Special Topics in Multimedia System

Dayalbagh Educational Institute (DEI)
Dayalbagh Agra

Indian Institute of Technology Delhi (IITD)
New Delhi

SIL801
Course Administration

Course web site

http://www.cse.iitd.ac.in/~pkalra/sil801

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Live class and interactive sessions:

Microsoft Team
Course Administration

Evaluation (Components)

Assignments (Reading and Implementation)

Exam

Term Paper Presentation

Project

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Course Outline

- Multimedia representation (Image/Video/Audio/Graphics)
- Multimedia compression (Coding Standards)
- Multimedia streaming and communication (Protocols, QoS)
- Multimedia applications
  - Multimedia communications (Mobile and IoT)
  - Tele-operations
  - Augmented Reality

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Multimedia

Historical Perspective: Digital Media

Sound | Video

Image | Geometry

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Audio

Digital Representation

Audio (Sound): continuous signal (wave form) in time 1D function $f(x)$

- **Period**: distance between two consecutive peaks or troughs of the wave.
- **Amplitude**: maximum displacement of the wave from its equilibrium position.

**Frequency**: reciprocal of period (measured in Hz i.e., cycles/sec) relates to the **pitch** of sound.

**Amplitude**: relates to the **loudness** of sound (measured in decibels – db).

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Audio

Digital Representation

Audio (Sound): continuous signal (wave form) in time 1D function $f(x)$

Continuous

Discrete

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Audio

Digital Representation

1D function $f(x)$

Discretization Process

Discretization in $x$: Sampling
Discretization in $f$: Quantization
Audio

Sampling and Quantization

Sampling

Quantization

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Audio

Sampling Rate

Rate at which the continuous wave is sampled (number of samples) measured in Hz

Telephone 8000 Hz, CD 44100 Hz

Quantization

Number of bits used to measure the amplitude

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Audio

Effect of Sampling Rate and Quantization

Storage and fidelity

voice quality: 8KHz (sampling) 8 bit (quantization) 8Kbytes/s

Sampling rate if not adequate can result in error and the digital representation is not able to do a faithful reconstruction of the signal.

Quantization determines the precision of a sample.

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Audio Formats

- au (SUN file format)
- Wav (Wave)
- midi (Music Instrument Digital Interface file format)
- aiff (Audio Interchange File Format)
- riff (Resource Interchange File Format)
- wma (Windows Media Audio format)
- mp3 (MPEG Audio Layer 3)

Related areas: Speech Processing, Music Processing

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Audio

Audio Tools

- Adobe Audition (formerly Cool Edit)
  - A powerful multi-track mix/edit tool
- Sound Forge
  - Sony audio editing software includes a powerful set of audio processes, tools, and effects for manipulating audio.
- Pro Tools
  - From Digidesign used by professionals in music production, TV and films
An image is a spatial representation of an object, a 2D or 3D scene.

- Abstractly, an image is a continuous function defining a rectangular region of a plane
  - intensity image - proportional to radiant energy received by a sensor/detector
- An image can be thought of as a function with resulting values of the light intensity at each point over a planar region.

2D function \( f(x,y) \)

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2D function $f(x,y)$

- Function (e.g. intensity) must be sampled at discrete intervals.
  - Points at which an image is sampled are called picture elements or pixels.
  - Resolution (spatial) specifies the number of pixels.
  - Precision (Quantization) of the intensity ($f$) value is the number of bits per pixel
    - A digital image can be represented by a matrix of numeric values each representing a quantized intensity value.
2D function $f(x,y)$

Sampling: Discretization in $x$ and $y$

Quantization

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Effect of spatial resolution
Effect of spatial resolution
Effect of quantization (no of bits per pixel)
Spatial resolution and quantization level determine the size of the image.

Gray scale (monochrome) image with 8 bit pixel:

\[256 \times 256 \times 8 \text{ bits} = 256 \times 256 \text{ bytes}\]

Color image (R, G, B) each color channel pixel is 8 bit:

\[256 \times 256 \times 24 \text{ bits} = 256 \times 256 \times 3 \text{ bytes}\]
Image Formats

- bmp (Bit Mapped format)
- giff (Graphics Interchange File Format)
- tiff (Tagged Image File Format)
- jpeg (Joint Photographic Experts Group)
Image

Image Tools

- Adobe Illustrator
  - A powerful publishing tool from Adobe
- Adobe Photoshop
  - Image processing and manipulation tool
- Number of public domain image processing tools are available

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Video

Video is a sequence of images in time

Image (Frame)

Time

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Video

Discretization

Image (Frame) discretization
+ Sampling in time
frame rate (frames per second fps)

Bandwidth requirement = image size in bytes x frame rate

NTSC (National Television Systems Committee)
30 frames/second

PAL (Phase Alternating Line)
25 frames/second
Video Editing Tools

- Adobe Premiere
  - Video and audio are arranged in tracks –superimposition of tracks
  - Built-in filters, transitions and motions
- Adobe After Effects
  - Special effects for lighting, shadows, motion blurring
- Final Cut Pro: from Apple
Graphics

Geometry Data: Meshes

- Points
- Connectivity

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Graphics

Resolution

Mesh
Graphics

Graphics Tools

- 3ds Max (from Autodesk Media and Entertainment)
  - 3D graphics application software (formerly 3D Studio Max)
- Maya (from Autodesk Media and Entertainment)
  - High end graphics software (originally from Alias Research)
- Application Program Interface (API)
  - OpenGL
  - DirectX
  - Java3D

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Multimedia Communication

Elements

- Text
- Sound
- Video
- Image
- Geometry/Graphics/Animation

Transmitter End

Acquisition and Storage
Compression
Synchronization
Integration

Communication Channel

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Multimedia Communication Elements

Communication Channel

Media Extractor → Synchronization → De-compression

Receiver End

Play back

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Multimedia Communication

Some Challenges

- Bandwidth capacity of the communication channel
- Real-time processing
- Synchronization (inter-media)
- Continuity (intra-media)
- End-to-end delay

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