18MCA41C – COMPUTER GRAPHICS AND MULTIMEDIA

Unit 5 MULTIMEDIA ARCHITECTURE & VIRTUAL REALITY

FACULTY

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Animation

- DESIGN OF ANIMATION SEQUENCES In general, an animation sequence is designed with the following steps:
- 1. Storyboard layout
- 2. Object definitions
- 3. Key-frame specifications
- 4. Generation of in-between frames

This standard approach for animated cartoons is applied to other animation applications as well, although there are many special application that do not follow this sequence.

- **The Storyboard layout** is an outline of the action. It defines the motion sequence as a
- set of basic events that are to take place. Depending on the type of animation to be produced, the storyboard could consist of a set of rough sketches or it could be a list of the basic ideas for the motion. **An object definition** is given for each participant in the action. Objects can bedefined interms of basic shapes, such as polygons or splines. In addition, the associatedmovements for each object are speeded along with the shape.
- **A keyframe** is a detailed drawing of the scene at a certain time in the animation sequence.
- Within each key frame, each object is positioned according to the time for that frame. Some key frames are chosen at extreme positions in the action; others are spaced so that the time interval between key frames is not to great. More key frames are specified for intricate motions than for simple, slowly varing motions.
- **In-between frames** are the intermediate frames between the key frames.
- The nurnber of in-betweens needed is determined by the media to be used to display theanimation. Film requires 24 frames per second, and graphics terminals are refreshedat the rate of 30 to 60 frames per second. Typically, time intervals for themotion are set up so that there arr from three to five in-betweens for each pair ofkey frames.

- **GENERAL COMPUTER-ANIMATION FUNCTIONS**

- Some steps in the development of an animation sequence are well-suited to computer solution. These include object manipulations and rendering, camera motions, and the generation of in-betweens. Animation packages, such as Wavefront,

- One function available in animation packages is provided to store and manage the object database. Object shapes and associated parameters are stored and updated in the database. Other object functions include those for motion generation and those for object rendering. Motions can be generated according to specified constraints using two-dimensional or three-dimensional transformations.

- **RASTER ANIMATIONS**

- On raster systems, we can generate real-time animation in limited applications using raster operations.
- Sequences of raster operations can be executed to produce real-time animation of either two-dimensional or three-dimensional objects, as long as we restrict the animation to motions in the projection plane.
- Then no viewing or visible- surface algorithms need be invoked.
- The animation is then accomplished by changing the color-table values so that the object is "on“ at successively positions along the animation path as the preceding position is set-to the background intensity

- **COMPUTER-ANIMATION LANGUAGES**

- Design and control of animation sequences are handled with a set of animation routines. A general-purpose language, such as C, Lisp, Pascal, or FORTRAN, is often used to program the animation functions, but several specialized animation languages have been developed. Animation functions include a graphics editor, a key-frame generator, an in-between generator, and standard graphics routines.

- The graphics editor allows us to design and modify object shapes, using spline surfaces, constructive solid-geometry methods, or other representation schemes.

- A typical task in an animation specification is scene description. This includes the positioning of objects and light sources, defining the photometric parameters (light-source intensities and surface-illumination properties), and setting the camera parameters (position, orientation, and lens characteristics).

- Another standard function is action specification. This involves the layout of motion paths for the objects and camera. And we need the usual graphics routines: viewing and perspective transformations, geometric transformations to generate object movements as a function of accelerations or kinematics path specifications, visible-surface identification, and the surface-rendering operations.

- **KEY FRAME SYSTEMS**

- We generate each set of in-betweens from the specification of two (or more) keyframes.
- Motion paths can be given with a kinematic a s a set of spline curves, or the motions can be physicdly bnscd by specifying the for acting on the objects to be animated.
- For complex scenes, we can separate the frames into individual components or objects called cels celluloid transparencies)

- **MORPHING**

- Transformation of object shapes from one form to another is called morphing, which is a shortened form of metamorphosis. Morphing methods can he applied to any motion or transition involving a change in shape. Given two key frames for an object transformation, we first adjust the object specification in one of the frames so that the number of polygon edges (or the number of vertices) is the same for the two frames.

- We can state rules for equalizing key frames in terms of either the number of edges or the number of vertices to be added to a key frame. Suppose we equalize the edge count, and parameters L_k and L_{k+1} denote the number of line segments in two consecutive frames. We then define

- **MOTION SPECIFICATIONS** There are several ways in which the motions of objects can be specified in an animation system.

$$L_{max} = \max(L_k, L_{k+1}), \qquad L_{min} = \min(L_k, L_{k+1})$$

- **Direct Motion Specification**The most straightforward method for defining a motion sequence is direct specification of the motion parameters. Here, we explicitly give the rotation angles and translation vectors. Then the geometric transformation matrices are applied to transform coordinate positions. Alternatively, we could use an approximating equation to specify certain kinds of motions.

- where A is the initial amplitude, w is the angular frequence, o, is the phase angle,and k is the damping constant. These methods can be used for simple user-programmed animation sequences.

$$y(x) = A\,|\sin(\omega x + \theta_0)|\,e^{-kx}$$

- **Goal-Directed Systems** At the opposite extreme, we can specify the motions that are to take place in general terms that abstractly describe the actions. These systems are referred to as goal directed because they determine specific motion parameters given the goals of the animation.

- Multimedia encompasses a large variety of technologies and integration of multiple architectures interacting in real time. All of these multimedia capabilities must integrate with the standard user interfaces such as Microsoft Windows.

Multimedia Systems Architecture

- Multimedia encompasses a large variety of technologies and integration of multiple architectures interacting in real time. All of these multimedia capabilities must integrate with the standard user interfaces such as Microsoft Windows.
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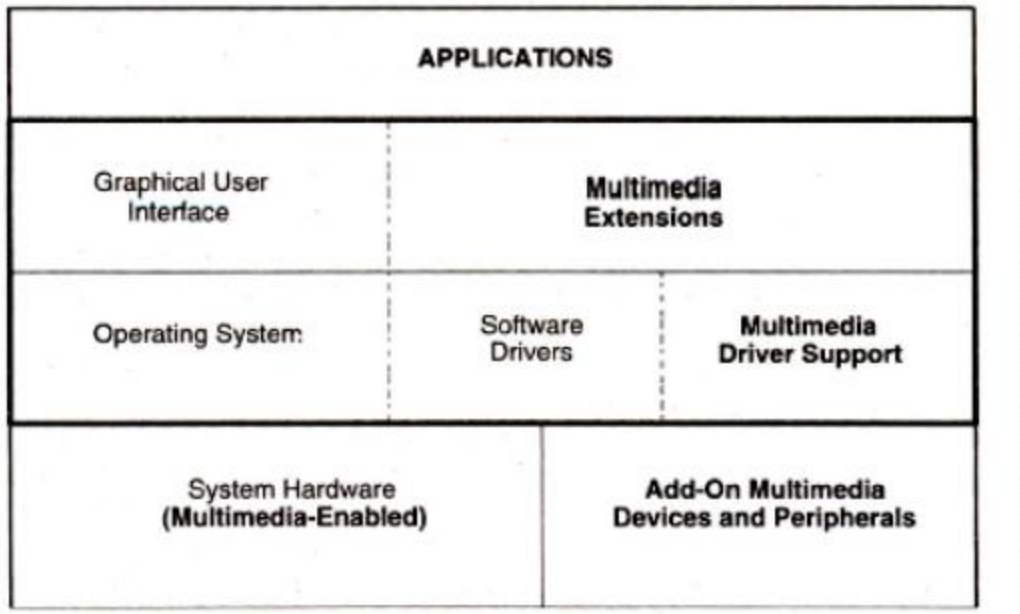
- **The** following figure describes the architecture of a multimedia workstation environment. In this diagram.



- The right side shows the new architectural entities required for supporting multimedia applications.
- For each special devices such as scanners, video cameras, VCRs and sound equipment-, a software device driver is need to provide the interface from an application to the device. The GUI require control extensions to support applications such as full motion video.

- **High Resolution Graphics Display**
  - The various graphics standards such as MCA, GGA and XGA have demonstrated the increasing demands for higher resolutions for GUIs.
- Combined graphics and imaging applications require functionality at three levels. They are provided by three classes of single-monitor architecture.

- **(i) VGA mixing: In** VGA mixing, the image acquisition memory serves as the display source memory, thereby fixing its position and size on screen:
- **(ii) VGA mixing with scaling:** Use of scalar ICs allows sizing and positioning of images in pre-defined windows.
- Resizing the window causes the things to be retrieved again.
- **(iii) Dual-buffered VGA/Mixing/Scaling:** Double buffer schemes maintain the original images in a decompression buffer and the resized image in a display buffer.

- The Interactive Multimedia Association has a task group to define the architectural framework for multimedia to provide interoperability. The task group has Concentrated on the desktops and the servers. Desktop focus is to define the interchange formats. This format allows multimedia objects to be displayed on any work station.
- The architectural approach taken by IMA is based on defining interfaces to a multimedia interface bus. This bus would be the interface between systems and multimedia sources. It provides streaming I/O service"s, including filters and translators **Figure 3.4** describes the generalized architectural approach
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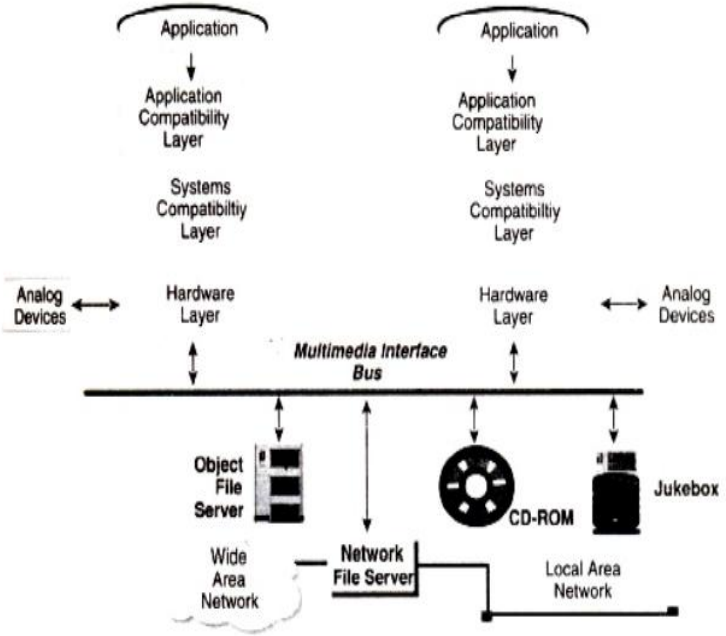

- Compression is the way of making files to take up less space. In multimedia systems, in order to manage large multimedia data objects efficiently, these data objects need to be compressed to reduce the file size for storage of these objects.

- **COMPRESSION AND DECOMPRESSION**

- Compression is the way of making files to take up less space. In multimedia systems, in order to manage large multimedia data objects efficiently, these data objects need to be compressed to reduce the file size for storage of these objects.

- Compression tries to eliminate redundancies in the pattern of data.

- For example, if a black pixel is followed by 20 white pixels, there is no need to store all 20 white pixels. A coding mechanism can be used so that only the count of the white pixels is stored. Once such redundancies are removed, the data object requires less time for transmission over a network. This in turn significantly reduces storage and transmission costs.

- **TYPES OF COMPRESSION**

- Compression and decompression techniques are utilized for a number of applications, such as facsimile system, printer systems, document storage and retrieval systems, video teleconferencing systems, and electronic multimedia messaging systems. An important standardization of compression algorithm was achieved by the CCITT when it specified Group 2 compression for facsimile system. .

- When information is compressed, the redundancies are removed.

- Sometimes removing redundancies is not sufficient to reduce the size of the data object to manageable levels. In such cases, some real information is also removed.
- The primary criterion is that removal of the real information should not perceptly affect the quality of the result.
- In the case of video, compression causes some information to be lost; some information at a delete level is considered not essential for a reasonable reproduction of the scene.
- This type of compression is called **lossy compression.**
- Audio compression, on the other hand, is not lossy. It is called **lossless compression**.

- **Lossless Compression.**

- In lossless compression, data is not altered or lost in the process of compression or decompression.
- Decompression generates an exact replica ofthe original object.
- Text compression is a good example of lossless compression.
- The repetitive nature of text, sound and graphic images allows replacement of repeated strings of characters or bits by codes.
- Lossless compression techniques are good for text data and for repetitive data in images all like binary images and gray-scale images.

- Some of the commonly accepted lossless standards are given below:
- **Packpits encoding (Run-length encoding)**
- **CCITT Group 3 I D**
- **CCITT Group 3 2D**
- **CCITT Group 4**
- **Lempe l-Ziv and Welch algorithm LZW.**

- Lossy compression is that some loss would occur while compressing information objects.

- Lossy compression is used for compressing audio, gray-scale or color images, and video objects in which absolute data accuracy is not necessary.

- The idea behind the lossy compression is that, the human eye fills in the missing information in the case of video.

- But, an important consideration is how much information can be lost so that the result should not affect. For example, in a grayscale image, if several bits are missing, the information is still perceived in an acceptable manner as the eye fills in the gaps in the shading gradient.
- Lossy compression is applicable in medical screening systems, video tele-conferencing, and multimedia electronic messaging systems.
- Lossy compressions techniques can be used alone o~' in combination with other compression methods in a multimedia object consisting of audio, color images, and video as well as other specialized data types.

- The following lists some of the lossy compression mechanisms:
- Joint Photographic Experts Group (JPEG)
- Moving Picture Experts Group (MPEG)
- Intel DVI
- CCITT H.261 (P * 24) Video Coding Algorithm
- Fractals.

- Compression schemes are
- **Binary Image compression schemes**
- Binary Image Compression Scheme is a scheme by which a binary image containing black and white pixel is generated when a document is scanned in a binary mode.
- The schemes are used primarily for documents that do not contain any continuous-tone information or where the continuous-tone information can be captured in a black and white mode to serve the desired purpose.
- The schemes are applicable in office/business documents, handwritten text, line graphics, engineering drawings, and so on. Let us view the scanning process. A scanner scans a document as sequential scan lines, starting from the top of the page.

compression schemes…..

- A scan line is complete line of pixels, of height equal to one pixel, running across the page. It scans the first line of pixels (Scan Line), then scans second "line, and works its way up to the last scan line of the page. Each scan line is scanned from left to right of the page generating black and white pixels for that scan line.
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- This uncompressed image consists of a single bit per pixel containing black and white pixels. Binary 1 represents a black pixel, binary 0 a white pixel. Several schemes have been standardized and used to achieve various levels of compressions. Let us review the more commonly used schemes.
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- **1 .Packpits Encoding(Run-Length Encoding)**
- It is a scheme in which a consecutive repeated string of characters is replaced by two bytes. It is the simple, earliest of the data compression scheme developed. It need not to have a standard. It is used to compress black and white (binary) images. Among two bytes which are being replaced, the first byte contains a number representing the number of times the character is repeated, and the second byte contains the character itself.
- In some cases, one byte is used to represent the pixel value, and the other seven bits to represents the run length.
- **2. CCITT Group 3 1-D Compression**
- This scheme is based on run-length encoding and assumes that a typical scanline has long runs of the same color.
- This scheme was designed for black and white images only, not for gray scale or color images. The primary application of this scheme is in facsimile and early document imaging system.

- **Data formatting for CClIT Group 3 2D**
- The 2D scheme uses a combination of additional codes called vertical code, pass code, and horizontal code to encode every line in the group of k lines.
-
- The steps for pseudocode to code the code line are:
- **(i)** Parse the coding line and look for the change in the pixel value. (Change is found at al location).
- **(ii)** Parse the reference line and look for the change in the pixel value. (Change is found at bl location).
- **(iii)** . Find the difference in location between bland a 1: delta = b1- al
- **Advantage of CClIT Group 3 2D**
- The implementation of the k factor allows error-free
-
- transmission . Compression ratio achieved is better than CClTT Group 3 1 D . It is accepted for document imaging applications.
- **Disadvantage**It doesn't provide dense compression
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- **CCITT Group 4 2D compression**
- CClTT Group 4 compression is the two dimensional coding scheme without the k-factor.
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- In this method, the first reference line is an imaginary all-white line above the top of the image.The first group of pixels (scanline) is encoded utilizing the imaginary white line as the reference line.

Multimedia Applications

- The first widely used application of multimedia is document image management. It is primarily intended for scanning documents and retaining their images.

- **MULTIMEDIA APPLICATIONS**
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- The first widely used application of multimedia is document image management. It is primarily intended for scanning documents and retaining their images.
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- Another application is image processing. It is also known as Image recognition. It is intended for recognizing objects by analyzing their raster images. Applications that present a view of generic multimedia applications are:
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- **1. Document Imaging**

- The fundamental concepts of storage, compression and decompression, and display technologies used for multimedia systems were developed for document image management. Organizations such as insurance agencies law offices,country and state governments, and the federal government manage large volumes of documents.

- Document image technology is adopted by Department of Defence for applications ranging from military personnel records to maintenance manuals and high-speed printing systems. Almost all document image system use workflows that are customized for the purpose for which they are being used. The workflow defines the sequence for scanning images, performing data *entry* based on the contents of the lmages, indexing them and storing them on optical media.

- **Document Image Hardware requirements:**

- Realtime image decompression and display place an important role on image processing hardware. Image decompression and display hardware supports 4 to 8 planes. 4 planes provide 16 colors and 8 planes provide 256 colors. The image planes are also called bit planes, because, they are addressed by a bit in a bytes. Images must be processed at the rate of tens to hundreds of pixels per nano-second.
- For high-resolution images, processing of the order of 10 pixels/ ns is enough for monochrome still images. Gray scale images consist of pixels that have shades of gray ranging from 16 to 256. Color images feature color hues instead of shades of gray. Most high-resolution monitors support 16 to 256 colors display capability. The number of colors that can be depicted depends on the number of bits used to define the palette.
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- **Image processing and Image Recognition**

- Image processing involves image recognition, Image enhancement,image synthesis, and image reconstruction.

- An image processing system may actually alter the contents of the image itself. Image processing systems employ the compression and decompression techniques, a wide range of algorithm for object recognition, comparing images of objects with pre-defined objects, extrapolating finer details to view edges more clearly, gray-scale balancing and gray-scale and color adjustments.

- Capabilities built in the compression boards might include the following

- * **Image calibration**: The overall image density is calibrated, and the image pixels are adjusted to a predefined level.
- * **Real time alignment**: The image is aligned in real-time for skewing caused by improper feeding of paper.
- * **Gray-Scale normalization**: The overall gray level of an image or picture is evaluated to determine if it is skewed in one direction and if it needs cOlTection.
- * **RGB hue intensity adjustment**: Too much color makes picture garish and fuzzy. Automatic hue intensity adjustment brings the hue intensity within pre-defined ranges
- . * **Color Separation**: A picture with very little color contrast can be dull and may not bring out the details. The hardware used can detect and adjust the range of color separation.
- * **Frame averaging**: The intensity level of the frame is averaged to overcome the effects of very dark or very light areas by adjusting the middle tones.

- IMAGE ANIMATION
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- Computers-created or scanned images can be displayed sequentially at controlled display speeds to provide image animation that simulates real processes.
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- The basic concept of displaying successive images at short intervals to give the perception of motion is being used successfully in designing moving parts such as automobile engines.
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- **Image annotation**
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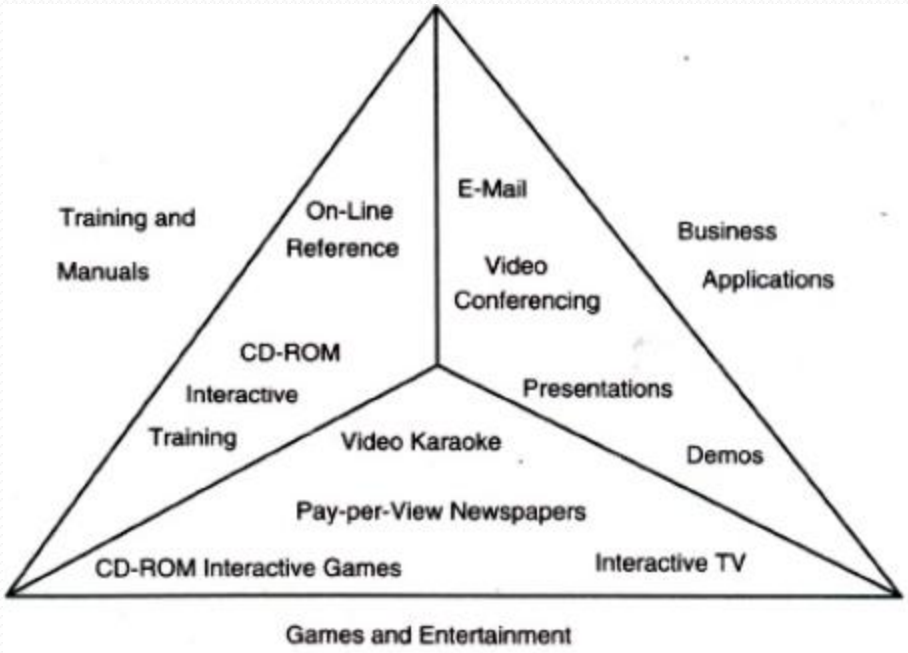
- Image annotation can be performed in one of two ways: as a text file stored along with the image or as a small image stored with the original image. The annotation is overlayed over the original image for display purposes. It requires tracking multiple image components associated with a single page, decompressing all of them, and ensuring correct spatial alignment they are overlayed.

- **Full motion Digital video Applications**
- Full motion video has applications in the games industry and training, as well as the business world. Full motion video is the most complex and most demanding component of multimedia applications.
- For business applications, some core requirements are needed.
- (i) Full-motion video clips should be sharable but should have only one sharable copy.
- (ii) It should be possible to attach full-motion video clips to other documents such as memos, chapter text, presentation, and so on.



- The following features should be available:
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- (a) Features, of a VCR metaphor, such as, rewind, fast-forward, play, and search.
- (b) Ability to move and resize the window displaying the video clip.
- (c) Ability to view the same clip on a variety of display terminal types with varying resolution capabilities without the need for storing multiple copies in different form
- (d) Ability to adjust the contrast and brightness of the video clip.
- (e) Ability to adjust the volume of the associated sound.
- (I) It should enable the users to place their own indexing marks to locate segments in video clip.
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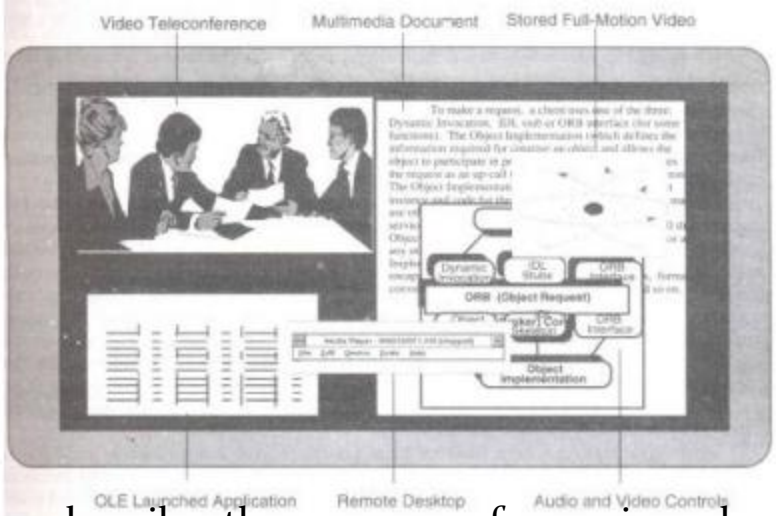
- **A Universal Multimedia Application**

- It is an application that works on universal data type. This means that the application manipulates datatypes that can be combined in a document, displayed 'on a screen, or printed, with no special manipulations that the user needs to perform. The application is truly distributed in nature.

- An important consideration for such a universal application is the methodology for dissemination of the information on a network.



- **Figure** describes the user screen for a universal multimedia application. **In** this screen, mix of windows for displaying still video and document images, a video conference window with a live session in progress, a remote live desk top, and a couple of other windows for applications such as electronic mail and desk top publishing.
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- To maintain all of these windows requires a substantial amount of CPU power. Digital Signal Processing assistance is needed to manage the multiple simultaneous decompressions for JPEG, MPEG and windows applications.

3. Full-Motion Video Messages

- In addition to textual messages, electronic mail capability allows embedding of voice messages and video messages. Video messages may consist of video snapshots or live video with full-motion picture and sound.

- Two technological concepts at play in the implementation of full motion video messages:
- (i) The storage and transmitted of a very large volume of data at a high rate,
- (ii) Decompression of that data to present a continuous play back

- **Audio and Video Indexing.**

- Indexing is an important and complex subject for multimedia design. Marking a position is called Indexing. Audio and video indexing are used in full-motion video in a manner similar to any video sequence, i.e.,. just as it would in a home movie, taped performance and so on.

- The needs of the application must be a strong consideration for the type of indexing provideq with the system.

- Key points for indexing of stored video clips:
- * Indexing is useful only if the video is stored, indexing information is lost.
-
- * When sound and video are decompressed and managed separately, synchronization is very important.

- * Depending on the application, indexing information must be maintained separately for sound and video components of a video clip.

What is Virtual Reality?

- o Simply put, VR is a computerized simulation of natural or imaginary reality.
- Often the user of VR is fully or partially immersed in the environment.
- Full immersion refers to someone using a machine to shield herself from the real world.
- Partial immersion happens when a person can manipulate a VR environment but isn't tucked or locked away in a machine.
- However, virtual reality doesn't necessarily have to be "full immersion" to be considered a true VR simulation.
- Games like Second Life on the PC and control devices like the Nintendo Wii remote are VRbased products.
- These items let users interact with a VR environment that is a computer simulation.
- These VR environments can be anything from a typical game, such as Super Mario Brothers, to a fully detailed city reconstitution or a fictional fantasy land.
- The only limit to a VR environment is the imagination and the resources that the creator has available.

INTRODUCTION

- **What is Virtual Reality(VR)?**

Virtual Reality refers to a high-end user interface that involves real-time simulation and interactions through multiple sensorial channels.

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- **Why VR?**

VR is able to immerse you in a computer-generated world of your own making: a room, a city, the interior of human body. With VR, you can explore any uncharted territory of the human imagination.

Brief History

- In 1950s, flight simulators were built by US Air Force to train student pilots.
- In 1965, a research program for computer graphics called “The Ultimate Display” was laid out.
- In 1988, commercial development of VR began.
- In 1991, first commercial entertainment VR system "Virtuality" was released.

Principle

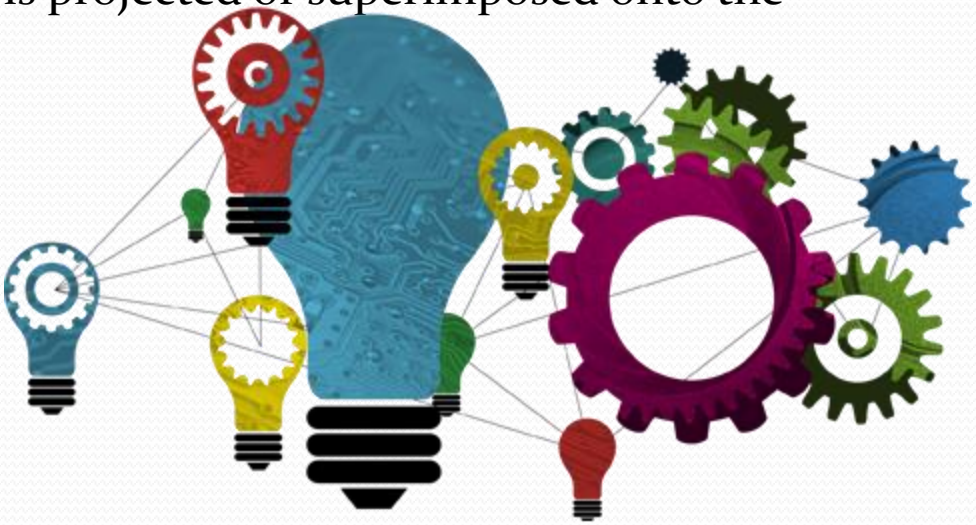
- The Virtual Reality System works on the following principle - It tracks the physical movements in the real world, then a rendering computer redraws the virtual world to reflects those movements.
- The updated virtual world is sent to the output (to the user in the real world).
- In this case, the output is sent back to a head mounted display.
- Hence, The user feels "immersed" in the virtual world - as if she was in the virtual world itself as all she can see is her rendered movements in the virtual world.

components of virtual reality systems

- REALITY ENGINE
- HEAD MOUNTED DISPLAY (HMD)
- AUDIO UNITS
- GLOVES

Reality engines

- Reality engines are based largely on the same components that make up a personal computer (PC), although much more computing power is required for the reality engine than is available in a standard PC.
- Virtual reality images are made with tiny dot like segments of a picture known as pixels, or picture elements.
- Each pixel itself is made up of hundreds of thousands of dots. Realistic images can be either opaque, in which all the viewer sees is the virtual world, or see-through, in which the virtual image is projected or superimposed onto the outer world



HEAD MOUNTED DISPLAY

- Head-mounted display (HMD) units use a small screen or screens (one for each eye) that are worn in a helmet or a pair glasses. Unlike a movie, where the director controls what the viewer sees, the HMD allows viewers to look at an image from various angles or change their field of view by simply moving their heads. HMD units usually employ cathode-ray tube (CRT) or liquid crystal display (LCD) technology.
- CRTs incorporate optic systems that reflect an image onto the viewer's eye. Although more bulky and heavy than LCD displays, CRT systems create images that have extremely high resolutions, making a scene seem that much more realistic.

civilian/commercial (medicine, video gaming, sports, etc.).

AUDIO UNITS

- The audio portion of virtual reality is transmitted through small speakers placed over each ear. Audio cues may include voices, singing, thud like noises of colliding objects—in short, any sound that can be recorded.
- Sounds that seem to come from above, below, or either side provide audio cues that mimic how sounds are heard in the real world. Three-dimensional (or omnidirectional) sound further enhances the virtual reality experience.

GLOVES

- Gloves in virtual reality allow the user to interact with the virtual world. For example, the user may pick up a virtual block, turn it over in a virtual hand, and set it on a virtual table.
- Wired with thin fiberoptic cables, some gloves use light-emitting diodes (LEDs) to detect the amount of light passing through the cable in relation to the movement of the hand or joint.
- The computer then analyzes the corresponding information and projects this moving hand into the virtual reality. Magnetic tracking systems also are used to determine where the hand is in space in relation to the virtual scene.

Types of Virtual Reality

Hardware

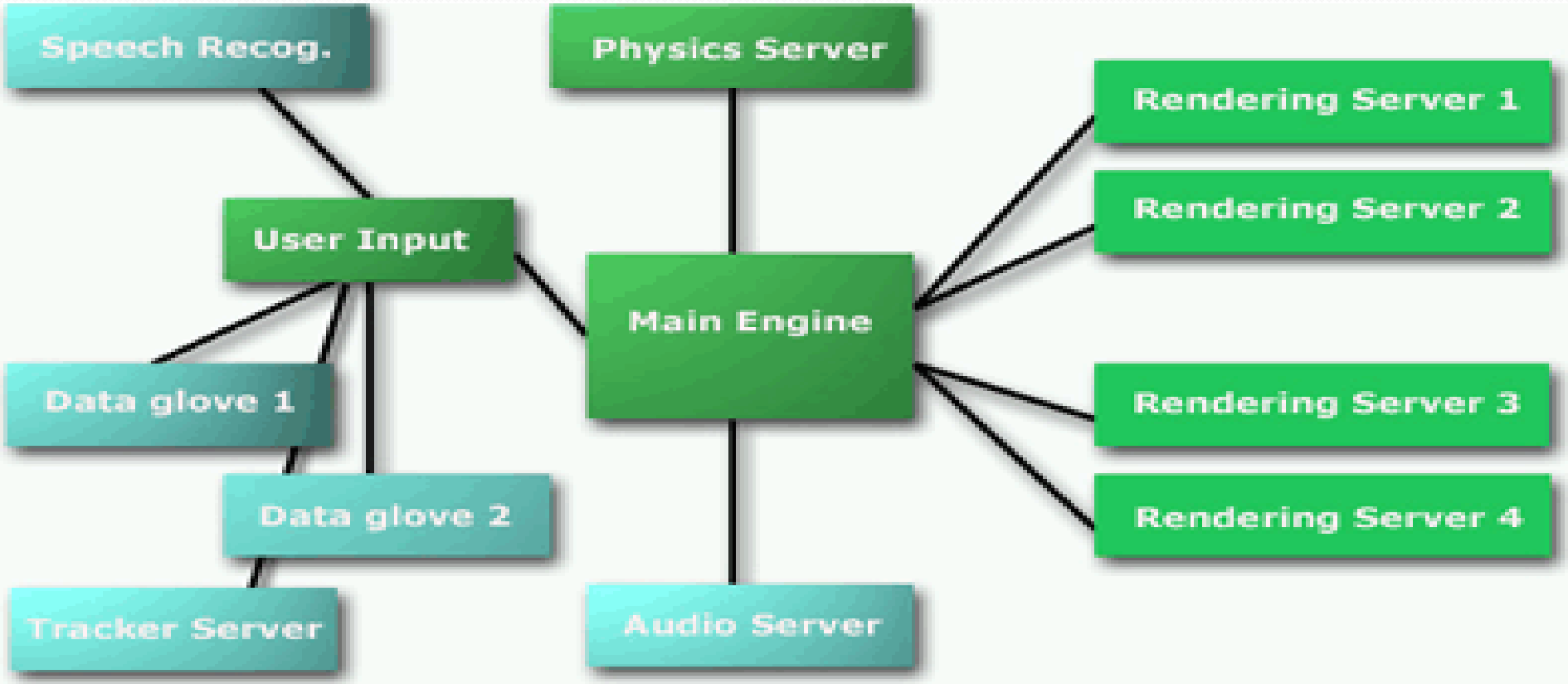
- Primary user input interfaces
- Tracking interfaces
- Visual interfaces
- Auditory interfaces
- Haptic interfaces
- Olfactory interfaces

Software

- Input Process
- Simulation Process
- Rendering Process
- World Database

Architecture of VR System

- Input Processor, Simulation Processor, Rendering Processor and World Database.



Applications of Virtual Reality

- **Entertainment**
  - More vivid
  - Move exciting
  - More attractive
- **Medicine**
  - Practice performing surgery.
  - Perform surgery on a remote patient.
  - Teach new skills in a safe, controlled environment.

Applications of Virtual Reality

- Manufacturing
  - Easy to modify
  - Low cost
  - High efficient
- Education & Training
  - Driving simulators.
  - Flight simulators.
  - Ship simulators.
  - Tank simulators.

Advantages

- Many different fields can use VR as a way to train students without actually putting anyone in harm's way. This includes the fields of medicine, law enforcement, architecture and aviation. VR also helps those that can't get out of the house experience a much fuller life.
- These patients can explore the world through virtual environments like Second Life, a VR community on the Internet, exploring virtual cities as well as more fanciful environments like J.R.R. Tolkien's Middle Earth.
- VR also helps patients recover from stroke and other injuries. Doctors are using VR to help reteach muscle movement such as walking and grabbing as well as smaller physical movements such as pointing. The doctors use the malleable computerized environments to increase or decrease the motion needed to grab or move an object.
- This also helps record exactly how quickly a patient is learning and recovering.

Disadvantages

- The hardware needed to create a fully immersed VR experience is still cost prohibitive. The total cost of the machinery to create a VR system is still the same price as a new car, around $20,000.
- The technology for such an experience is still new and experimental. VR is becoming much more commonplace but programmers are still grappling with how to interact with virtual environments.
- The idea of escapism is common place among those that use VR environments and people often live in the virtual world instead of dealing with the real one.
- This happens even in the low quality and fairly hard to use VR environments that are online right now. One worry is that as VR environments become much higher quality and immersive, they will become attractive to those wishing to escape real life. Another concern is VR training.
- Training with a VR environment does not have the same consequences as training and working in the real world. This means that even if someone does well with simulated tasks in a VR environment, that person might not do well in the real world.

Current problems & Future work

☹ Cybersickness / simulator sickness
☹ Low-fidelity
☹ Expensive
☹ Lack of integration between application packages

☺ High-fidelity system
☺ Cost-saving
☺ Collaborative
☺ High-level contact between participants in distributed VR

Conclusion

- VR introduces a new way of interacting with computers
- The best of VR is yet to come
- Web is very suitable for VR applications, but the proper technology is not yet there

References

- Roof calculator-software,calculates & tracks materials, estimates
  Put a roofing estimate together in under 2 minutes and get a complete roof material list !

  3d Animation UK Studios creating Virtual Reality Pictures
  UK 3D Animation company has a Computer Graphics portfolio that includes UK Architectural Rendering, UK Product Visualisation, 3D Virtual Tours.

  Aarkid 3d presentations
  Virtual tours to highlight your products' unique features

  CAD Drafting Services
  www.dp-draftingservices.com specializes in cad drafting services and raster to vector (R2V) conversions for all types of HVAC, architectural, mechanical and engineering projects.

  CadCells.com - Cells and Custom User Interfaces For Microstation J,v8 and AutoCAD Users
  Provides Microstation cell libraries for J and v8, AutoCAD, cad libraries.

THANK YOU

This content is taken from the text books and reference books prescribed in the syllabus.