VIDEO AND ANIMATION

Chapter 4

4.1. Basic Video Concepts: Representation and Format

Video Signal Representation

In conventional TV sets, the video signal is displayed using a cathode ray tube. An electron beam carries corresponding pattern information such as intensity in a viewed scene.

Video signal representation includes three aspects:

1. the visual representation
2. transmission
3. digitization

4.1. Basic Video Concepts: Representation and Format

1. Visual Representation

The objective is to offer the viewer a sense of presence in the scene and of participation in the events portrayed. To meet the objective, the televised images should convey spatial and temporal content of the scene.

Important measures taken for the purpose include

1. ***Vertical Detail and the Viewing Distance***
2. ***Horizontal Detail and Picture Width***
3. ***Total Detail Content of the Image***
4. ***Perception of Depth***
5. ***Luminance and Chrominance***
6. ***Temporal Aspects of Illumination***
7. ***Continuity of Motion***
8. ***Flicker***
9. ***Temporal Aspect of Video Bandwidth***

4.1. Basic Video Concepts: Representation and Format

1)Visual Representation

1. Vertical Detail and the Viewing Distance

Geometry of the field occupied by the television image is based on the ratio of picture width and height, called as aspect ratio (W/L=4/3=1.33)

Viewing distance **D determines the angle H subtended by the picture height.** The angle is usually measured by the ration of the viewing distance to the picture height (D/H). The smallest detail that can be reproduced in the image is pixel

Both the number of pixels per scanned line and the number of lines per frame vary; the actual numbers used being determined by the *aspect ratio.* This is the ratio of the screen width to the screen height. The aspect ratio of current television tubes is 4/3 with older tubes – on which PC monitors are based – and 16/9 with widescreen television tubes.

4.1. Basic Video Concepts: Representation and Format

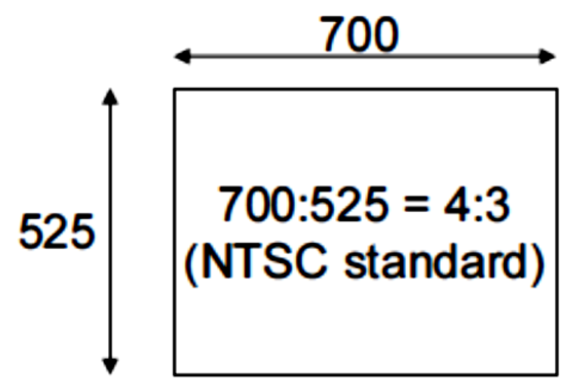
1)Visual Representation

1. Vertical Detail and the Viewing Distance (cont..)

Geometry of the television image is based on the *aspect ratio*, which is the ratio of the picture width W to the height H (W:H).

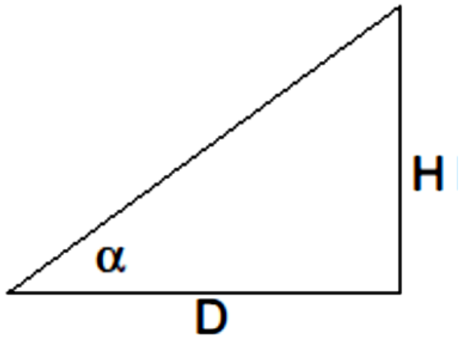
The conventional aspect ratio is 4/3 = 1.33 (W/H = 4/3)

Modern systems use 16/9 = 1.77



The *viewing distance* D determines the angle α subtended by the picture height H.

This angle is measured by the ratio of the picture height to viewing distance: $\tan(\alpha) = H/D$.



4.1. Basic Video Concepts: Representation and Format

1)Visual Representation(cont..)

2.*Horizontal Detail and Picture Width*

Picture width chosen for the conventional television services is **4/3 * picture height**. Using the aspect ratio, we can determine the horizontal field of view from the horizontal angle.

The horizontal detail or the picture width is again dependent upon the aspect ratio and is given by **aspect ratio*height of picture.**

4.1. Basic Video Concepts: Representation and Format

1)Visual Representation(cont..)

3. Total Detail Content of the Image

The **vertical resolution** is equal to the number of picture elements separately presented in the **picture height**, while the number of elements in the **picture width** is equal to the **horizontal resolution** times the aspect ratio.

The product of horizontal and vertical elements gives the **total picture elements in the image**.

The total detail content of the image is given by the number of pixels used to represent the image and is given by the resolution.

Thus total detail content of the image is the product of **Vertical Detail * Horizontal Detail.**

4.1. Basic Video Concepts: Representation and Format

1)Visual Representation(cont..)

4.Perception of Depth

In natural vision, perception of the third **spatial(3D/4D) dimension, depth,** depends primarily on the angular separation of the images received by the **two eyes if the viewer.**

In the flat image television, a considerable degree of depth perception is inferred from the perspective appearance of the subject matter.

As the screen is two dimensional a special measure is taken to give the sense of depth. This involves the perspective representation of the image content. This is again governed by the focal length of the lenses and changes in depth of focus in camera.

4.1. Basic Video Concepts: Representation and Format

1)Visual Representation(cont..)

5.Luminance and Chrominance

Color vision is achieved through three signals, proportional to the relative **intensities of Red, green and blue lights (RGB) in each portion** of the scene.

During the transmission of the signals from the camera to the television (display), a different division of signals in comparison to the RGB division is often used.

This color encoding during transmission uses luminance and chrominance.

The term **luminance** is used to refer to the **brightness** of a source, and the **color information** is referred by the **chrominance**.

Human eye however is more sensitive to luminance than to chrominance. The color encoding during transmission uses luminance and two chrominance signals (for hue and saturation).

4.1. Basic Video Concepts: Representation and Format

1)Visual Representation(cont..)

5.Luminance and Chrominance(cont..)

Thus luminance (Y_s) and two chrominance blue chrominance(C_b), and the red chrominance(C_r) are then used to represent the video content where

$$Y_s = 0.299\ R_s + 0.587\ G_s + 0.144\ B_s$$

$$C_b = B_s - Y_s \quad \text{and}$$

$$C_r = R_s - Y_s$$

4.1. Basic Video Concepts: Representation and Format

1)Visual Representation(cont..)

6.Temporal Aspects of Illumination

In contrast to continuous pressure waves of an acoustic signal, a discrete sequence of individual pictures can be perceived as a continuous sequence.

This property is used in television and **motion pictures**. The rate of repetition of the images must be high enough to **guarantee smooth motion** from **frame to frame** and the persistence of vision extends over the interval between flashes.

One of the major characteristics of human eye is that if the still images are shown in rapid succession, **human eye perceive the motion** i.e. it does not notice the brief cut off of the light.

Thus if the rate of succession is sufficiently high still images can be used to represent motion as the persistence of vision extends over the interval between flashes.

4.1. Basic Video Concepts: Representation and Format

1)Visual Representation(cont..)

7.Continuity of Motion

NTSC (**N**ational **T**elevision **S**ystems **C**ommittee) specified the frame rate for maintaining the visual-aural carrier separation at **4.5 MHz was 30 frames/sec** but has been changed to 29.97 HZ.

PAL (**P**hase **A**lternating **L**ine) adopted the frame repetition rate of **25 Hz**, and the frame rate is **25frames/sec**. Digital motion picture uses frame rate of **50 frames/sec**.

As stated above, motion can be represented by showing the still images in rapid succession. This can be done by showing the still images 15 frames per second. Video motion seems smooth and is achieved at only 30 frames per second.

4.1. Basic Video Concepts: Representation and Format

1)Visual Representation(cont..)

8.Flicker

Through a slow motion, a periodic fluctuation of brightness perception, a flicker effect arises. The marginal value to avoid flicker is at least 50 refresh cycles per second.

To achieve continuous flicker-free motion, we need relatively high refresh frequency.

Movies and television apply some technical measures to work with lower motion frequencies. When the **refresh rate of frames is smaller than the eye will notice the cutoff of light between the frames and there arises the flickering rate**. The marginal value to avoid flicker is at least 50 refresh cycles per second.

4.1. Basic Video Concepts: Representation and Format

1)Visual Representation(cont..)

9.Temporal Aspect of Video Bandwidth

The most important factor to determine at which bandwidth the video can be transmitted is its temporal specification. Temporal specification depends on the rate of the visual system to scan pixels, as well as on the human eye‟s scanning capabilities.

In a HDTV (High Definition TV) device, a pixel can be scanned in less than a tenth of a millionth of a second. From the human visual perspective, the eye requires that a video frame to be scanned every 1/25 second, this time is equivalent to the time during which human eye does not see the flicker effect.

The choice of bandwidth for transmission of the video signal depends on the rate of the visual system to scan pixels, as well as on the human eye‟s scanning capabilities. From the human visual perspective, the eye requires that a video frame be scanned every 1/25 second.

4.1. Basic Video Concepts: Representation and Format

2) Transmission

Standards for transmission of video are: NTSC (***N****ational* ***T****elevision* ***S****ystem* ***C****ommittee) and* PAL *(****P****hase* ***A****lternating* ***L****ine).* Approaches of color encoding are: RGB, YUV (luminance Y, two chrominance channels U and V), YIQ, Composite, etc.

Different color encoding techniques can be employed while transmitting the video signal and they are:

1. ***RGB signal***
2. ***YUV signal***
3. ***YIQ signal***
4. ***Composite signal***

4.1. Basic Video Concepts: Representation and Format

2) Transmission (cont..)

i. RGB signal

In this case separate signal coding is done for the individual R, G and B components of the image and these components are transmitted separately.

ii.YUV signal

This model exploits the fact that the human eye is more sensitive to brightness i.e. luminance than to color information i.e. chrominance. Thus instead of separating the color component the brightness and the coloration of the image is separated.

Thus luminance(Y_s) and two chrominance blue chrominance (C_b), and the red chrominance (C_r)

are then used to represent the video content where

$Y_s = 0.30\ R_s + 0.59\ G_s + 0.11\ B_s$

$U = (B_s - Y_s) \times 0.493$

$V = (R_s - Y_s) \times 0.877$

4.1. Basic Video Concepts: Representation and Format

2) Transmission (cont..)

iii.YIQ signal

This model is very much similar to YUV model and is used in NTSC system. The image information is broken down into three components a luminance component and two chrominance component given by following relation.

$$Y = 0.30\ R_s + 0.59\ G_s + 0.11\ B_s$$

$$I = 0.60\ R_s - 0.28\ G_s + 0.32\ B_s$$

$$Q = 0.21\ R_s + 0.52\ G_s + 0.31\ B_s$$

4.1. Basic Video Concepts: Representation and Format

2) Transmission(cont..)

iv. Composite signal

The alternative to component coding composes all information into one signal; consequently, the individual components (RGB, YUV, and YIQ) must be combined into one signal.

The basic information consists of luminance information and chrominance difference signals.

4.1. Basic Video Concepts: Representation and Format

3) Digitalization

Digitalization is a **process of changing the continuously varying signal into discrete components.**

This basically uses mathematical process like ***Fourier analysis*** or a series of step consisting of sampling and quantizing.

Sampling is the process that actually digitizes the spatial position of the image while quantizing digitizes its color information.

Sampling involves dividing the picture at **M*N array** of points while quantizing involves dividing the signal into a range of gray level values.

Finally the digital motion video is created by digitizing the pictures temporally.

4.1. Basic Video Concepts: Representation and Format

Computer Video Format

Computer video format depends on the input and output devices for the motion video medium

- ✓ Current video digitizers differ in digital image resolution, quantization and frame rate
- ✓ Most often used display is raster display
- ✓ The raster display architecture (as shown below)

4.1. Basic Video Concepts: Representation and Format

Some computer video controller standards **(Computer Video Formats)** are given below:

Color Graphics Adapter (CGA)

Resolution: 320*200

Color depth: 2 bits/pixel

Image size: 16 KB

No. of colors: 4

Storage Capacity: 320*200*4/8=16,000 bytes

Enhanced Graphics Adapter (EGA)

Resolution: 640*350

Color depth: 4 bits/pixel

Image size: 112 KB

No. of colors: 16

Storage Capacity: 640*480*4/8=112,000 bytes

4.1. Basic Video Concepts: Representation and Format

Video Graphics Array (VGA)

Resolution: 649*480

Color depth: 8 bits/pixel

Image size: 307.2 KB

No. of colors: 256

Storage Capacity: 640*480*8/8=307,200 bytes

8514/A Display Adapter Mode

Resolution: 1024*768

No. of colors: 256

Storage Capacity: 1024*768*8/8=786,432 bytes

4.1. Basic Video Concepts: Representation and Format

Extended Graphics Array (XGA)

Resolution: 640*480 / 1024*768

Color depth: 65,000 colors / 256

colors No. of colors: 256

Storage Capacity: 1024*768*8/8=786,432 bytes

Super VGA (SVGA)

Resolution: 1024*768

Color depth: 24 bits/pixel

Image size: 2.35 MB

No. of colors: 2^{24}

Storage Capacity: 1024*768*24/8=2,359,296 bytes

4.2. Television

Television

Conventional Systems

Conventional television systems employ the following standards:

- NTSC
- SECAM
- PAL

4.2. Television

NTSC

- National Television Systems Committee
- Developed in the U.S.
- Oldest and most widely used television standard
- Color carrier is used with approximately 4.429 MHz or with approximately 3.57 MHz.
- Uses a quadrature amplitude modulation with a suppressed color carrier
- Works with a motion frequency of approximately 30 Hz
- A picture consists of 525 lines
- 4.2 MHz is used for the luminance and 1.5 MHz is used for each of the two chrominance channels.

4.2. Television

NTSC

N T S C National Television System Committee	
Lines/Field	525/60
Horizontal Frequency	15.734 kHz
Vertical Frequency	60 Hz
Color Subcarrier Frequency	3.579545 MHz
Video Bandwidth	4.2 MHz
Sound Carrier	4.5 MHz

4.2. Television

SECAM

- **SE**quential **C**ouleur **A**vec **M**emoire
- Used in France and Eastern Europe
- Unlike NTSC and PAL, it is based on frequency modulation
- Uses a motion frequency of 25 Hz
- Each picture has 625 lines

SECAM **S**equential **C**ouleur **A**vec **M**emoire *or* **S**equential **C**olor with **M**emory		
SYSTEM	**SECAM B,G,H**	**SECAM D,K,K1,L**
Line/Field	625/50	625/50
Horizontal Frequency	15.625 kHz	15.625 kHz
Vertical Frequency	50 Hz	50 Hz
Video Bandwidth	5.0 MHz	6.0 MHz
Sound Carrier	5.5 MHz	6.5 MHz

4.2. Television

PAL

- Phase Alternating Line
- Invented in 1963 by W. Bruch
- Used in parts of Western Europe
- Uses a quadrature amplitude modulation similar to NTSC, but the color carrier is not suppressed

P A L Phase Alternating Line			
SYSTEM	**PAL**	**PAL N**	**PAL M**
Line/Field	625/50	625/50	525/60
Horizontal Freq.	15.625 kHz	15.625 kHz	15.750 kHz
Vertical Freq.	50 Hz	50 Hz	60 Hz
Color Sub Carrier	4.433618 MHz	3.582056 MHz	3.575611 MHz
Video Bandwidth	5.0 MHz	4.2 MHz	4.2 MHz
Sound Carrier	5.5 MHz	4.5 MHz	4.5 MHz

4.2. Television

High Definition Television

The formats used in HDTV are:

- **720p** - 1280x720 pixels progressive
- **1080i** - 1920x1080 pixels interlaced
- **1080p** - 1920x1080 pixels progressive

HDTV is high-resolution digital television (DTV) combined with Dolby Digital surround sound (AC- 3).
HDTV is the highest DTV resolution in the new set of standards. This combination creates a stunning image with stunning sound. **HDTV** requires new production and transmission equipment at the **HDTV stations**, as well as new equipment for reception by the consumer. The higher resolution picture is the main selling point for HDTV.

4.2. Television

High Definition Television

High-Definition Television (HDTV) is defined by the image it presents to its viewer, which has the following characteristics:

Resolution

The HDTV image has approximately twice as many horizontal and vertical pixels as conventional systems. Luminance detail is also increased by employing a video bandwidth approximately five times that used in conventional systems.

Aspect Ratio

The aspect ratio of the HDTV images is 16/9 = 1.777.

Viewing Distance

Since the eye‟s ability to distinguish details is limited, the more detailed HDTV image should be viewed closer than conventional systems.

INTRODUCTION TO VIRTUAL REALITY(VR) AND ANIMATION

Virtual Reality(VR)

Virtual Reality(VR)

- **Virtual reality** or **virtual realities** (**VR**), also known as **immersive multimedia** or **computer-simulated reality**, is a computer technology that replicates an environment, real or imagined, and simulates a user's physical presence and environment to allow for user interaction. Virtual realities artificially create sensory experience, which can include sight, touch, hearing, and smell.
- Most up-to-date virtual realities are displayed either on a computer monitor or with a virtual reality headset (also called **head mounted display**)
- Some simulations include additional sensory information and focus on real sound through speakers or headphones targeted towards VR users

Why Virtual Reality(VR) ?

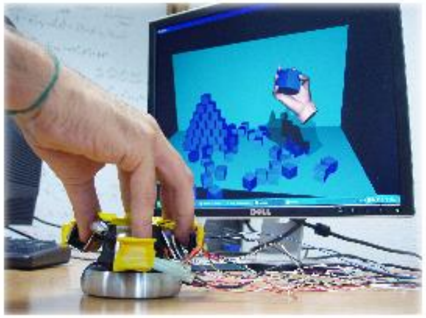
- VR is able to immerse you in a computer-generated world of your own making: a room, a city, the interior of human body. With VR, you can explore any uncharted territory of the human imagination.

Types of VR(Virtual Reality)

1. Windows on World(WoW) (also called Desktop VR)
2. Immersive VR
3. Telepresence
4. Mixed Reality(Augmented Reality)
5. Distributed VR

Types of VR(Virtual Reality)..

- Windows on World(WoW)
  - Also called Desktop VR.
  - Using a conventional computer monitor to display the 3D virtual world.

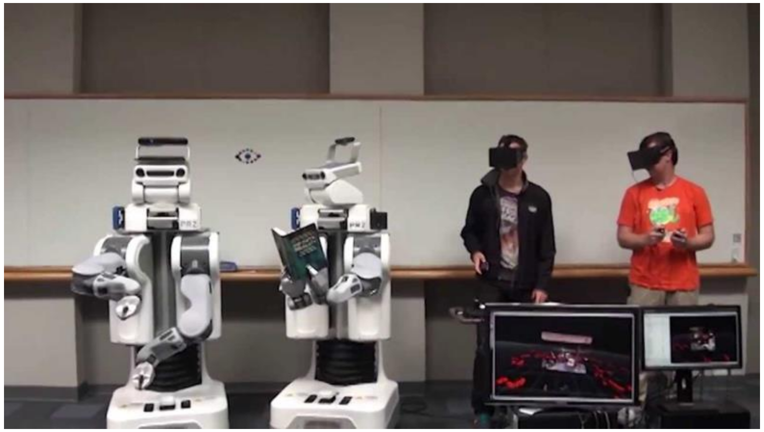


Types of VR(Virtual Reality)..

- Immersive VR
  - Completely immerse the user's personal viewpoint inside the virtual 3D world.
  - The user has no visual contact with the physical word.
  - Often equipped with a Head Mounted Display (HMD).

Types of VR(Virtual Reality)..

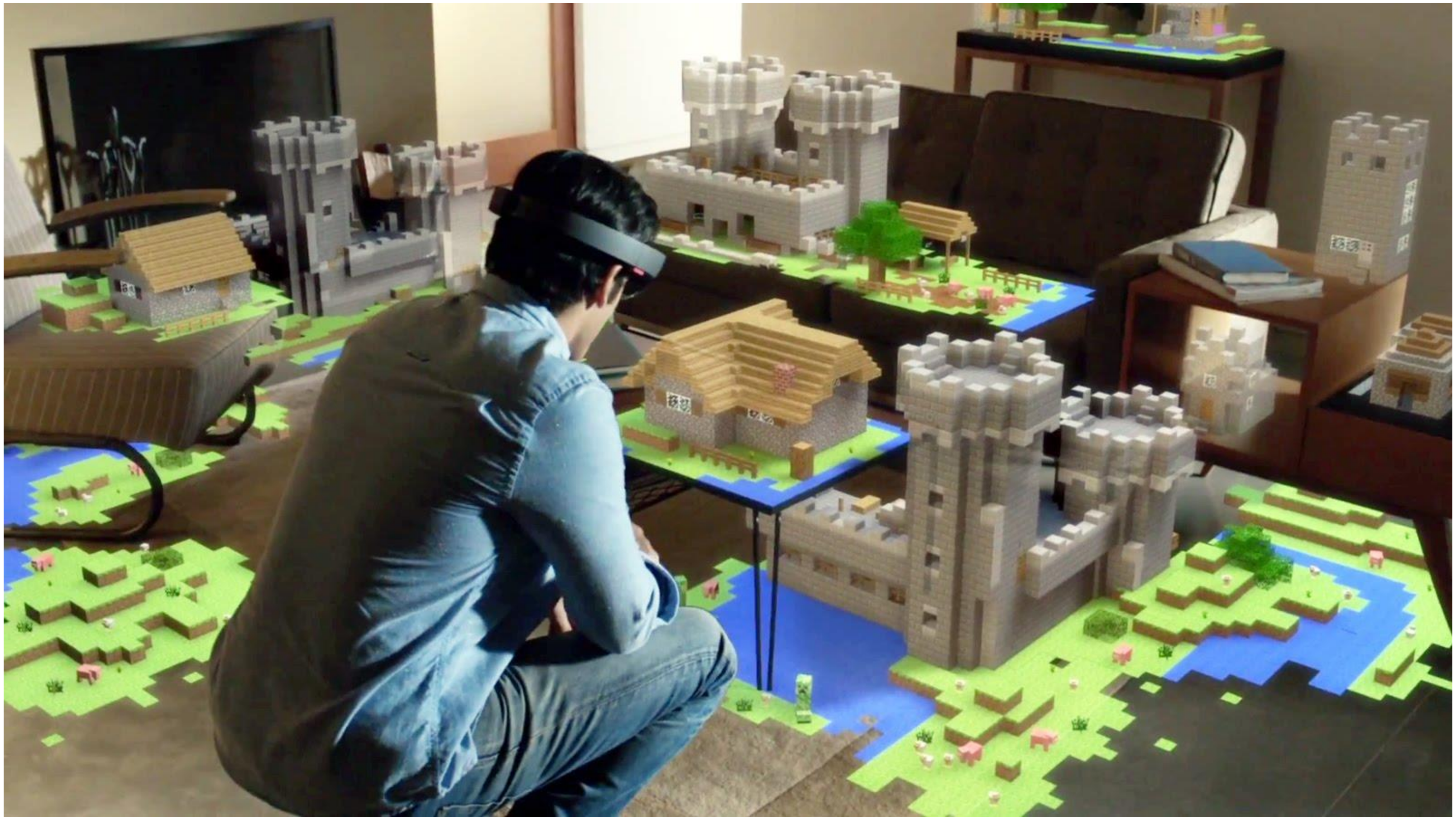
- Telepresence
  - A variation of visualizing complete computer generated worlds.
  - Links remote sensors in the real world with the senses of a human operator. The remote sensors might be located on a robot. Useful for performing operations in dangerous environments.



Types of VR(Virtual Reality)…

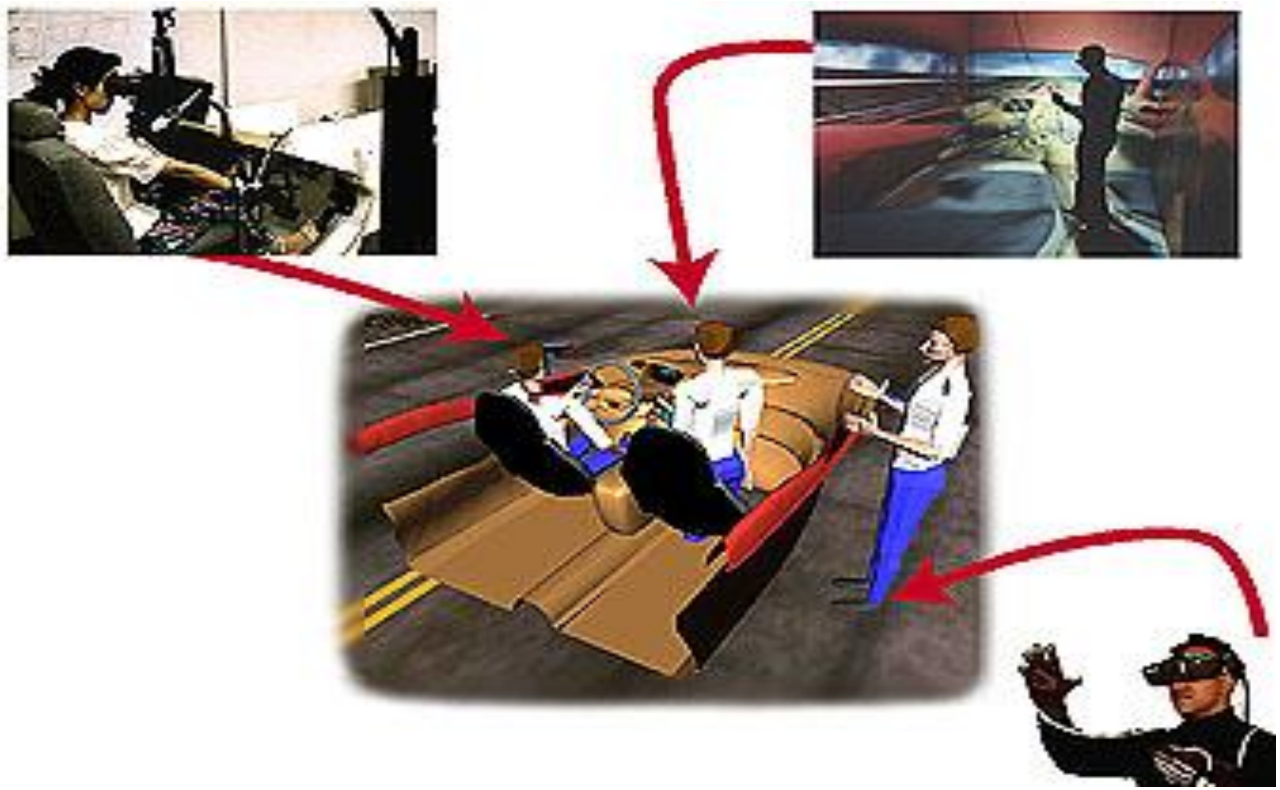
- Mixed Reality(Augmented Reality)
  - The seamless merging of real space and virtual space.
  - Integrate the computer-generated virtual objects into the physical world which become in a sense an equal part of our natural environment.

Augmented VR



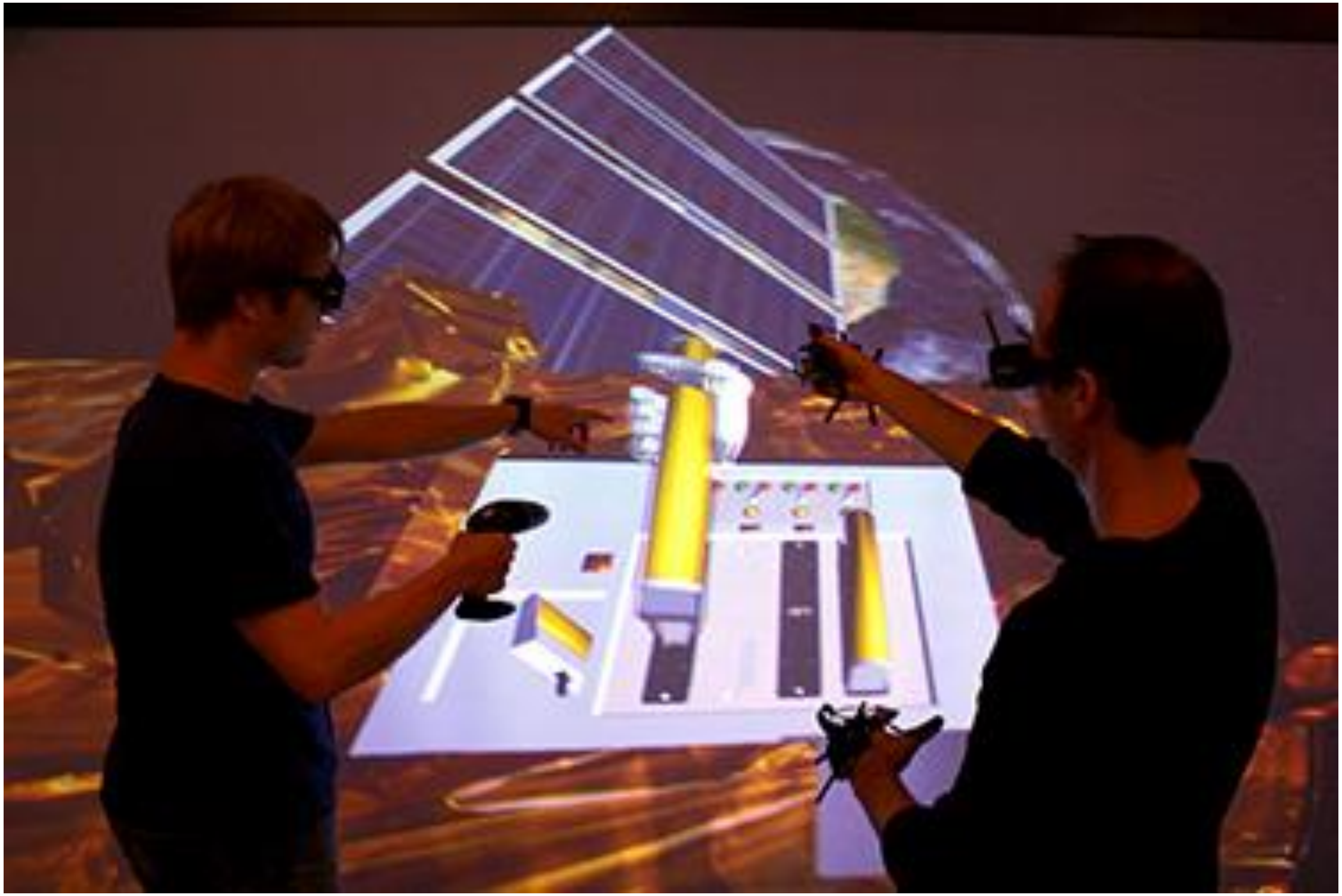
Types of VR(Virtual Reality)…

- Distributed VR
  - A simulated world runs on several computers which are connected over network and the people are able to interact in real time, sharing the same virtual world.



Distributed VR

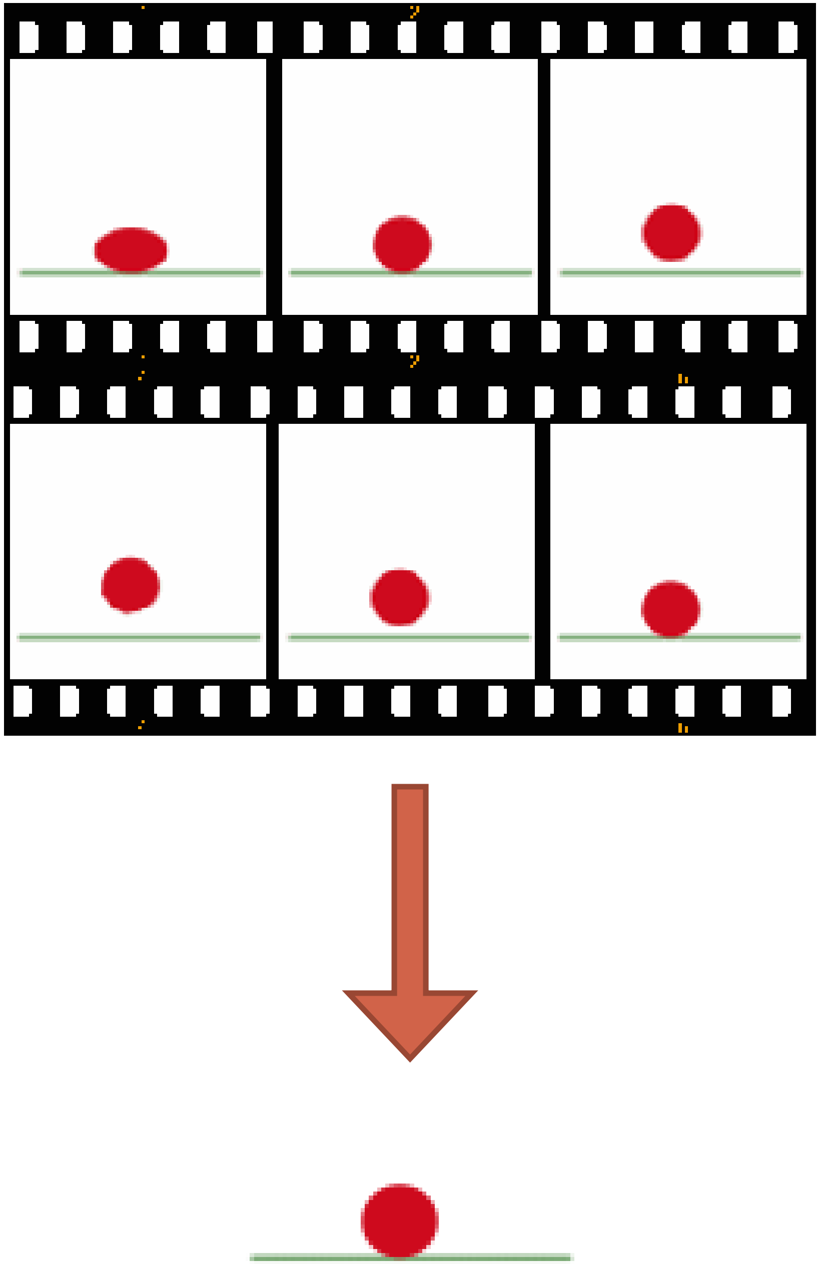
Distributed VR



4.3.ANIMATION

Introduction

- **Animation** is the process of making the illusion of motion and change by means of the rapid display of a sequence of static images that minimally differ from each other. The illusion—as in motion pictures in general—is thought to rely on the phenomenon. Animators are artists who specialize in the creation of animation.
- Animation is the creation of the “illusion of movement” using a series of still images.
- A collection of static image joined together and shown consecutively so that appear to move.



Introduction ….

- Animation creation methods include the traditional animation creation method and those involving stop motion animation of two and three-dimensional objects, paper cutouts, puppets and clay figures. Images are displayed in a rapid succession, usually 24, 25, 30, or 60 frames per second.

Introduction ….

to animate = "to bring to life"

Animation **covers changes in:**

time-varying positions (motion dynamics),

shape, color, transparency, structure and texture of an object (update dynamics) as well as lightning, camera position, camera orientation and focus.

Basic Concepts **of animation are:**

Input Process

- Key frames, where animated objects are at extreme or characteristic positions must be digitized from drawings.
- Often a post-processing by a computer is required.

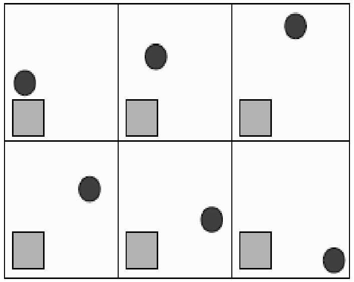
Composition Stage

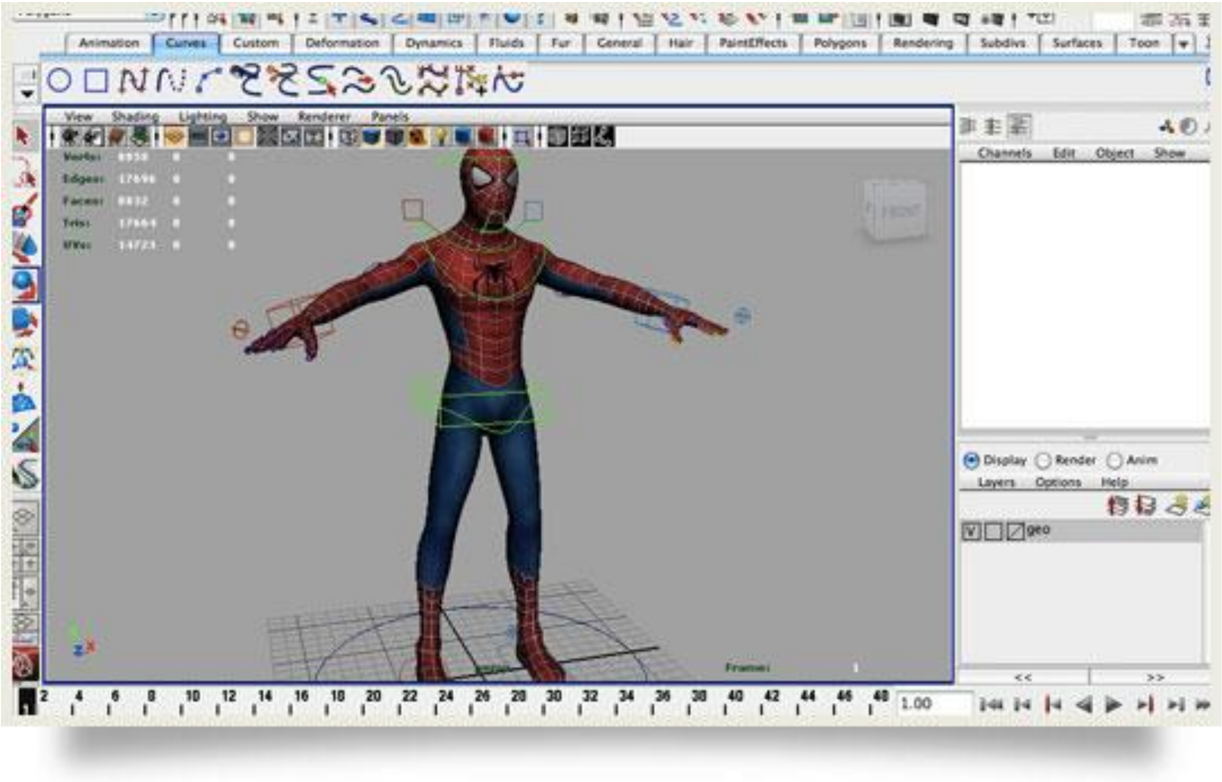
Foreground and background figures are combined to generate an individual frame.

Placing of several low-resolution frames of an animation in an array leads to a *trail film* (pencil test), by the use of the *pan-zoom* feature (This feature is available for some frame buffers).

The frame buffer can take a part of an image (pan) and enlarge it to full screen (zoom).

Continuity is achieved by repeating the pan-zoom process fast enough.



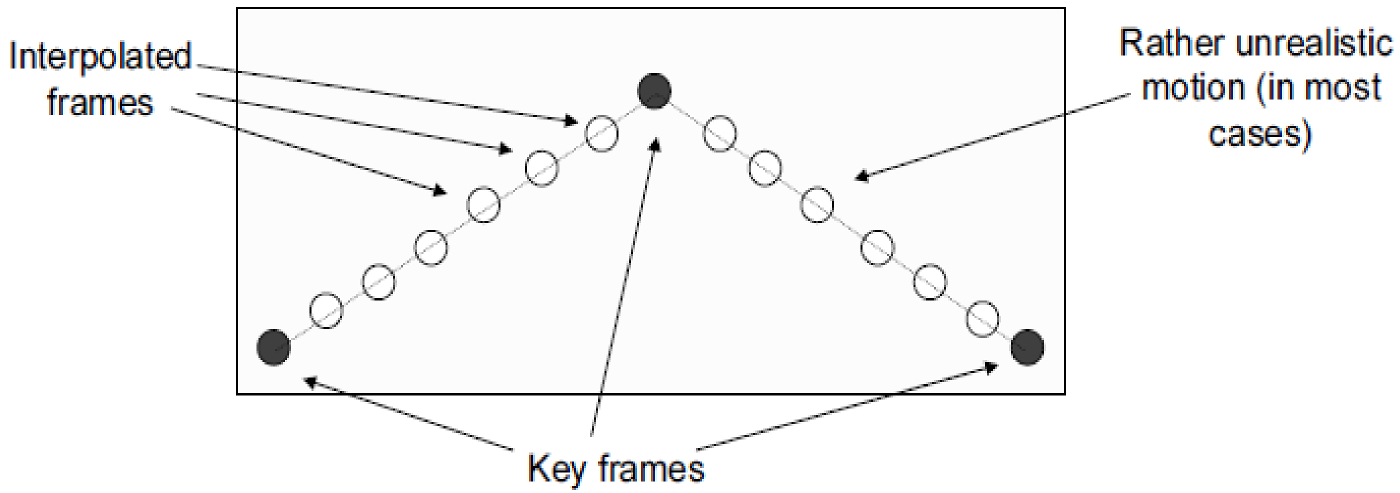


In-between Process

Composition of intermediate frames between key frames.

Performed by linear interpolation (lerping) between start- and end-positions.

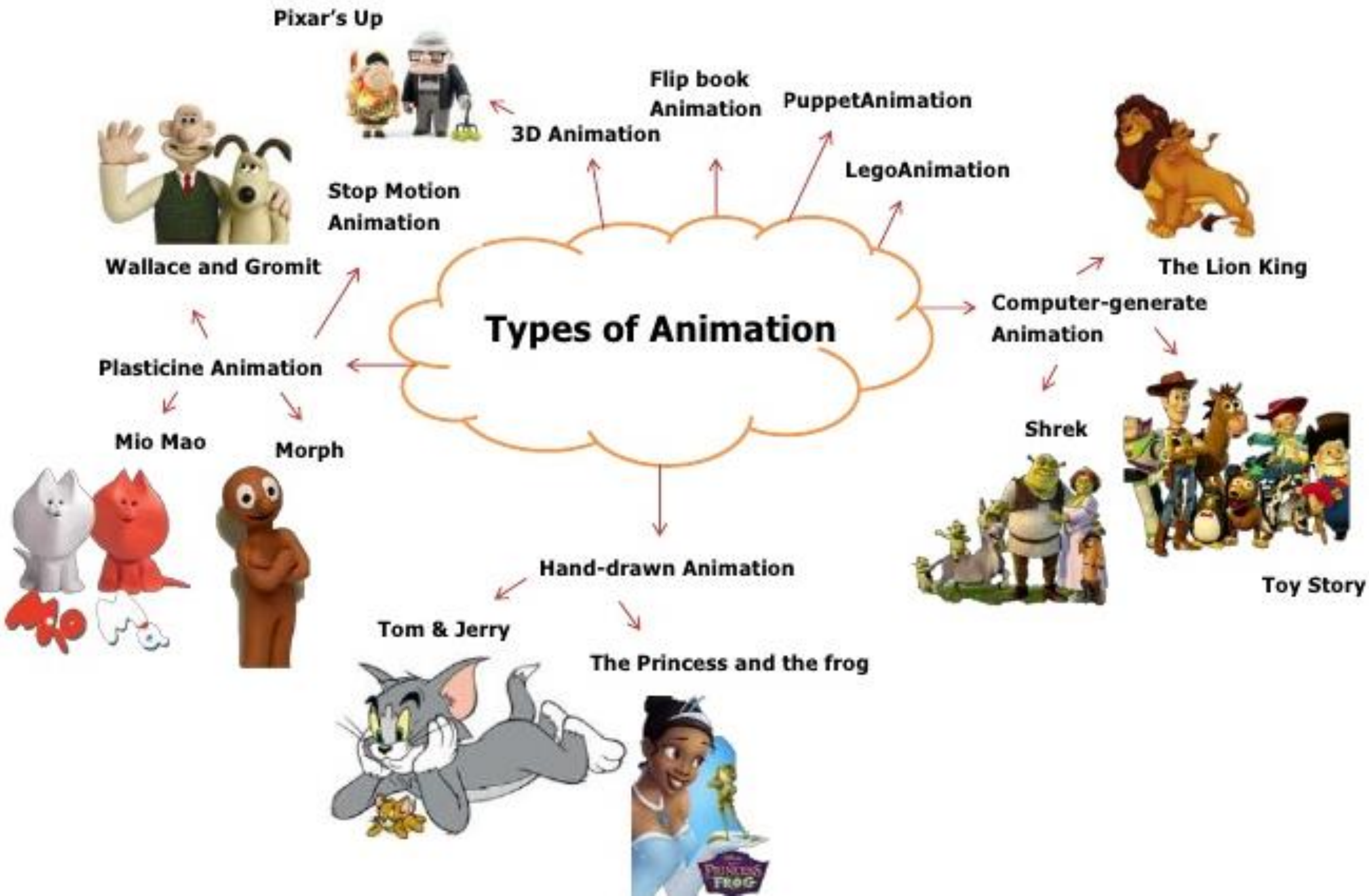
To achieve more realistic results, cubic spline-interpolation can be used.



Types of Animation

- Hand Drawn Animation
- Stop Motion Animation
- Computer animation

Types

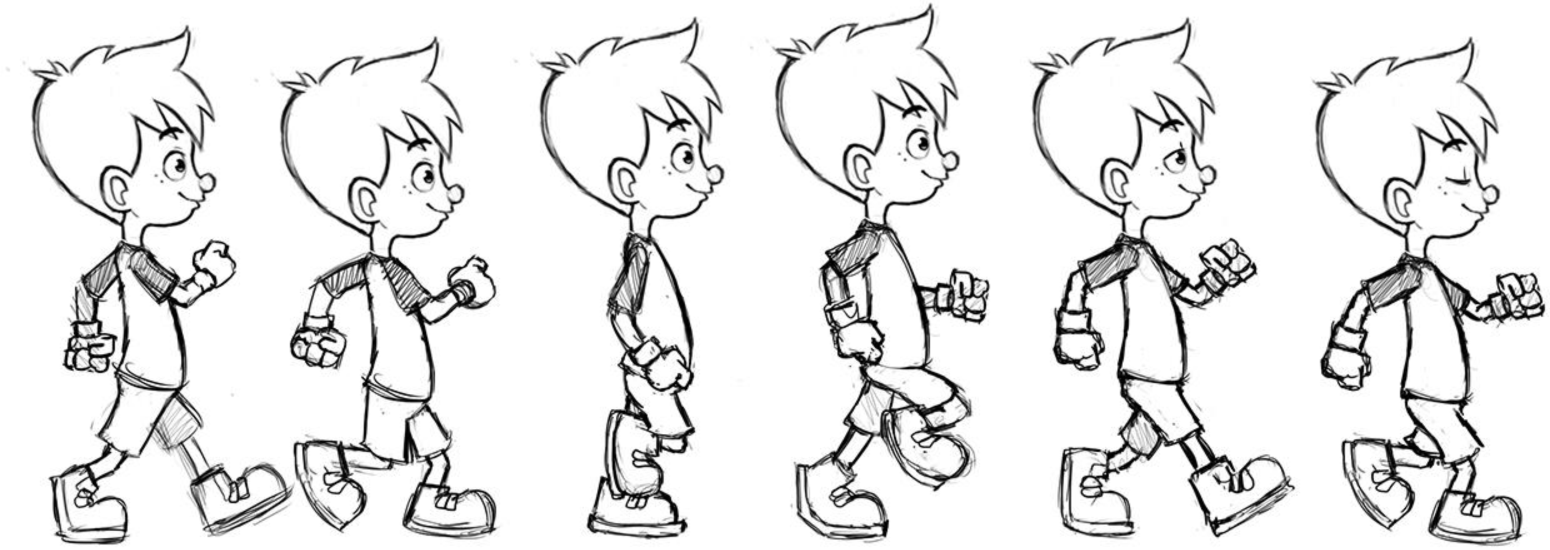

Types of Animation
Pixar's Up
3D Animation
Flip book Animation
PuppetAnimation
LegoAnimation
Stop Motion Animation
Wallace and Gromit
The Lion King
Computer-generate Animation
Plasticine Animation
Mio Mao
Morph
Shrek
Toy Story
Hand-drawn Animation
Tom & Jerry
The Princess and the frog

Hand Drawn Animation

- Done by an artist who draws each character and movement individually
- Very time consuming to have to draw, then color, then photograph each picture
- Draw pictures first, then color them on celluloid, then they pictures and animate them
- Very expensive due to hours of labor involved
- Examples: older Disney Movies i.e. Bambi, Fox and Hound, Cinderella etc.

Hand Drawn Animation

Hand Drawn Animation



Stop Motion Animation

- Can be done by virtually anyone, with no extensive training
- Does not take that much time relative to the other 2 methods
- Uses jointed figures or clay figures that can be moved to make motions
- Take still pictures of the individual movements, then use relatively inexpensive computer software to animate
- We use Movie Maker Software to complete our animations
- Not very expensive because all you need is a digital camera and the software comes with windows XP operating system
- Examples: star wars, robot chicken, old Rudolph the red Nosed Reindeer.

Stop Motion Animation

Stop Motion Animation

Computer Animation

- All characters and movements are generated using computer animation software
- Can also be very time consuming as they can get very complicated in movements and effects
- All characters are fully animated with no still pictures
- Can be very expensive because of the complexity of the stunts and animation being done
- Huge budgets because the animation sequences more complicated these days eg. The war scenes in Lord of the Rings etc.
- Examples: Toy story , finding Nemo, Matrix, Lord of the Rings

Basic Step Of Animation

1. Shooting reference video
2. Key posing
3. Blocking
4. Splining
5. Smoothing
6. Adding life

1. Shooting Reference Video

- This is a very important and **overlooked** step. It's weird how people really think they know what certain actions look like and how long they take, but in reality they are often wrong.
- Physical actions is something you **need to analyze** before animating, especially if you're a beginner.
- You have a shot of a guy throwing a baseball? Better YouTube some reference video of pitchers throwing balls. Don't assume you know what an action looks like just because you've seen it before. Looking at an action as an **animator** is completely different than looking at it as a regular viewer.

2. Posing

- After shooting a reference, it's time to create the key poses of the shot.
- These poses are called key poses because they are the most important poses of the shot. These are the poses that convey the story of the shot. We better make sure we **get those poses right**, because we're going to build on those for the rest of the process.

3. Blocking

- Once we’re happy with our key poses, we start **breaking down** the movement from each pose to the next by adding ‘in between’ (also known as breakdown poses or passing poses). These are the poses that connect the key poses.
- We keep adding more poses until the movement looks as good as it could, while still staying in **stepped mode** (stepped mode is when you don’t allow interpolation between poses, which results in a very choppy/blocky motion).

4. Splining

- Splining is a 3D animation term. It’s the process in which you convert the interpolation of the keys from stepped to spline. In other words – you make the computer connect the movement between each of your poses, and that makes the movement **look smoother.**
- The problem is that the computer doesn’t do a very good job at interpolating. It only works with what it has. That’s why the better the blocking is – the better the splined version is going to look.

5. Smoothing and offset

- Now that all of our keys are on spline mode, we have to work on them. We need to clean up all the curves and make sure the movement looks smooth.
- It's also a good idea to **offset** some of the actions so it doesn't look so **'stop and start'**, as if the character is doing all the motion at once. By the end of this step your shot should look pretty solid and almost finished.

6. Adding life

- This step is the a lot of fun. We’ve already finished with the grunt work of animating and it’s time to add the fun stuff. In this step we add **small imperfections** that bring life to the character. Maybe an extra blink or a mouth twitch here and there. The difference between the last 2 steps is small but very noticeable.

Transmission of Animation:

One of the following two approaches may be used for the transmission of animation over computer networks:

- ***Symbolic Representation***
- ***Pixmap Representation***

Symbolic Representation

The symbolic representation (e.g. circle) of animation objects (e.g. ball) is transmitted together with the operation commands (e.g. roll the ball) performed on the object, and at the receiver side the animation is displayed.

The transmission time is short because the symbolic representation of an animated object is smaller in byte size than its pixmap representation. However, the display time at the receiver takes longer because the scan-converting operation has to be performed at the receiver side.

The transmission rate (bits/sec or bytes/sec) of animated objects depends on:

- ✓ The size of the symbolic representation structure, where the animated object is encoded,
- ✓ The size of the structure, where the operation command is encoded, and
- ✓ The number of animated objects and operation commands sent per second.

Pixmap Representation

The pixmap representation of the animated objects is transmitted and displayed on the receiver side.

The transmission time is longer in comparison to the previous because of the size of the pixmap representation. However, the display time is shorter because the scan-conversion of the animated objects is avoided at the receiver side.

It is performed at the sender side where animation objects and operation commands are generated. The transmission rate of the animation is equal to the size of the pixmap representation of an animated object (graphical image) multiplied by the number of graphical images per second.

Animation Uses

- Animated Movies: Million dollar industry;
- 1-20 millions spent on each movie
- Animation and computer graphics effects are used in movies frequently
- Video games
- TV programs(e.g. Weather, News)
- Used online (images, ads, chatting)
- Simulations (science and Engineering)
- Virtual Reality (e.g. second life)

Morphing

It is derived from the word metamorphosis, which means the transformation shape, appearance of one thing into another. The transformation of object shapes from one form to another is called morphing.

Also it can be defined as:

- Transition from one object to another.
- Process of transforming one image into another.

Morphing

Assignments:

1. What do you mean by computer based animation? List the different types of animation languages.
2. List three distinct models of color used in Multimedia. Explain why there are a number of different color models exploited in multimedia data formats.
3. Explain Tele-services and the implementation of Conversation services in Multimedia communication.
4. Explain the methods that are used to control animation.
5. Discuss the YUV model for video transmission.
6. How long will it take to transmit a ` minute long video of spatial resolution 640×480, 32 bits per pixel and 12 frames per second through a communication link at a constant rate of 56 K bits PS.
7. Describe the television standards.

Finished !!!!!