# CM3106 Chapter 1: Introduction to Multimedia

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# What is Multimedia?

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Multimedia can have many definitions these include:

**A computer system perspective definition:**

**Multimedia** means that computer information can be represented through audio, video, and animation in addition to traditional media (i.e., text, graphics/drawings, images).

# General Definition

**A good general working definition for this module is:**

**Multimedia** is the field concerned with the **computer controlled** integration of text, graphics, drawings, still and moving images (Video), animation, audio, and any other media where every type of information can be represented, stored, transmitted and processed **digitally**.

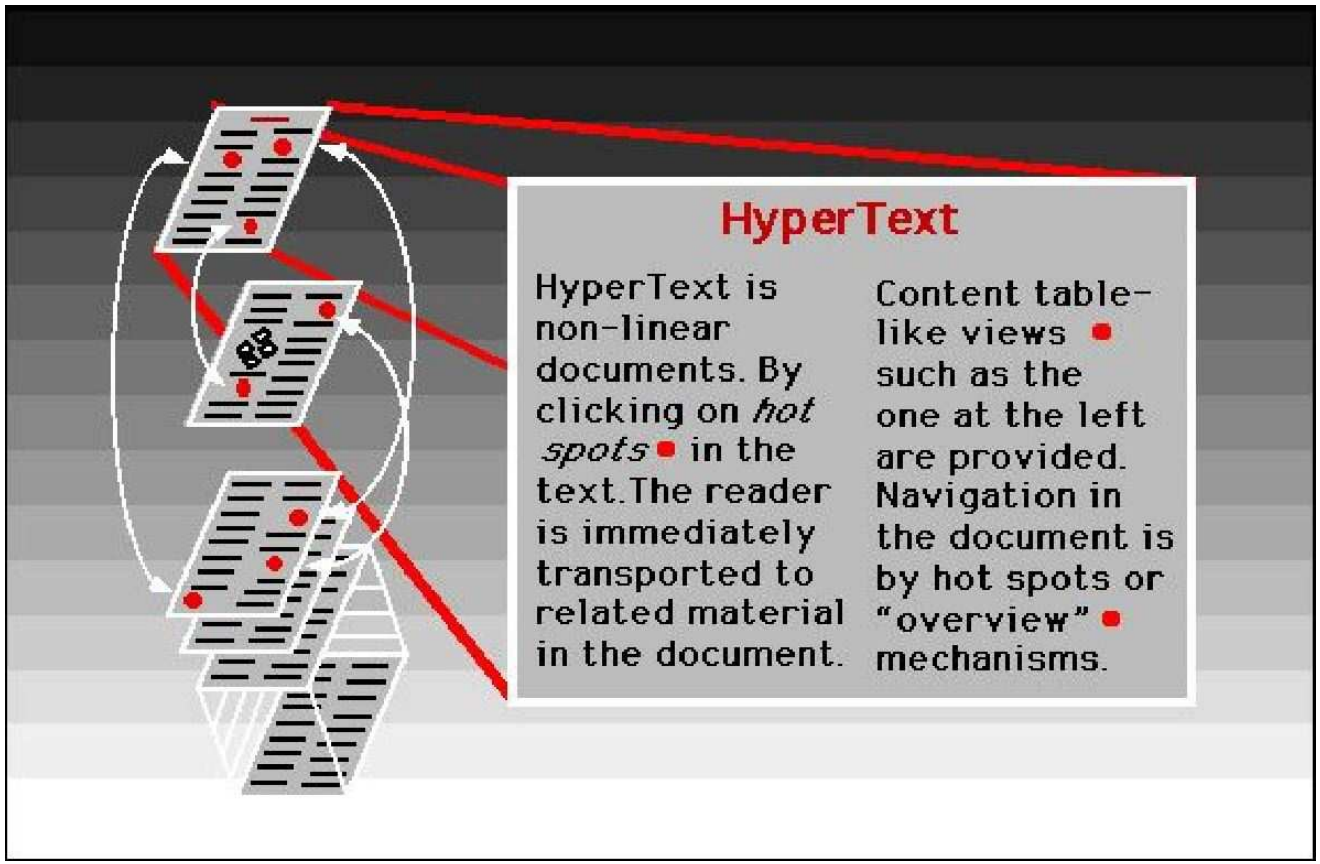
# Multimedia Application Definition

## Multimedia Application:

A **Multimedia Application** is an application which uses a collection of multiple media sources e.g. text, graphics, images, sound/audio, animation and/or video.

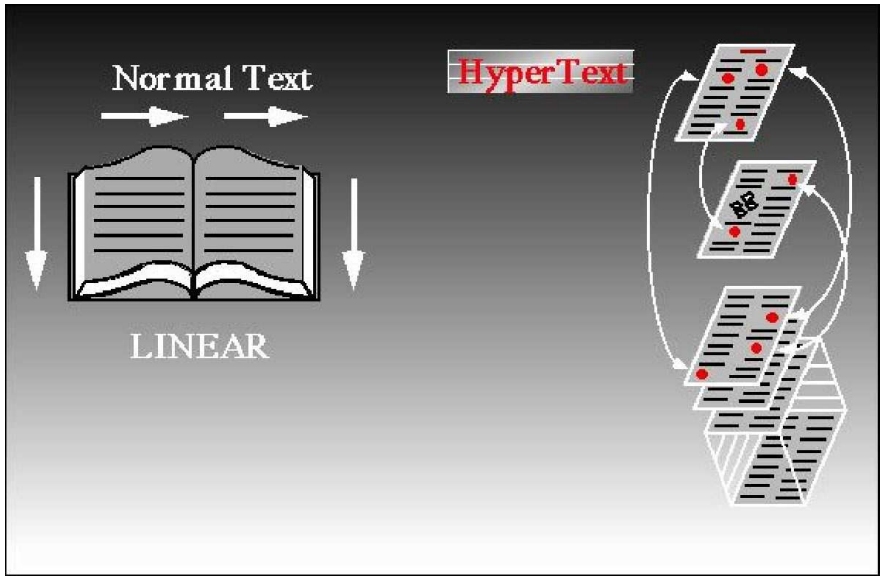
# What is HyperText and HyperMedia?

*Hypertext* is a text which contains links to other texts. The term was invented by Ted Nelson around 1965.



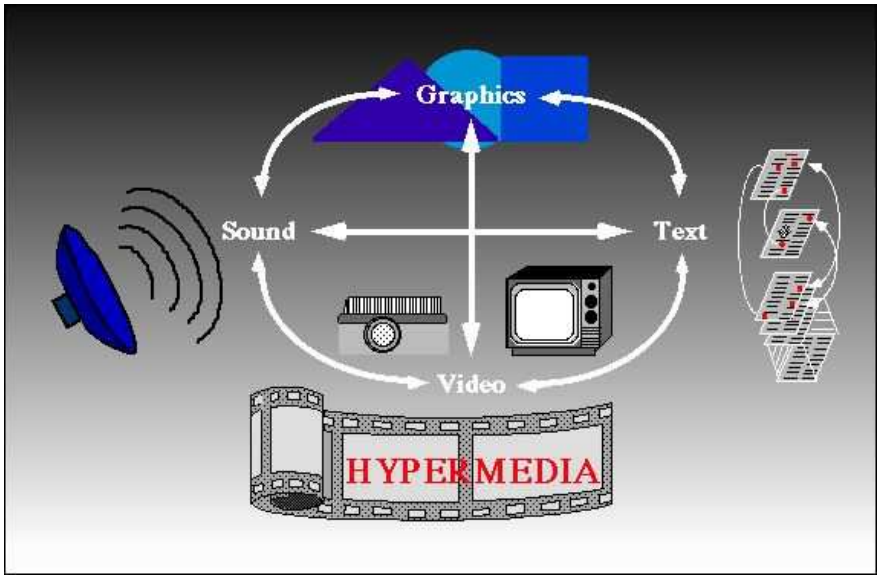
# HyperText Navigation

Traversal through pages of hypertext is therefore usually non-linear (as indicated below).




This has implications in layout and organisation of material — and depends a lot on the application at hand.

# Hypermedia




## Hypermedia definition:

*HyperMedia* is not constrained to be text-based. It can include other media, e.g., graphics, images, and especially continuous media – sound and video.

# Example Hypermedia Applications?

*Example*

# Example Hypermedia Applications?

- The World Wide Web (WWW) is a clear example of a hypermedia application.
- Powerpoint
- Adobe Acrobat (or other PDF software)
- Adobe Flash
- Many many others?

# Multimedia Applications

Examples of Multimedia Applications include:

- World Wide Web
- Multimedia Authoring, *e.g.* Adobe/Macromedia Director
- Hypermedia courseware
- Video-on-demand
- Interactive TV
- Computer Games
- Virtual reality
- Digital video editing and production systems
- Multimedia Database systems

# Multimedia Systems

## Multimedia System Definition

A **Multimedia System** is a system capable of processing multimedia data and applications.

A **Multimedia System** is characterised by the processing, storage, generation, manipulation and rendition of Multimedia information.

# Characteristics of a Multimedia System

A **Multimedia system** has four basic characteristics:

- Multimedia systems must be **computer controlled**.
- Multimedia systems are **integrated**.
- The information they handle must be represented **digitally**.
- The interface to the final presentation of media is usually **interactive**.

# Challenges for Multimedia Systems

- Distributed Networks
- Temporal relationship between data
  - Render different data at same time — continuously.
  - Sequencing within the media:
    **playing frames in correct order/time frame in video**
  - **Synchronisation** — inter-media scheduling

    **E.g.** Video and Audio — Lip synchronisation is clearly important for humans to watch playback of video and audio and even animation and audio.

    Ever tried watching an out of (lip) sync film for a long time?

# Key Issues for Multimedia Systems

The key issues multimedia systems need to deal with here are:

- How to represent and store temporal information.
- How to strictly maintain the temporal relationships on play back/retrieval
- What process are involved in the above.
- Data has to represented **digitally** — Analog–Digital Conversion, Sampling *etc.*
- Large Data Requirements — bandwidth, storage,

**Data compression is usually mandatory**

# Desirable Features for a Multimedia System

Given the above challenges the following feature a desirable (**if not a prerequisite**) for a Multimedia System:

Very High Processing Power — needed to deal with large data processing and real time delivery of media. Special hardware commonplace.

Multimedia Capable File System — needed to deliver real-time media — *e.g.* Video/Audio Streaming.

Special Hardware/Software needed – *e.g.* RAID technology.

Data Representations — File Formats that support multimedia should be easy to handle yet allow for **compression/decompression** in **real-time**.

# Desirable Features for a Multimedia System (cont.)

**Efficient and High I/O** — input and output to the file subsystem needs to be efficient and fast. Needs to allow for real-time recording as well as playback of data. *e.g.* Direct to Disk recording systems.

**Special Operating System** — to allow access to file system and process data efficiently and quickly. Needs to support direct transfers to disk, real-time scheduling, fast interrupt processing, I/O streaming *etc.*

# Desirable Features for a Multimedia System (cont.)

**Storage and Memory** — large storage units (of the order of hundreds of Tb if not more) and large memory (several Gb or more). Large Caches also required and high speed buses for efficient management.

**Network Support** — Client-server systems common as distributed systems common.

**Software Tools** — user friendly tools needed to handle media, design and develop applications, deliver media.

# Components of a Multimedia System

Now let us consider the Components (Hardware and Software) required for a multimedia system:

Capture devices — Video Camera, Video Recorder, Audio Microphone, Keyboards, mice, graphics tablets, 3D input devices, tactile sensors, VR devices. Digitising Hardware

Storage Devices — Hard disks, CD-ROMs, DVD-ROM, *etc*

Communication Networks — Local Networks, Intranets, Internet, Multimedia or other special high speed networks.

Computer Systems — Multimedia Desktop machines, Workstations, MPEG/VIDEO/DSP Hardware

Display Devices — CD-quality speakers, HDTV,SVGA, Hi-Res monitors, Colour printers *etc.*

# Applications

Examples of Multimedia Applications include:

- World Wide Web
- Hypermedia courseware
- Video conferencing
- Video-on-demand
- Interactive TV
- Groupware
- Home shopping
- Games
- Virtual reality
- Digital video editing and production systems

# Multimedia Data:Input and Format
# Text and Static Data

- Source: keyboard, speech input, optical character recognition, data stored on disk.
- Stored and input character by character:
  - Storage of text is 1 byte per char / more bytes for Unicode.
  - For other forms of data (*e.g.* Spreadsheet files). May store format as text (with formatting) others may use binary encoding.
- Format: Raw text or formatted text *e.g* HTML, Rich Text Format (RTF), Word or a program language source (Java, Python, MATLAB *etc.*)
- Not temporal — **BUT** may have natural implied sequence *e.g.* HTML format sequence, Sequence of C program statements.
- Size Not significant w.r.t. other Multimedia data.

# Graphics

- Format: constructed by the composition of primitive objects such as lines, polygons, circles, curves and arcs.
- Input: Graphics are usually generated by a graphics editor program (*e.g.* Illustrator) or automatically by a program (*e.g.* Postscript).
- Graphics are usually editable or revisable (unlike Images).
- Graphics input devices: keyboard (for text and cursor control), mouse, trackball or graphics tablet.
- graphics standards : OpenGL, PHIGS, GKS
- Graphics files usually store the primitive assembly
- Do not take up a very high storage overhead.

# Images

- Still pictures which (uncompressed) are represented as a bitmap (a grid of pixels).
- Input: digitally scanned photographs/pictures or direct from a digital camera.
- Input: May also be generated by programs "similar" to graphics or animation programs.
- Stored at 1 bit per pixel (Black and White), 8 Bits per pixel (Grey Scale, Colour Map) or 24 Bits per pixel (True Colour)
- Size: a 512x512 Grey scale image takes up 1/4 MB, a 512x512 24 bit image takes 3/4 MB with no compression.
- This overhead soon increases with image size — modern high digital camera 10+ Megapixels $\approx$ 29MB uncompressed!
- **Compression** is commonly applied.

# Audio

- Audio signals are continuous analog signals.
- Input: microphones and then digitised and stored
- CD Quality Audio requires 16-bit sampling at 44.1 KHz Even higher audiophile rates (e.g. 24-bit, 96 KHz)
- 1 Minute of Mono CD quality (uncompressed) audio requires 5 MB.
- 1 Minute of Stereo CD quality (uncompressed) audio requires 10 MB.
- Usually **compressed** (E.g. MP3, AAC, Flac, Ogg Vorbis).

# Video

- Input: Analog Video is usually captured by a video camera and then digitised.
- There are a variety of video (analog and digital) formats
- Raw video can be regarded as being a series of single images. There are typically 25, 30 or 50 frames per second.
- *E.g.* A $512 \times 512$ size monochrome video images take $25 \times 0.25 = 6.25$MB for a second to store uncompressed.
- Typical PAL digital video ($720 \times 576$ pixels per colour frame) $\approx 1.24 \times 25 = 31$MB for a second to store uncompressed.
- High Definition video on Blu-ray (up to $1920 \times 1080 = 2$ Megapixels per frame) $\approx 6.2 \times 25 = 155$MB for a second to store uncompressed. (There are higher possible frame rates!)
- Digital video **clearly needs** to be **compressed** for most times.

# Summary: This Course is Essentially about Multimedia Data Compression

How can we compress data?

Lossy v Lossless :

Lossless : Ideal (*e.g.* zip, unix compress) not good enough for MM data!

Lossy :Throw away nonessential (perceptually less relevant) parts of the data stream

**FILTER** the data somehow.

Examples: MP3, JPEG, MPEG Video/Audio

# Compression: Is there another way?

Compression via Synthesis :

Encode how to make (**synthesise**) the data

- can be done in many less bits in certain cases.

  Examples: Vector Graphics (Flash), MPEG Video, MP4 (Audio), MIDI: