Unit 6
Computer Animation

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- **Introduction**
  - ✓ **Computer animation**, or **CGI animation**, is the process used for generating animated images.
  - ✓ Computer Generated Imagery encompasses both static scenes and dynamic images, while computer animation *only* refers to the moving images.

- **Definition**
  - ✓ **Animation** is the process of making the illusion of motion by means of the rapid display of a sequence of static images that minimally differ from each other.
  - ✓ Animation can be recorded with either
    - **Analogue media -** a flip book, motion picture film, video tape,
    - **Digital media -** including formats withanimated GIF, Flash animation and digital video.
    - To display animation, a digital camera, computer, or projector are used along with new technologies that are produced.

- **Key-Frame Animation**
  - ✓ A **key frame** in **animation** and filmmaking is a drawing that defines the starting and ending points of any smooth transition.
  - ✓ The drawings are called "**frames**" because their position in time is measured in **frames** on a strip of film.
  - ✓ Key frames are important frames during which an object changes its size, direction, shape or other properties.
  - ✓ A sequence of key frames defines which movement the viewer will see
  - ✓ The position of the key frames on the film, video, or animation defines the timing of the movement
  - ✓ Since, only two or three key frames over the span of a second do not create the illusion of movement, the remaining frames are filled with inbetweens.
- **CONSTRUCTION OF AN ANIMATION SEQUENCE**

  Generally, an animation sequence is obtained using:
  1. **Storyline or Story board layout**
  2. **Object definitions**
  3. **Key frame specification**
  4. **Generation of in between frames or Twinning**
- Most animations are frame by frame where each frame of the scene is independently generated & stored for later processing or displayed in real-time playback

- **STORYLINE OR STORY BOARD LAYOUT**
  1. It is an **outline or sketch out** of action defines the motion sequence as a set of basic events that are to take place.
- **Object definitions**
  1. An **object** is an participant in an action that can have some properties and have relationships with other objects.
  2. An **object definition** is given to each participant in the action defined
  3. Objects can be defined in terms of **basic shapes,** such as polygon or splines.
  4. In addition, the **associated movements** for each
  5. object are specified along with the shape
- **Key frame specification**
  1. A **key frame** is a detailed drawing of the scene at a certain time in the animation sequence.
  2. Within each key frame, each object is positioned according to the time for that frame.
  3. Some key frames are chosen at extreme positions in the action, other are spaced so that the time interval between key frames is not too great.
  4. More key frames are specified for intricate motions than for simple slowly varying motions.
- **Generation of in between frames or Twinning**
  1. Twinning is short for in-betweening
  2. It is a process of generating intermediate frames between the key frames.
  3. This gives appearance that the first frame evolves smoothly into second one
  4. In-betweens are drawings between key frames that help create the illusion of motion.
  5. The number of in between frames needed is determined by the media to be used to display the animation.
  6. **Film** requires 24 frames per second, and **graphic terminals** are refreshed at the rate of 30 to 60 frames per second.

- **Motion Control Methods(MCM)**
  - ✓ The key issue of Computer Animation is the way of defining motion, commonly known as **Motion Control Methods(MCMs)**.
  - ✓ An MCM specifies how an object is animated.
  - ✓ MCMs may be classified based on the nature of the information which is directly manipulated: geometric, physical, or behavioral
- **Types of MCM**
  1. **Methods based on Geometric and Kinematics information**
  2. **Methods based on Physical information**
  3. **Methods based on Behavioral information**

- **Methods based on Geometric and Kinematics information**
  1. These methods are heavily relied upon an **animator**.
  2. Motion is locally controlled and defined in terms of coordinates, angles, velocities, or accelerations.
  3. The **Performance Animation** which consists in magnetic or optical measurement and recording of direct actions of a real person for immediate or delayed playback.
  4. The technique is especially used today in production environments for 3D character animation.

5. **Key frame animation** is still another popular technique in which the animator explicitly specifies the kinematics by supplying keyframes values whose "in-between" frames are interpolated by the computer.
6. **Inverse kinematics** is a technique coming from robotics, where the motion of links of a chain is computed from the end link trajectory.
7. **Image Morphing** is a warping-based technique which interpolates the features between two images to obtain a natural in between image. For geometric deformations, multi-layered models are particularly useful for modeling 3D characters.

- **Methods based on Physical information**
  1. In these methods, the animator provides physical data and the motion is obtained by solving the dynamic equations.
  2. Motion is globally controlled.
  3. We may distinguish methods based on parameter adjustment and constraint-based methods, where the animator states in terms of constraints the properties the model is supposed to have, without needing to adjust parameters.

- **Methods based on Behavioral information**
  - ✓ A behavioral motion control method consists of driving the behavior of autonomous creatures by providing high-level directives indicating a specific behavior without any other stimulus.
  - ✓ Ex. Distributed behavioral model to simulate flock of birds.
  - ✓ Relationships of different objects are taken into account.

- **Procedural Animation**
  - ✓ Procedural animation corresponds to the creation of a motion by a procedure describing specifically the motion.
  - ✓ Procedural animation should be used when the motion can be described by an algorithm or a formula.
  - ✓ For example, consider the case of a clock based on the pendulum law.

Example

```
create CLOCK (...);
for FRAME:=1 to NB_FRAMES
TIME:=TIME+1/24;
ANGLE:=A*SIN (OMEGA*TIME+PHI);
MODIFY (CLOCK, ANGLE);
draw CLOCK;
record CLOCK
erase CLOCK
```

- **Key-Frame Animation vs. Procedural Animation**
  - › In a **procedural animation** objects are animated by a procedure -- a set of rules -- not by key framing.
  - › The animator specifies rules and initial conditions and runs simulation.
  - › Rules are often based on physical rules of the real world expressed by mathematical equations.
  - › **Key-Frame Animation -** the animator creates the behavior of a model manually
  - › The animator has direct control over the positions, shapes, and motions of models at any moment in the animation.

- On the other hand, to produce a procedural animation the animator provides initial conditions and adjusts rather abstract physical parameters, such as forces and torques, in order to control positions, shapes, and motions of models.
- The effect of changing a parameter value is often unpredictable in procedural animation.
- The animator has to run a simulation to see the result.

- **Introduction to Morphing**
  - Morphing is a special effect
  - It smoothly transforms one picture or object into another
  - Image morphing means creating a sequence of images which when played in sequence, show one image being slowly changed into another image.
  - Intermediate images that bridge the transition are calculated from the source and destination images using mathematical formula. Techniques used are : Mesh and field morphing
  - Morphing is a combination of
    - **Cross-dissolving changes the image's color pixel by pixel**
    - **Warping - changes the shape of image by moving the pixels around**