Hz has a bandwidth (BW) of:

BW= 3200-200 = 3000 Hz

Harmonics

- Few objects produce sound of a single frequency. Most musical instruments, for example, generate multiple frequencies for each note.
- The combinations of frequencies generated by an instrument are known as the **timbre.**
- A timbre consists of a fundamental or main frequency and other minor frequencies known as **overtones** or **harmonics**.

Harmonics of a Compound Wave



Velocity of Sound

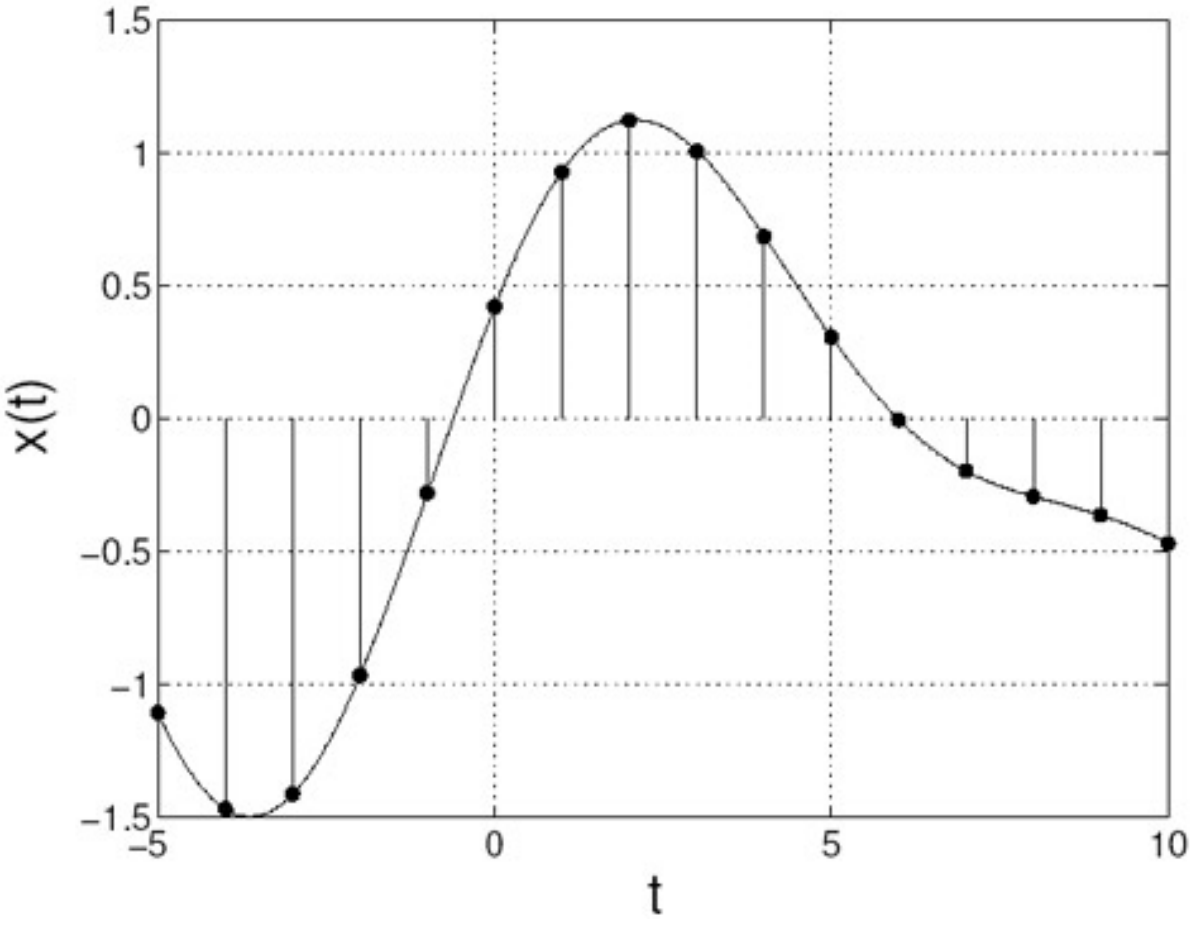
- The velocity of sound may be found directly by measuring the time required for the waves to travel a measured distance.
- The velocity varies greatly with the medium through which it travels.

Medium	Meters/second
Air	331.5
Hydrogen	1270
Carbon dioxide	258
Water	1450
Iron	5100
Glass	5500

Sampling

- Audio signal is an analog signal
- Computers store digital signal
- To convert analog signal into digital signal we have to do sampling

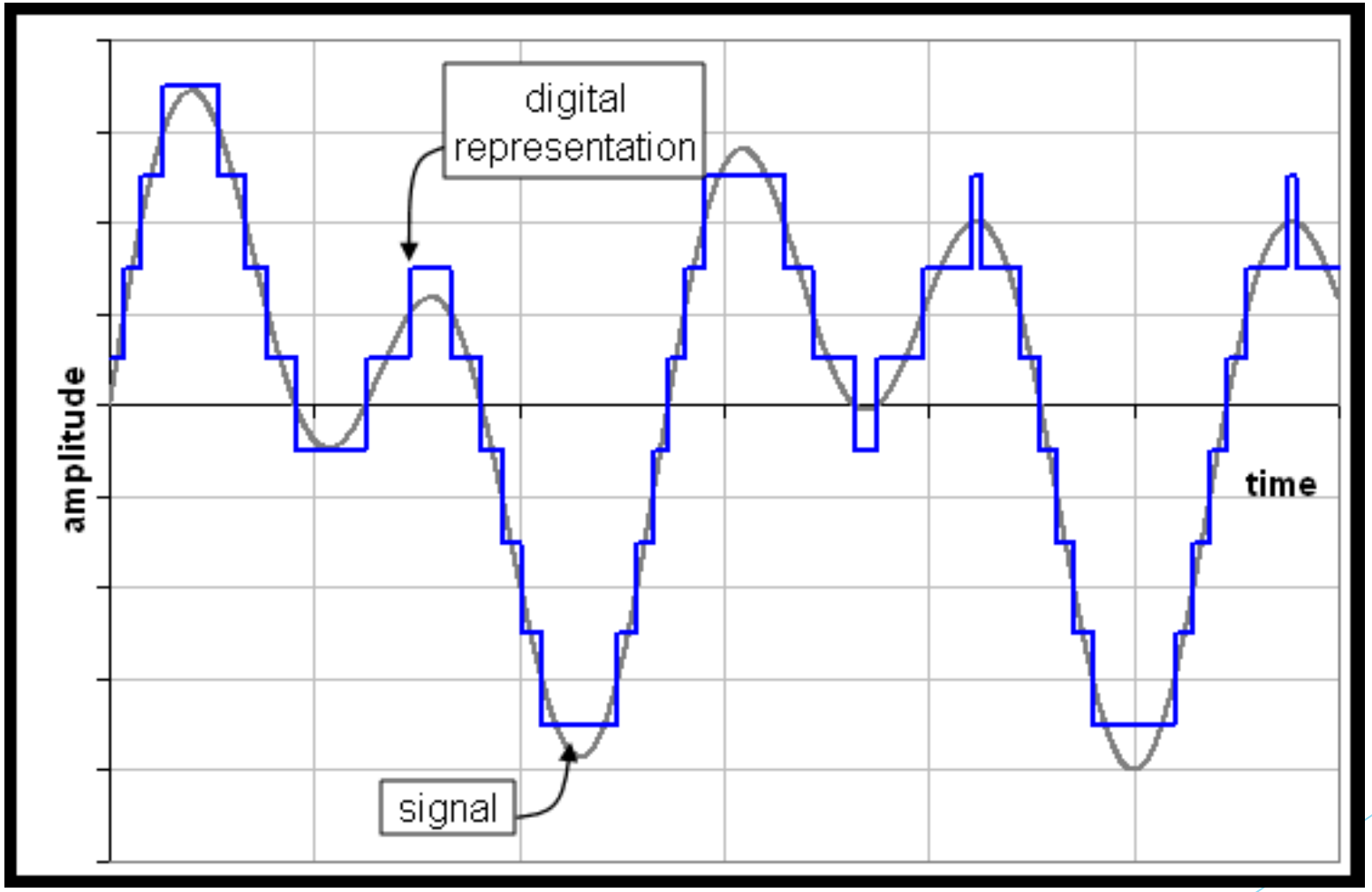
Sampling



Quantization

- Sample values can be in a large range and include real numbers.
- To store sample values with less number of bits quantization is used.
- In quantization the values in a range are mapped to a single number

Quantization



Sample Audio Data

- 20,000 Hz sound, sampled at 40,000 sample/second
- Quantization level: 256 (8 bits)
- 40,000 * 1 bytes /sec data

- With 65,536 (16 bits) quantization levels, data size will be 40,000 * 2 = 80,000 bytes/second

Fidelity

- Fidelity is defined as the closeness of the recorded version to the original sound. In the case of digital speech, it depends on the number of bits per sample (quantization) and the sampling rate.

- A really high-fidelity (hi-fi) recording takes up a lot of memory space (176.4 Kb for every second of audio of stereo quality sampled at 16 bits, 44.1 kHz per channel).

- Fortunately for most computer multimedia applications, it is not necessary to have very high fidelity sound.

Sound Formats and Settings

- Mono Recording:

  File size = Sampling rate x duration of recording in seconds x (bits per sample/8) x 1

- Stereo Recording:

  File size = Sampling rate x duration of recording in seconds x (bits per sample/8) x 2

Sound Quality

Sampling rate (kHz)	Bit-resolution (bits)	Stereo/Mono	Bytes needed for one minute (MB)	Comments
44	16	Stereo	10.5	CD-quality sound.
44	16	Mono	5.25	Good quality for voice-overs.
44	8	Stereo	5.25	Good quality for playback.
44	8	Mono	2.6	Good quality for recording a mono audio source.
22	16	Stereo	5.25	Good quality reproduction but not CD quality.
22	16	Mono	2.6	OK for narration.
22	8	Stereo	2.6	Good for stereo recording when playback equipment quality is low.
22	8	Mono	1.3	Sounds like good AM radio quality.
11	16	Stereo	2.64	No advantage in using stereo.
11	16	Mono	1.32	Sounds muffled. The lowest standard you should use, unless you are using for telephony applications.

Audio Representation Standards

- *wav* - standard audio file format used mainly in Windows PCs. Commonly used for storing uncompressed, CD-quality sound files.
- *mp3* - the MPEG Layer-3 format is the most popular format for downloading and storing music.
- *au* - the standard audio file format used by Sun, Unix and Java. The audio in *au* files can be uncompressed or compressed.

Summary

- Audio is an important media type used for transferring information, creating sound effects, music, and so on.
- Audio data is in the form of the sound wave. Therefore, to store it in our digital computers, we need to sample it. The samples are quantized.
- Digital audio data is transmitted over the internet, with many real-time applications. Therefore, compressing audio is necessary.