CIT 3204: Multimedia Systems

Chapter 1: Introduction to Multimedia Systems / Technologies

1.1. Definitions

1) **Multimedia:** "Multimedia is a combination of text, graphic, sound, animation, and video that is delivered interactively to the user by electronic or digitally manipulated means".
2) **Multimedia Systems**: is a system capable of processing multimedia data and applications. A Multimedia System is characterized by the processing, storage, generation, manipulation and rendition of Multimedia information.
3) **Multimedia Technology:**
   - A technology which stores data as text, photo, pictures, music, sounds, graphic, film and animation and gives the methods to collect and modify the data as desired.
   - Multimedia technology refers to interactive, computer-based applications that allow people to communicate ideas and information with digital and print elements.
   - Multimedia technology refers to both the hardware and software used to create and run Multimedia systems.

   Multimedia technologies enable the users to integrate and manipulate data from diverse sources such as video, images, graphics, animation, audio and text on a single hardware platform. The integration of multimedia technology into the communication environment has the potential to transform an audience from passive recipients of information to active participants in a media-rich learning process
4) **Multimedia Traffic**: The transmission of data representing diverse media over communication networks.
5) **Multimedia Application**: An Application which uses a collection of multiple media sources e.g. text, graphics, images, sound/audio, animation and/or video.
6) **Multimedia Networking**: the design of networks that can handle multiple media types with ease and deliver scalable performance
7) **Digital Media:**
   - "The creative convergence of digital arts, science, technology and business for human expression, communication, social interaction and education".
   - Digital media is a form of electronic media where data are stored in digital form. It can refer to the technical aspect of storage and transmission of information or to the "end product", such as digital video, augmented reality, digital signage, digital audio, or digital art. Examples of digital media types include: Windows Media Audio (WMA), Windows Media Video (WMV), MP3, JPEG, and AVI.

1.2.Components/Types of Multimedia

There are five components of multimedia i.e. text, sound, images, animation and video.

1) Text: Text or written language is the most common way of communicating information. It is one of the basic components of multimedia. It was originally defined by printed media such as books and newspapers that used various typefaces to display the alphabet, numbers, and special characters. Text provides opportunities to extend the traditional power of text by linking it to other media, thus making it an interactive medium. Types of text
   a) Static Text: In static text, the words are laid out to fit in well with the graphical surroundings. The words are built into the graphics just like the graphics and explanation given in the pages of the book, the information is well laid out and easy to read.
   b) Hypertext: A hypertext system consists of nodes. It contains the text and links between the nodes, which define the paths the user can follow to access the text in non-sequential ways. The links represent associations of meaning and can be thought of as cross-references. This structure is

created by the author of the system, although in more sophisticated hypertext systems the user is able to define their own paths. The hypertext provides the user with the flexibility and choice to navigate through the material.

Text should be used to convey imperative information and should be positioned at appropriate place in a multimedia product. Well-formatted sentences and paragraphs are vital factors, spacing and punctuation also affects the readability of the text. Fonts and styles should be used to improve the communication of the message more appropriately.

2) **Image:** Images are an important component of multimedia. These are generated by the computer in two ways, as bitmap or raster images and as vector images.
   a) **Raster or Bitmap Images:** The most common and comprehensive form of storage for images on a computer is a raster or bitmap image. Bitmap is a simple matrix of the tiny dots called pixel that forms a raster or bitmap image. Each pixel consists of two or more colours. The colour depth is determined by how much data, in bits is used to determine the number of colours e.g. one bit is two colours, four bits means sixteen colours, eight bits indicates 256 colours, 16 bits yields 65,536 colours and so on. Comprehensive image means that an image looks as much as possible like the real word or original product. This means that the proportion, size, colour, and texture must be as accurate as possible. Bitmap formats are Windows Bitmap (BMP), Device Independent Bitmap (DIB), and Windows Run Length Encoded (RLE)
   b) Vector Images: Vector images are based on drawing elements or objects such as lines, rectangles, circles and so forth to create an image. The advantage of vector image is the relatively small amount of data required to represent the image and therefore, it does not requires a lot of memory to store. The image consists of a set of commands that are drawn when needed. A bitmap image requires the number of pixels to produce appropriate height, width and colour depth, the vector image is based on a relatively limited number of drawing commands.

3) **Animation:** Animation consists of still images displayed so quickly that they give the impression of continuous movement. Animation is the rapid display of a sequence of images of 2-D artwork or model positions in order to create an illusion of movement. It is an optical illusion of motion due to the phenomenon of persistence of vision, and can be created and demonstrated in a number of ways. The most common method of presenting animation is as a motion picture or video program, although several other forms of presenting animation also exist.

   Animations may be two or three dimensional (2D or 3D). There are two basic types of animations,
   a) Path Animation: Path animations involve moving an object on a screen that has a constant background e.g. a cartoon character may move across the screen regardless any change in the background or the character.
   b) Frame Animation: In frame animations, several objects are allowed to move simultaneously and the objects or the background can also change. The moving objects are one of the most appropriate tools to enhance understanding, as they allow the learner to see the demonstration of changes, processes and procedures. Animation uses very little memory in comparison to digital video as it consists of drawing and moving instructions.
4) **Sound:** Sound is probably the most sensuous element of multimedia. It is meaningful speech in any language, from a whisper to a scream. It can provide the listening pleasure of music, the startling accent of special effects, or the ambience of a mood setting background. Two types;
   a) **Digital Audio**: Digitized sound is sampled sound. Sampling means measuring the quantity we are interested in, usually at evenly spaced intervals. A sample of sound is taken and stored as digital information in bits and bytes. The quality of digital audio also relies on the quality of the

original audio source, capture devices, supporting software and the capability of playback environment.

Multimedia products benefit from digital audio as informational content such as a speech or voice-over and as special effects to indicate that a program is executing various actions such as jumping to new screens. The three sampling frequencies used in multimedia are CD-quality 44.1 kHz, 22.05 kHz and 11.025 kHz. Digital audio plays a key role in digital video.

b) **Musical Instrument Digital Identifier** (**MIDI):** Musical Instrument Digital Identifier (MIDI) is a communication standard developed in the early 1980s for electronic musical instruments and computers. It is a standard adopted by the electronic music industry for controlling devices, such as synthesizers and sound cards, that emit music. This technical standard describes a communication protocol, digital interface and electrical connectors (plugs and jacks) and allows a wide variety of electronic musical instruments, computers and other related music and audio devices to connect and communicate with one another.

At minimum, a MIDI representation of a sound includes values for the note's pitch, length, and volume. It can also include additional characteristics, such as attack and delay time. The MIDI standard is supported by most synthesizers, so sounds created on one synthesizer can be played and manipulated on another synthesizer. Computers that have a MIDI interface can record sounds created by a synthesizer and then manipulate the data to produce new sounds.

5) **Video:** Video is defined as the display of recorded real events on a television type screen. The embedding of video in multimedia applications is a powerful way to convey information. It can incorporate a personal element, which other media lack. The personality of the presenter can be displayed in a video. The video may be categorized in two types, analog video and digital video.
   a) **Analog Video:** Analog video is the video data that is stored in any non-computer media like videotape, laserdisc, film etc. It is further divided in two types, composite and component analogue video.
      - Composite Analog Video has all the video components including brightness, colour, and synchronization, combined into one signal. Due to the composition or combining of the video components, the quality of the composite video is resulted as colour bleeding, low clarity and high generational loss. Generational loss means the loss of quality when the master is copied to edit or for other purpose. Composite video is also susceptible to quality loss from one generation to other.
      - Component analog video is considered more advanced than composite video. It takes different components of video such as colour, brightness and synchronization and breaks them into separate signals. S-VHS and Hi-8 are examples of this type of analog video in which colour and brightness, information are stored on two separate tracks. In early 1980s, Sony had launched a new portable, professional video format “Betacam” in which signals are stored on three separate tracks.
   b) **Digital Video:** It is the most engaging of multimedia venues, and it is a powerful tool for bringing computer users closer to the real world. Digital video is storage intensive. A high quality colour still image on a computer screen requires one megabyte or more of storage memory. To provide the appearance of motion, picture should be replaced by at least thirty times per second and the storage memory required is at least thirty megabyte for one second of video. The more times the picture is replaced, the better is the quality of video. Digital video formats can be divided into two categories, composite video and component video.

- Composite digital recording formats encode the information in binary (0's and 1's) digital code. It retains some of weakness of analogue composite video like colour and image resolution and the generation loss when copies are made.
- Component digital is the uncompressed format having very high image quality. It is highly expensive. Some popular formats in this category are "Digital Bitacam" and D-5 developed in 1994 and DVCAM developed in 1996.

1.3. Categories of Multimedia

Multi media can be categorized as either Linear or Non-Linear

1) Linear: Linear Multimedia is a type of a multimedia that is designed to be presented in a sequential manner. It has a distinct beginning and end. It goes on a logical flow from a starting point to a conclusion

   It is usually intended for display purposes with not much interaction or distraction from the audience. Because of its nature where audience participation is not expected, Linear Multimedia may also be referred to as "Passive Multimedia". In this kind of presentation, the creator of the multimedia is in control. This kind of media is preferred if interaction is not necessary in the presentation

   Main goals include: to entertain, to transmit knowledge, and to make people familiar on a certain topic WITHOUT any form of diversion

   Examples may be:

   a) A power point presentation
   b) A slideshow of pictures that goes on with a specific direction
   c) A storyline/ A movie
   d) An anime episode
   e) A You tube video

   Advantages

   a) Audience gets to focus and concentrate on a specific topic
   b) There is logical order in the presentation
   c) Presenter controls the flow of the presentation
   d) Effective when we need our audience to absorb the information well

   Disadvantages

   a) Minimal interactivity, or none at all
   b) Audience has no say on the topic they want to dwell into

2) Non Linear: Non-linear multimedia is a non-sequential type of multimedia where the person's participation is crucial. In this type of media, the person needs to interact with a computer program, thus making him in control of the experience. With the presence of an interface, the person and the computer interacts with each other. From a starting point, the person using a nonlinear multimedia is given a range of options that, according to his own preferences, will lead him to a new information

   - *Interactive multimedia: Interactive multimedia**,** any computer-delivered electronic system that allows the user to control, combine, and manipulate different types of media, such as text, sound, video, computer graphics, and animation*
   - *Hyperactive:* Interactive Multimedia which provides a structure of linked elements through which the user can navigate

   Examples

   a) A Website

b) A search engine's home page
c) A DvD menu screen
d) A Youtube Channel
e) An anime or Korean drama streaming site

Advantages

a) The person is in control and may use the multimedia according to his preferences and needs.
b) Intuitive understanding: Interactive media makes technology more intuitive to use.
c) Effects on learning: Interactive media is helpful in the following four development dimensions in which young children learn: social and emotional, language development, cognitive and general knowledge, and approaches toward learning.
d) Relationships: Interactive media promotes dialogic communication

Disadvantages

e) Requires a level of computer literacy from the user
f) May be unorganized if not used well

1.4. Multimedia and Hypermedia

Hypermedia is used as a logical extension of the term hypertext in which graphics, audio, video, plain text and hyperlinks are intertwined to create a generally non-linear medium of information. This contrasts with the broader term multimedia, which may be used to describe non-interactive linear presentations as well as hypermedia.

The basic difference between hypermedia and multimedia is in the organization and the linkages of the information fragments. The information fragments in the multimedia are organized linearly whereas in hypermedia, these are organized non-linearly with links to each other

The World Wide Web is a classic example of hypermedia.

1.5. History of Multimedia:

a) Newspaper: perhaps the first mass communication medium, uses text, graphics, and images.
b) Motion pictures: conceived of in 1830's in order to observe motion too rapid for perception by the human eye.
c) Wireless radio transmission.
d) Television: the new medium for the 20th century, established video as a commonly available medium and has since changed the world of mass communications.
e) Computers / networks
f) Internet

1.6. Multimedia System's Hardware

Multimedia hardware includes;

a) Processor The heart of any multimedia computer is its processor.
b) Memory and Storage Devices
   - Primary Memory
   - Flash Memory
   - Secondary Memory:
c) Input Devices

• Keyboard • Mouse	• Digitizer • Magnetic Ink Card Reader	• Optical Mark Reader (OMR)

• Joystick • Light Pen • Track Ball • Scanner	(MICR) • Optical Character Reader (OCR) • Bar Code Readers	• Voice Systems - o Microphone- o Speaker- • Digital Camera - • Digital Video Camera

d) Output Devices - Following are few of the important output devices, which are used in Computer Systems:
   - Monitors -
   - Printers -
     - ✓ Dot Matrix Printer
     - ✓ Daisy Wheel
     - ✓ Line Printers
     - ✓ Laser Printers
     - ✓ Inkjet Printers
   - Screen Image Projector

e) Speakers and Sound Card

1.7. Multimedia Software

Multimedia software tells the hardware what to do. There are various software available in the market such as Paint Brush, Photo Finish, Animator, Photo Shop, 3D Studio, Corel Draw, Sound Blaster, IMAGINET, Apple Hyper Card, Photo Magic, Picture Publisher.

1.7.1. Multimedia Software Categories

Following are the various categories of Multimedia software

1) Device Driver Software- These softwares are used to install and configure the multimedia peripherals.
2) Music sequencing and notation
3) Digital audio: Digital Audio tools deal with accessing and editing the actual sampled sounds that make up audio.
4) Media Players- Media players are applications that can play one or more kind of multimedia file format.
5) Media Conversion Tools- These tools are used for encoding / decoding multimedia contexts and for converting one file format to another.
6) Multimedia Editing Tools- These tools are used for creating and editing digital multimedia data.
7) e Animation
8) Multimedia Authoring Tools- These tools are used for combing different kinds of media formats and deliver them as multimedia contents.

1.8. Multimedia Application Tools

Multimedia applications are created with the help of following tools and packages;

- **Text Editing Tools**- These tools are used to create letters, resumes, invoices, purchase orders, user manual for a project and other documents. MS-Word is a good example of text tool. It has following features:
  - Creating new file, opening existing file, saving file and printing it.
  - Insert symbol, formula and equation in the file.
  - Correct spelling mistakes and grammatical errors.
  - Align text within margins.
  - Insert page numbers on the top or bottom of the page.
  - Mail-merge the document and making letters and envelopes.
  - Making tables with variable number of columns and rows.

- **Painting and Drawing Tools**- These tools generally come with a graphical user interface with pull down menus for quick selection. Some examples of drawing software are Corel Draw, Freehand, Designer, Photoshop, Fireworks, Point etc. These software have following features:
    - Tools to draw a straight line, rectangular area, circle etc.
    - Different colour selection option.
    - Pencil tool to draw a shape freehand.
    - Eraser tool to erase part of the image.
    - Zooming for magnified pixel editing.
- **Image Editing Tools**- Image editing tools are used to edit or reshape the existing images and pictures. These tools can be used to create an image from scratch as well as images from scanners, digital cameras, clipart files or original artwork files created with painting and drawing tools. Examples of Image editing or processing software are Adobe Photoshop and Paint Shop Pro.
- **Sound Editing Tools**- These tools are used to integrate sound into multimedia project very easily. The presence of sound greatly enhances the effect of a mostly graphic presentation, especially in a video. Examples of sound editing software tools are: Cool Edit Pro, Sound Forge and Pro Tools. These software have following features:
    - Record your own music, voice or any other audio.
    - Record sound from CD, DVD, Radio or any other sound player.
    - You can edit, mix the sound with any other audio.
    - Apply special effects such as fade, equalizer, echo, reverse and more.
- **Video Editing Tools**- These tools are used to edit, cut, copy, and paste your video and audio files. Examples of video editing software are Adobe Premiere and Adobe After Effects.
- **Animation and Modeling Tools**- An animation is to show the still images at a certain rate to give it visual effect with the help of Animation and modeling tools. These tools have features like multiple windows that allow you to view your model in each dimension, ability to drag and drop primitive shapes into a scene, color and texture mapping, ability to add realistic effects such as transparency, shadowing and fog etc. Examples of Animations and modeling tools are 3D studio max and Maya.

1.9. Why Multimedia Systems are Important

1) Digital audio/video is revolutionizing music, film, game, and video & audio industries
2) Convergence of computers, telecommunication, radio, and TV
    - Caused by technology and competition
    - Dramatic changes in products and infrastructure
3) New application potential
    - Huge potential markets
    - Improving our lives (learning, entertainment, and work)
4) Interesting technical issues

1.10. Characteristics of a Multimedia System

A Multimedia system has four basic characteristics:

1) Multimedia systems must be computer controlled.
2) Multimedia systems are integrated.
3) The information they handle must be represented digitally.
4) The interface to the final presentation of media is usually interactive.

1.11. Features of Multimedia Systems/Technology

1) Interactivity: When the end-user is able to control the elements of media that are required, and subsequently obtains the required information in a non-linear way
2) Navigation: Enables the user to explore and navigate from one web page to another.
3) Hyperlink: Non-linear navigation of "jumping" for the required information.
4) Easy to use,
5) Easy to understand

1.12. Challenges for Multimedia Systems

1) Supporting multimedia applications over a computer network renders the application *distributed*. Multimedia systems may have to render a variety of media at the same instant -- a distinction from normal applications.
2) There is a temporal relationship between many forms of media (*e.g.* Video and Audio) There are 2 forms of problems here
   a) Sequencing within the media -- *playing frames in correct order/time frame in video*
   b) *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.

   The key issues multimedia systems need to deal with here are:
   a) How to represent and store temporal information.
   b) How to strictly maintain the temporal relationships on play back/retrieval
   c) What process are involved in the above.
3) Data has to represented *digitally* so many initial source of data needs to be *digitize* -- translated from analog source to digital representation. The will involve scanning (graphics, still images), sampling (audio/video) although digital cameras now exist for direct scene to digital capture of images and video.
4) The data is *large* several Mb easily for audio and video -- therefore storage, transfer (bandwidth) and processing overheads are high. Data compression techniques very common.

1.12.1. Desirable Features for a Multimedia System

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

1) **Very High Processing Power:** needed to deal with large data processing and real time delivery of media. Special hardware commonplace.
2) **Multimedia Capable File System**: needed to deliver real-time media -- *e.g.* Video/Audio Streaming. Special Hardware/Software needed *e.g* RAID technology.
3) **Data Representations/File Formats that support multimedia:** Data representations/file formats should be easy to handle yet allow for compression/decompression in real-time.
4) **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.
5) **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.*
6) **Storage and Memory**; large storage units (of the order of 50 -100 Gb or more) and large memory (50 -100 Mb or more). Large Caches also required and frequently of Level 2 and 3 hierarchy for efficient management.
7) **Network Support**: Client-server systems common as distributed systems common.
8) **Software Tools**: user friendly tools needed to handle media, design and develop applications, deliver media.

1.13. Forces Driving the Multimedia Revolution

Factors Contributing towards the development of Multimedia Technology:

1) **Price:** The drop in the prices of multimedia components assures us that multimedia technological development will be more rapid in the future. Today the price of a multimedia products are dropping rapidly, this increases the demand for them as they become more affordable.
2) **MMX Technologies:** Enabled the computer systems to interact fully with the audio, video elements and compact-disc drive, more effectively.
    - a single instruction, multiple data (SIMD) instruction set designed by intel.
    - ***Multimedia Extensions***, a set of 57 multimedia instructions built into Intel microprocessors and other x86-compatible microprocessors.
3) **Development of DVD Technology:** DVD technology has replaced VHS technology and laser disk in the production of digital videos or films because DVD pictures are clearer, faster, higher quality, higher capacity and lower price.
4) **Erasable Compact Discs (CD-E):** Since it is re-writable, it enables us to change data, to archive large volumes of data and also to backup copies of data stored in the hard disk
5) **Software Development:** Software applications for education, games and entertainment became easier to use with these various additional elements in the MMX Technologies. As Visual programming was introduced, multimedia software development became easier, faster and increased rapidly.
6) **Internet:** Brought dramatic changes in the distribution of multimedia materials.
7) **Increased usage of Computers:** Previously, computers were used for just Word Processing, with the development of multimedia technology, text is not the only main medium used to disseminate information but also graphics, audio, video, animation and interactivity. Hence, computers role has diversified and now act as the source for education, publication, entertainment, games and many others.

1.14. Multimedia Systems' Application Areas

Multimedia finds its application in various areas including, but not limited to,

1) **Education:** In Education, multimedia is used to produce computer-based training courses (popularly called CBTs) and reference books like encyclopaedia and almanacs. A CBT lets the user go through a series of presentations, text about a particular topic, and associated illustrations in various information formats. Education areas Multimedia is used includes;
    a) **Edutainment** is an informal term used to describe combining education with entertainment, especially multimedia entertainment.
    b) **Infotainment:** Combination of information and entertainment.
    c) **Digital Library:** With the existence of the digital or virtual library, students no longer need to go to libraries but can search and obtain information that they require through the Internet.
    d) Distance learning, using interactive multimedia while teaching, multimedia training products
    e) **Reference Source:** Using multimedia to obtain information that we require. *Eg. Multimedia Encyclopedias, directories, electronic books and dictionaries etc.*
2) **Multimedia in Business**- Multimedia can be used in many applications in a business such as;
    a) Voice Mail
    b) Electronic Mail
    c) Multimedia based FAX
    d) Office Needs
    e) Employee Training
    f) Sales and Other types of Group Presentation
    g) Records Management

3) **Mathematical and Scientific Research:** In Mathematical and Scientific Research, multimedia is mainly used for modeling and simulation. Representative research can be found in journals such as the Journal of Multimedia.
4) **Engineering:** Software engineers may use multimedia in Computer Simulations for anything from entertainment to training such as military or industrial training. Multimedia for software interfaces are often done as collaboration between creative professionals and software engineers.
5) **Communication Technology and Multimedia Services**- The advancement of high computing abilities, communication ways and relevant standards has started the beginning of an era where you will be provided with multimedia facilities at home. These services may include:
    a) Basic Television Services
    b) Interactive entertainment
    c) Digital Audio
    d) Video on demand
    e) Home shopping
    f) Financial Transactions
    g) Interactive multiplayer or single player games
    h) Digital multimedia libraries
    i) E-Newspapers, e-magazines
6) **Industry:** In the Industrial sector, multimedia is used as a way to help present information to shareholders, superiors and coworkers. Multimedia is also helpful for providing employee training, advertising and selling products all over the world via virtually unlimited web-based technologies.
    a) **Video Teleconferencing:** Transmission of synchronized video and audio in real-time through computer networks in between two or more multi-points (or participants) separated by locations.

    Advantages Disadvantages
        - Reduces travelling cost and saves time;
        - Increases productivity and improves the quality of teaching and learning;
        - Make quick and spontaneous decisions;
        - Increases satisfaction in teaching or at the workplace
        - Video requires more bandwidth than audio.
    b) **Multimedia Store and Forward Mail:** Allow users to generate, modify and receive documents that contain multimedia. *Eg. Gmail, Hotmail, Yahoo etc*
7) **Advertising and Purchasing:** By using multimedia marketing of new products can be greatly enhanced. Multimedia boost communication on an affordable cost opened the way for the marketing and advertising personnel. Most web sites have many advertisements with multimedia features with the objective of marketing merchandise or offering services online.
8) **Creative industries:** Creative industries use multimedia for a variety of purposes ranging from fine arts, to entertainment, to commercial art, to journalism, to media and software services provided for other industries
9) **Commercial:** Much of the electronic old and new media utilized by commercial artists is multimedia. Exciting presentations are used to grab and keep attention in advertising.
10) **Health Applications:** Multimedia best use in hospitals is for real time monitoring of conditions of patients in critical illness or accident. The conditions are displayed continuously on a computer screen and can alert the doctor/nurse on duty if any changes are observed on the screen. Multimedia makes it possible to consult a surgeon or an expert who can watch an ongoing surgery line on his PC monitor and give online advice at any crucial juncture.