ATME COLLEGE OF ENGINEERING

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DEPARTMENT OF COMPUTER SCIENCE AND DESIGN

LECTURE NOTES

COURSE: MULTIMEDIA SYSTEM AND DESIGN

COURSE CODE: BCG613A

SEMESTER: VI

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MULTIMEDIA SYSTEM DESIGN-BCG613A

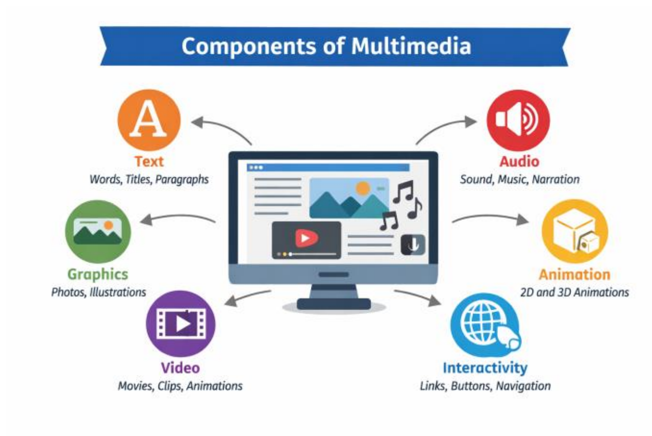
MODULE-1 NOTES

Introduction to Multimedia

Multimedia refers to the computer-controlled integration of text, graphics, images, sound, animation, and video, allowing information to be presented, stored, transmitted, and processed digitally. It combines multiple media types to enhance communication and interactivity.

Multimedia systems are designed to **store, process, transmit, and present information digitally**. The presence of a computer enables **control, synchronization, and interactivity**, which distinguishes multimedia from simple media collections.

Components of Multimedia



A multimedia system typically consists of the following elements:

Text: Text is the most basic and widely used component of multimedia and is mainly used to convey factual information, instructions, titles, labels, and menus. It provides structure and clarity to multimedia applications and is easy to create, edit, and store.Text acts as the **backbone** of multimedia communication.

Graphics and Images: Graphics and images form the visual component of multimedia. Graphics are computer-generated visual representations such as drawings, charts, diagrams, and illustrations that help in explaining complex ideas more clearly than text alone. Images, on the other hand, are static visual representations such as photographs or scanned pictures that add realism and detail to multimedia content. Both graphics and images enhance the visual appeal of an application and improve user understanding by presenting information in an intuitive form.

Audio: Audio is another important component of multimedia and includes speech, music, and sound effects. Audio enhances user interaction and makes multimedia applications more engaging and realistic. It is commonly used for narration, background music, alerts, and feedback. In multimedia systems, audio is stored in digital form after undergoing processes such as sampling and quantization.

Animation: Animation refers to the display of a sequence of images in rapid succession to create the illusion of motion. It is especially useful for demonstrating processes, simulations, and events that change over time. Animation helps users visualize abstract concepts and dynamic behavior, making it an effective learning and communication tool in multimedia applications.

Video: Video is the most information-rich component of multimedia and consists of real-world moving images, often combined with audio. It provides a high level of realism and is widely used in movies, video lectures, video conferencing, and surveillance systems. However, video requires large storage space and high processing power compared to other multimedia components.

Multimedia Presentation and Production: A **multimedia presentation** refers to the organized and computer-controlled integration of multiple media elements such as text, graphics, images, audio, animation, and video to convey information effectively to the user.

The purpose of a multimedia presentation is to improve communication by making information more attractive, understandable, and engaging. These presentations may be linear, such as video-based content, or non-linear, where users can navigate freely using menus, buttons, and hyperlinks.

Multimedia production is the systematic process of planning, designing, authoring, and integrating different media elements such as text, graphics, images, audio, animation, and video into a single, computer-controlled application in order to create an effective, interactive, and user-friendly multimedia presentation.

multimedia presentation production and its stages

Multimedia Presentation production refers to the process of creating a multimedia presentation — a "show" where content is expressed through a combination of media types like text, images, graphics, audio, video, and animation.

It involves:

- Planning the content
- Creating media elements
- Integrating them using authoring tools
- Testing and delivering the final product

1. **Planning the Content:**
   Planning is the first and most important step in multimedia production. In this stage, the objectives, target audience, scope, and purpose of the presentation are clearly defined. The content is organized through script writing, storyboarding, and flowchart preparation. Proper planning ensures logical sequencing of information and effective communication.
2. **Creating Media Elements:**
   In this step, all required multimedia components such as text, images, graphics,

audio, video, and animation are created or collected. Media elements may be designed, recorded, scanned, or digitized depending on project needs. Editing and formatting are also performed to ensure quality and consistency.

3. **Integrating Them Using Authoring Tools:**
   After creating the media elements, they are assembled and integrated using multimedia authoring tools. Interactivity, navigation controls, hyperlinks, and synchronization of audio and video are added. This step combines all components into a structured and functional multimedia presentation.
4. **Testing and Delivering the Final Product:**
   In the final step, the multimedia presentation is tested to check for errors, broken links, synchronization issues, and performance problems. Necessary corrections are made to improve quality. After testing, the final product is published and delivered through appropriate platforms such as web, CD/DVD, or other digital media

Characteristics of a Multimedia Presentation

1. Integration of multiple media
2. Interactivity with user
3. Non-linear navigation
4. Computer-controlled
5. Enhanced communication and understanding

1. Integration of multiple media: A multimedia presentation integrates text, graphics, images, audio, animation, and video in a single application. This combined use of media makes the content more attractive, meaningful, and easy to understand.

2. Interactivity with user: Multimedia presentations allow users to interact with the content using menus, buttons, and links. This interaction helps users control the flow of information and learns at their own pace.

3. Non-linear navigation: In a multimedia presentation, users are not forced to follow a fixed sequence. They can move freely between different sections based on their interest or requirement.

4. Computer-controlled: All media elements in a multimedia presentation are controlled by a computer system. The computer manages storage, synchronization, and presentation of different media components.

5.Enhanced communication and understanding: Multimedia presentations improve communication by using both visual and audio elements. This helps users understand complex information more easily and improves learning effectiveness.

Uses of Multimedia

- **Education and e-learning:**
  Multimedia is widely used in education and e-learning to make teaching more interactive and

interesting. The use of text, images, audio, video, and animation helps students understand concepts easily and improves learning and retention.

- **Training and simulations:**
  In training and simulation applications, multimedia is used to demonstrate real-life situations in a safe environment. Animations, videos, and interactive simulations help users practice skills and understand procedures without risk.
- **Entertainment (games, movies):**
  Multimedia plays a major role in entertainment such as games and movies by combining graphics, sound, animation, and video. It provides rich visual effects, realistic sound, and interactive experiences that engage users.
- **Business presentations and marketing:**
  Multimedia is used in business presentations and marketing to communicate ideas effectively and attract customers. Audio-visual content, animations, and videos make presentations more appealing and persuasive.
- **Engineering and scientific applications:**
  In engineering and scientific fields, multimedia is used for data visualization, simulations, and analysis. It helps in explaining complex designs, processes, and experimental results clearly and efficiently.

Analog and Digital Representations

An **analog representation** refers to information represented using **continuous signals** that vary smoothly with time or space. In this form, signal values can take any value within a given range. Examples of analog representation include natural sound waves, human speech, music, temperature variations, and analog video signals. These signals are typically represented by continuous mathematical functions, such as sine waves, where both time and amplitude are continuous. Because of their continuous nature, analog signals can represent real-world phenomena very accurately; however, they are more susceptible to noise and distortion during transmission and storage.

Digital representation, on the other hand, represents information using **discrete values** from a finite set of numbers. According to Parekh, digital signals are obtained by converting analog signals into digital form through the process of digitization. In digital representation, media data is encoded as binary numbers consisting of 0s and 1s, which can be easily processed by computers. Each value represents a specific amplitude level at a specific time instant, making the signal discrete in both time and amplitude.

Analog Representation	Digital Representation
1. Analog representation uses **continuous signals** that vary smoothly with time or space. 2. Signal values can take **any value within a range**. 3. It closely represents **real-world physical signals** like sound and light. 4. Analog signals are **more affected by noise**	1. Digital representation uses **discrete values** taken from a finite set of numbers. 2. 2. Signal values are represented as **binary numbers (0s and 1s)**. 3. It represents information in a form suitable for **computer processing**. 4. Digital signals are **less affected by noise** and can be corrected using error control

and distortion. 5. Copying analog data leads to **loss of quality**. 6. Storage and transmission are **difficult and less efficient**. 7. Processing analog signals requires **analog hardware**. 8. Examples include **human voice, analog video, and radio signals**.	techniques. 5. Digital data can be copied **without loss of quality**. 6. Storage, transmission, and compression are **easy and efficient**. 7. Digital signals are processed using **digital computers and software**. 8. Examples include **digital audio, images, video, and computer files**.

Digitization

Digitization is the process of converting analog signals into digital form. It consists of:

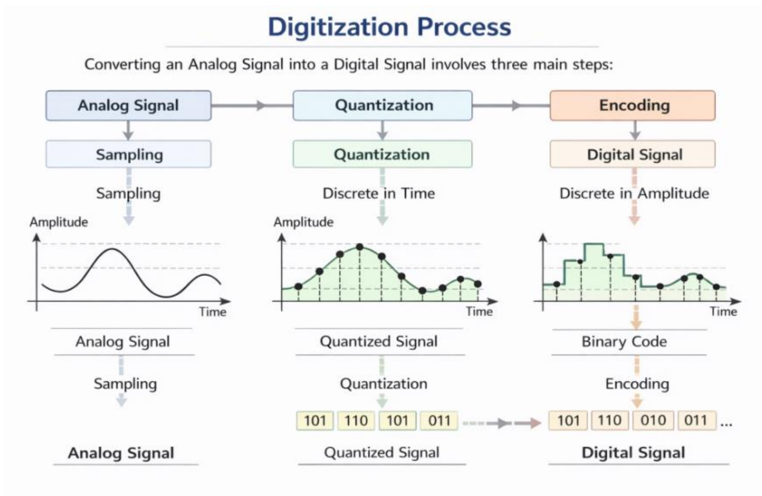
1. **Sampling** – measuring signal at regular intervals
2. **Quantization** – assigning sampled values to discrete levels
3. **Encoding** – converting values into binary form

Digitization: Digitization is the process of converting an analog signal into a digital form so that it can be processed by a computer. It is an essential process in multimedia systems because computers can handle only digital data.

1. Sampling: Sampling is the process of measuring the amplitude of an analog signal at regular time intervals. The number of samples taken per second is called the sampling rate, and it determines the quality of the digital signal.

2. Quantization: Quantization is the process of mapping each sampled value to the nearest discrete amplitude level. During this process, a small error called quantization error is introduced due to rounding.

3. Encoding: Encoding is the process of converting the quantized values into binary numbers. These binary values represent the digital signal and are stored or transmitted by the computer.



Digital-to-Analog Conversion (DAC)

Digital-to-Analog Conversion (DAC) is the process of converting digital data (binary values 0s and 1s) into a continuous analog signal. In multimedia systems, data such as audio and video are stored in digital form, but output devices like speakers and monitors require analog signals. Hence, DAC is necessary to reconstruct the original signal.

In DAC, digital code words are given as input. The converter produces corresponding voltage levels for each digital value. This output initially appears as a **staircase waveform**, because each sample is held constant for a short duration. Since this staircase signal is not smooth, it is passed through a **low-pass filter** to remove high-frequency components and smooth the waveform. The filtered output closely resembles the original analog signal.

DAC is commonly used in sound cards, audio players, and multimedia communication systems. However, small errors may occur due to approximation during conversion. Therefore, the number of conversions should be minimized to reduce signal loss.

Figure 2.17 Decoder: Digital to analog conversion

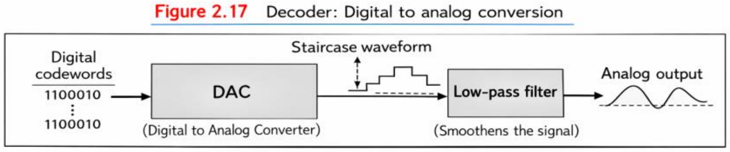
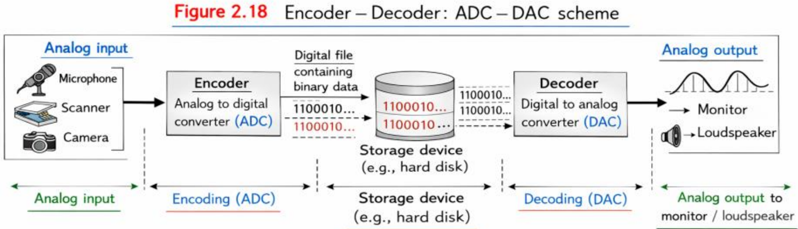


Figure 2.18 Encoder – Decoder: ADC – DAC scheme



Nyquist's Sampling Theorem

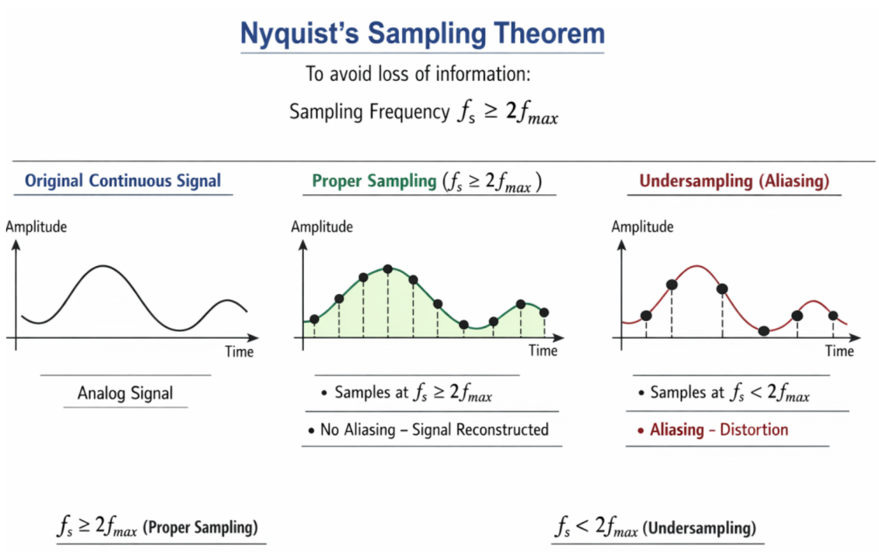
Theorem: An analog signal can be **perfectly reconstructed from its samples** if the **sampling frequency is at least twice the highest frequency component present in the signal**.

fs≥2fmaxf_s \ge 2f_{max}fs≥2fmax

Where:

- fsf_sfs = Sampling frequency
- fmaxf_{max}fmax = Highest frequency present in the signal
- 2fmax2f_{max}2fmax = **Nyquist rate**

Nyquist's Sampling Theorem explains the minimum sampling rate required to convert an analog signal into a digital signal without losing information. If the sampling frequency is less than twice the highest frequency of the signal, different frequency components overlap, causing distortion known as **aliasing**. When the signal is sampled at or above the Nyquist rate, the original analog signal can be accurately reconstructed from its digital samples. This theorem forms the foundation of digitization in multimedia systems, especially for audio and video signals.



Quantization Error: quantization is the process of mapping each sampled value of an analog signal to the nearest level within a finite set of discrete digital values. During this process, the exact amplitude of the original analog sample often cannot be represented precisely because digital systems have a **limited number of levels determined by the number of bits**. The **difference between the original analog value and the corresponding quantized digital value** is called the **quantization error**.

quantization error is an inevitable consequence of digitization and is often referred to as **quantization noise** when considering its effect on the overall signal. The magnitude of this error depends on the **step size** between quantization levels; larger step sizes produce greater error, while smaller step sizes reduce it. The **number of bits per sample** directly affects the step size: increasing the bit depth increases the number of discrete levels, which reduces the quantization error and improves the accuracy of the digital representation.

Quantization error is important in multimedia because it affects the **quality of digital audio, images, and video**. In audio, for example, a low bit depth can result in noticeable hiss or distortion, while in images it may produce visible banding in smooth color gradients. choosing an appropriate number of bits during quantization, multimedia designers can **minimize quantization error while balancing storage and processing requirements**.

eq=x(n)−xq(n)

where
x(n)x(n)x(n) = original sampled value
xq(n)x_q(n)xq(n) = quantized value

Cause of Quantization Error

1. Limited number of quantization levels – Only 2n2^n2n levels are available for n-bit representation.
2. Rounding or truncation – Sample values are rounded to nearest level.

Methods to Reduce Quantization Error

1. Increase number of bits (increase quantization levels).
2. Use non-uniform quantization.
3. Proper signal scaling before ADC.