Video and Animation

Motion

- Both video and animation give us a sense of motion
- They exploit some properties of human eye's ability of viewing pictures
- Motion video is the element of multimedia that can hold the interest of viewers in a presentation

Visual Representation

- The visual effect of motion is due to a biological phenomenon known as *persistence of vision*
  - An object seen by the human eye remains mapped on the eye's retina for a brief time after viewing (approximately 25 ms)
- Another phenomenon contributing to the vision of motion is known as *phi phenomenon*
  - When two light sources are close by and they are illuminated in quick succession, what we see is not two lights but a single light moving between the two points

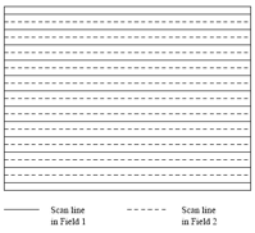
Visual Representation

- Due to the above two phenomena of our vision system, a discrete sequence of individual pictures can be perceived as a continuous sequence
- *Temporal aspect of Illumination* — To represent visual reality, two conditions must be met
  - the rate of repetition of the images must be high enough to guarantee smooth motion from frame to frame
  - the rate must be high enough so that the persistence of vision extends over the interval between flashes

Visual Representation

- The frequency at which the flicking light source must be repeated before it appears continuous is known as the *fusion frequency*
  - This depends on the brightness of the light source
  - The brighter the light source the higher the fusion frequency
- It is known that we perceive a continuous motion to happen at any frame rate faster than 15 frames per second
  - PAL television system has a frame rate of 25 frames/s
  - It will look jerky at this frame rate

Visual Representation



Broadcast television

- There are mainly three conventional broadcast television systems
- *NTSC*(National Television Systems Committee) developed in the U.S. and used in North and South America, Japan
  - A picture consists of 525 lines and frame rate is approximately 30Hz

Broadcast television

- *SECAM*(SEquential Couleur Avec Memoire) is a standard used in France and Eastern Europe
  - A picture consists of 625 lines and frame rate is 25Hz
- *PAL*(Phase Alternating Line) is used in most part of western Europe, most part of Asia (including China and Hong Kong) and other countries
  - A picture consists of 625 lines and frame rate is 25Hz

Video resolution

- The smallest detail that can be reproduced in the image is a pixel
- Practically, some of the scene inevitably fall between scanning lines, so that two lines are required for such picture elements
- Only about 70% of the vertical detail is presented by the scanning lines

Video resolution

- *Aspect ratio* is the ratio of the picture width to height. It is 4:3 for conventional TV
- The picture width, horizontal resolution and the total detail content of the image can be calculated

System	Total Lines	Active Lines	Vertical Resolution	Horizontal Resolution	Total Pixels
NTSC	525	484	242	330	106,000
PAL	625	575	290	425	165,000
SECAM	625	575	290	465	180,000

Video resolution

- Conventional video systems have relative low resolution
  - compare to computer screens: typical resolution of 640×480, even up to 1024×768
- One consequence of this low resolution is that video played on computer screen are usually in a small window

Video resolution

- On the other hand, even with this low resolution, the amount of data in video is huge

  Consider PAL TV at 25 frames per second, if we sample at 352×288 with 16 bits per pixel, the raw video size is

  $$352 \times 288 \times 16 \times 25 = 40.55\text{Mbit/s} = 5\text{Mbytes/s}$$

  - Compare this with a typical Ethernet bandwidth of 10Mbit/s
  - or a double speed CD-ROM drive of 300Kbyte/s
- Therefore, we need to compress the video data

Digitalising Video

- We need to *capture* or *digitise* video for playing back on computers or integrating into multimedia applications
- We need to take a lot of samples
  - At 25 frames per second, each frame requires $1/25 = 40ms$
  - There 625 scan lines in each frame, giving each scan line is $40ms/625 = 64\mu s$
  - At a horizontal resolution of 425 pixel, the time for sampling each pixel is $64\mu s/425 = 0.15\mu s$, i.e., sampling rate is at least 7Mhz

Digitalising Video

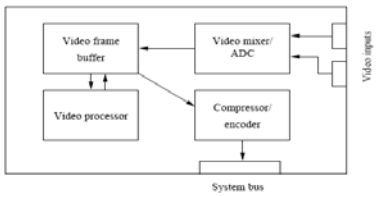
- This requires very fast hardware
- Hardware required to capture video:
  - Video sources: TV, VCR, LaserDisc player, Camcorder
  - Video capture card
  - Storage space: large hard disk

Video capture cards

- There are many different video capture cards on the market
- The common features in these cards are:
  - Can accept composite video or S-VHS in NTSC or PAL; high-end capture cards can accept digital video (DV)
  - Video input mixer and ADC — to select/combine video sources, to convert analog video signal to digital samples
  - Video frame buffer — temporary storage for video frame
  - Video processor — to filter or enhance the video frame, e.g., reduce noise, adjust brightness, contrast and colour

Video capture cards

- Compressor/encoder — to compress and encode the digita video into a required format
- Interface to the system PCI bus



Video formats

- AVI (Audio Video Interleaved) format was defined by Microsoft for its Video for Windows systems
  - It supports video playback at up to 30 frames per second on a small window (typical size 300×200 with 8 or 16 bit colour)
  - It is a software-only system
  - It supports a number of compression algorithms

Video formats

- QuickTime was originally developed by Apple for storing audio and video in Macintosh systems
  - It supports video playback at up to 30 frames per second on a small window (typical size 300×200 with 8 or 16 bit colour)
  - It is a software-only system
  - It supports a number of compression algorithms

- MPEG (Motion Picture Expect Group) is a working group under ISO
  - There are several versions of mpeg standard. The most commonly used now is mpeg-1
  - It requires hardware support for encoding and decoding (or slow systems)
  - The maximum data rate is 1.5Megabit/sec
  - The next generation mpeg-2 is now getting popular
  - Mpeg-2 improves mpeg-1 by increasing the maximum data rate to 15Mbit/sec
  - It can interleave audio and video

Animation

- To *animate* something is, literally, to bring it to life
- An animation covers all changes that have a visual effect
- Visual effect can be of two major kinds:
  - *motion dynamic* — time varying positions
  - *update dynamic* — time varying shape, colour, texture, or even lighting, camera position, etc.
- The visual effects is the result of exploiting the properties of human vision system as described above (in the section about video)
- A computer animation is an animation performed by a computer using graphical tools to provide visual effects

Input process

- The first step in producing computer animation is *input process*
- *Key frames* have to be created and input into the computer
- *Key frames* are the frames in which the objects being animated are at extreme or characteristic positions

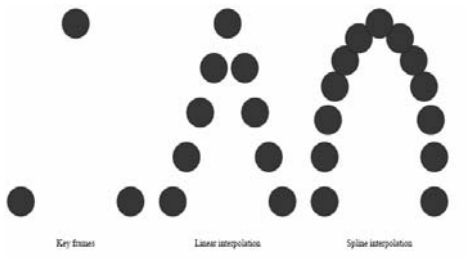
Input process

- They can be drawn using traditional artistic tools, such as pen and brush, and then digitised
  - The digital images may need to be cleaned up
- They can also be created using drawing or painting tools directly
- In *composition stage*, the foreground and background figures are combined to generate the individual frames

Inbetween process

- The animation of movement from one position to another needs a composition of frames with intermediate positions in between the key frames
- The process of *inbetweening* is performed in computer animation through *interpolation*
  - The system is given the starting and ending positions
  - It calculates the positions in between

Inbetween process



Interpolation

- The easiest interpolation is *linear* interpolation
  - It has many limitations: the object does no move smoothly, look unreal
- *Spline* interpolation can make object move more smoothly
- Inbetweening also involves interpolating the shapes of objects

Interpolation

- Some animation involves changing the colour of objects
  - This is usually done using colour look-up table(CLUT)
  - By cycling through the colours in the CLUT, the objects' colours will change
- *Morphing* is a popular effect in which one image transforms into another

Controlling animation

- Full explicit control — the animator provides a description of everything that occurs in the animation
  - either by specifying simple changes, such as scaling, transformation
  - or by providing key frames
- Procedural control — using a program to calculate the position, angle, etc. of the objects
  - In physical systems, the position of one object may influence the motion of another

Controlling animation

- Constraint-based systems — movement of objects that are in contact with each other is constraint by physical laws
  - An animation can be specified by these constraints
- Tracking live action —
  - People or animals act out the parts of the characters in the animation
  - The animator trace out the characters

- *Kinematics* refers to the position and velocity of points

  The ball is at the origin at time t = 0. It moves with a constant acceleration in the direction (1,1,5) thereafter.

  - The final result of an animation is the sum of all the steps. If it does not fit, the animator has to try again. This is known as *forward kinematics*.

Kinematics

- *Inverse kinematics (IK)* is concerned with moving a skeleton from one pose to another.
  - The animator specifies the required postition of the end effector, the IK algorithm will calculate the joint position, angle, etc.
- *Dynamics* takes into account the physical laws that govern the masses and forces acting on the objects

  The ball is at the origin at time t = 0 second. It has a mass of 200 grams. The force of gravity acts on it.

- **The rules governing the showing of video apply to animation as well**
- **The frame rate should be at least 10, preferably 15 to 20, to give a reasonably smooth effect**
- **There are basically three common ways to display animation**

The Steps

- **Generate a digital video clip**

  Many Animation tools will export an animation in common digital video format, e.g., QuickTime
- **Create a package including runtime system of the animation tool**

  For example, Director can create a projector including all casts. The projector can then be distributed and play the animation.
- **Show the animation in the animation tool**

Example Animation Tools

- **Macromedia Director and Flash**

  It is one of the most popular interactive animation tool for generating interactive multimedia applications
- **MetaCreations Poser**

  It understands human motion and inverse kinematics, e.g., move an arm the shoulders will follow.

Example Animation Tools

- **Discreet 3D Studio Max**

  Very popular for creating 3D animations
- **Animation language — VRML (Virtual Reality Modelling Language)**

EXERCISE

Briefly distinguish between the three analog video formats:

a) NTSC
b) SECAM
c) PAL

ANSWERS TO EXERCISE

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