
Video and Animation

Prof. S. Shakya

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**
- **Due to the above two phenomena of our vision system, a discrete sequence of individual pictures can be perceived as a continuous sequence**

Visual Representation

- ***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**
- **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**

Visual Representation

- **Another problem known as *flicker* occurs due to a periodic fluctuation of brightness perception**
- **A technique known as *interleaving* improves the view by**
 - **dividing a frame into two fields, each contains the alternative scan lines, and**
 - **displaying the field in twice of the frames rate**

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**
- ***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**

Video resolution

- **Conventional video systems have relative low resolution**
 - **compare to computer screens: typical resolution of**
 - **640 x 480, even up to 1024 X 768**
 - **One consequence of this low resolution is that video played on computer screen are usually in a small window**
 - **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 x 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 *digitize* 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 $1/25 = 40\text{ms}$
- There 625 scan lines in each frame, giving each scan line is $40\text{ms}/625 = 64\mu\text{s}$
- At a horizontal resolution of 425 pixel, the time for sampling each pixel is $64\mu\text{s}/425 = 0.15\mu\text{s}$, i.e., sampling rate is at least 7Mhz
- 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

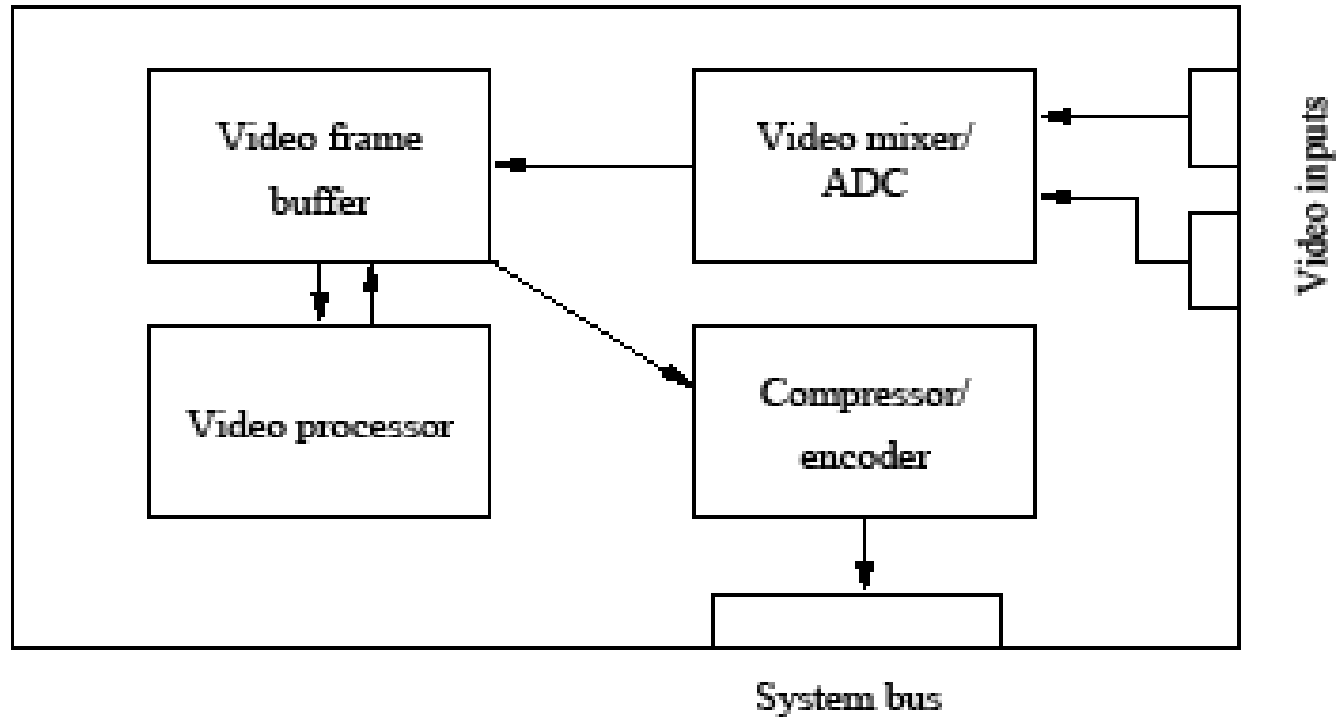
Video capture cards

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

Video capture cards



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 300X200 with 8 or 16 bit colour)**
- **It is a software-only system**
- **It supports a number of compression algorithms**
- **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 300X200 with 8 or 16 bit colour)**
- **It is a software-only system**
- **It supports a number of compression algorithms**

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
- 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

- The easiest interpolation is *linear* interpolation
- *It has many limitations: the object does not move smoothly, look unreal*
- *Spline* interpolation can make object move more smoothly
- Inbetweening also involves interpolating the shapes of objects
- 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*
- **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**

Controlling animation

- **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*.
- **Inverse kinematics (IK)** is concerned with moving a skeleton from one pose to another.
- *The animator specifies the required position 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.*

Displaying animation

- 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
 - **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**

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.*
- **Discreet 3D Studio Max**
- *Very popular for creating 3D animations*
- **Animation language—VRML (Virtual Reality Modeling Language)**

Video formats

MPEG (Motion Picture Expert 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 (on 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**