
Animations

Animations

Computer animation generally refers to any time sequence of visual changes in a scene.

Computer generated animation could display time variations in

- object size, color, transparency or surface texture.

Computer animations can be generated by changing

- camera parameters, such as position, orientation and focal length.

Computer animations are produced by changing

- lighting effects or other parameters
- procedures associated with illumination and rendering.

Design of Animation Sequences

Animation sequence is designed with the following steps.

- Storyboard Layout
- Object Definitions
- Key-Frame specifications
- Generation of in-between frames.

1. Storyboard Layout

- Outline of the action.
- Defines the set of basic events that are to take place.
- Story board consists of rough sketches or basic ideas for motion.
- Storyboard is divided into scene segments.
- Animators and Mentors decide which segments each animator will work on.
- Segments are reviewed and revised.
- Dialog is created based on storyboard and segments.



2.Object Definition

Object definition is given for each participant in the action.

In simple manual systems, the objects can be simply the artist drawings

In computer-generated animations, models are used

Objects can be defined with basic shapes such as polygons or splines.

The associated movements along with the shape are also specified.

Examples of models:

- a "flying logo" in a TV ad
- a walking stick-man

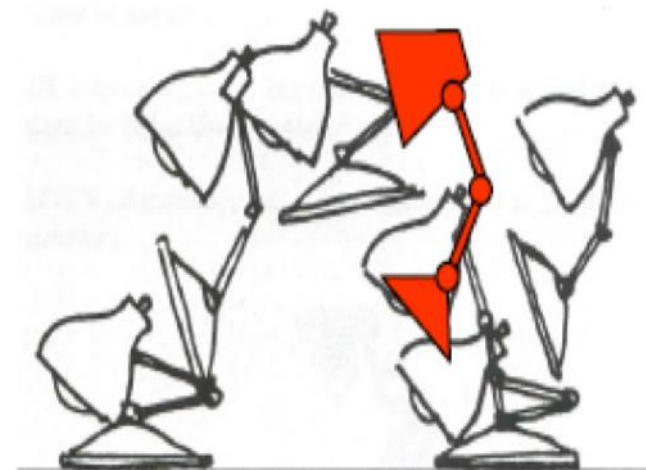
3.Key Frame Specifications

Define character poses at specific time steps called “keyframes”

Some key frames are chosen at extreme or characteristic positions in the action.

Others are spaced so that the time interval between key frames is not too large.

More key frames are specified for intricate motions than for simple and slowly varying motions.



4.In-Between Frames

They are intermediate frames between the key frames.

Interpolate variables describing keyframes to determine poses for character “in-between”.

Interpolation is either be linear interpolation, spline interpolation or cubic spline interpolation.

The process of generating in-betweens is called in-betweening.

The number of in-betweens needed is determined by the media to be used to display the animation.

- Film requires 24 frames per second and graphics terminals are refreshed at a rate of 30 to 60 frames per second.

Time intervals for motion are setup so that there are from 3 to 5 in-betweens for each pair of key frames.

Depending upon the speed specified for the motion, some key frames can be duplicated.

Animation Systems

Raster animation systems : Use a sequence of raster operations to produce real-time animation of 2-D or 3-D objects.

Key-frame systems: Designed to generate the in-betweens from the user specified key frames using interpolation.

Parameterized systems :

- Allow object-motion characteristics to be specified as part of the object definitions.
- These characteristics are controlled by adjustable parameters: degrees of freedom, motion limitations, and allowable shape changes.

Scripting systems: object specifications and animation sequences to be defined with user-input script

Raster Animation Systems

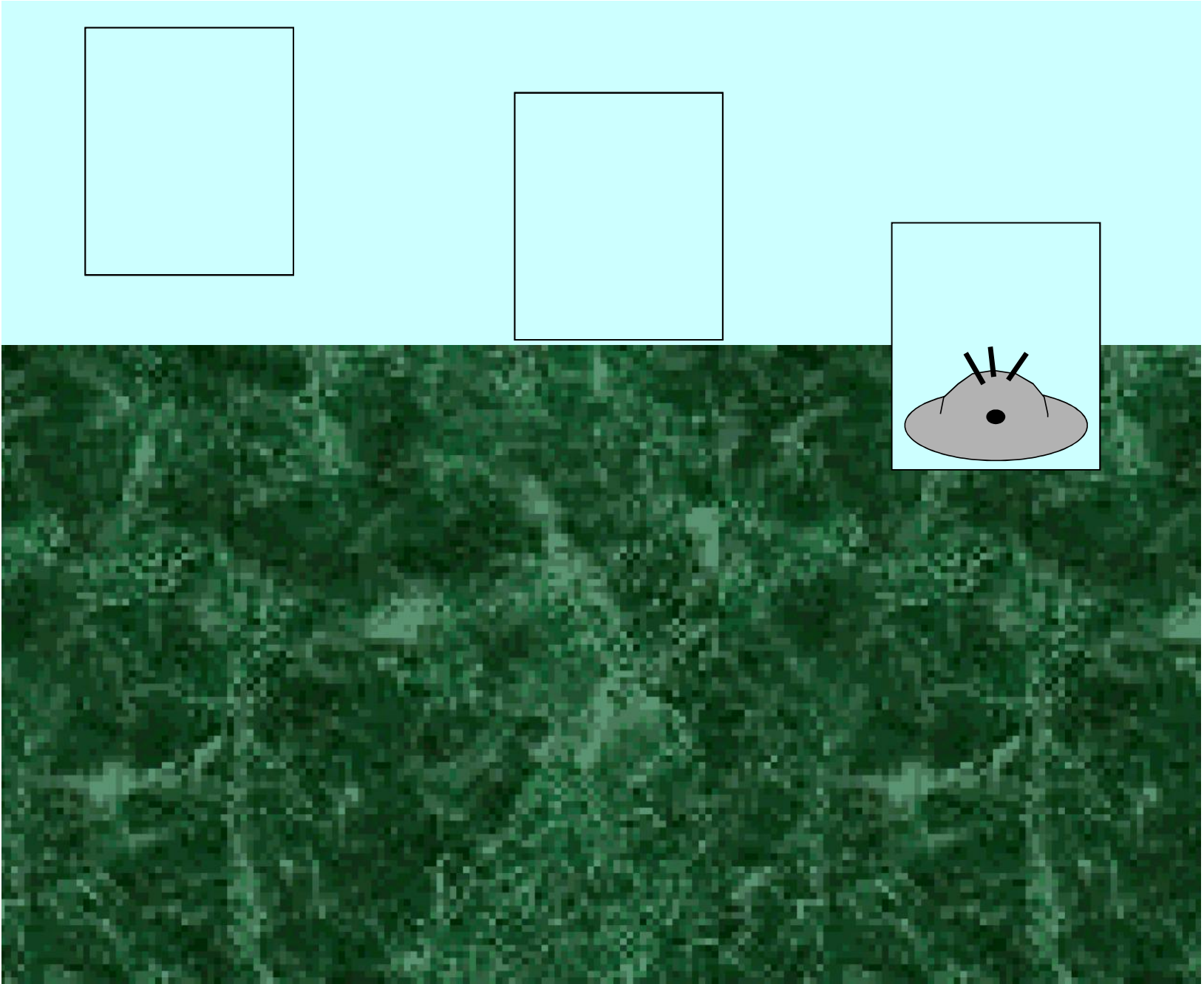
Real time animations are generated for limited applications using raster operations.

Animation done using raster operations or colour-table transformations.

Raster based animation frames are made up of individual pixels. These pixels each contain information about the colour and brightness of that particular spot on the image

Color Table Transformations:

- Predefine the objects at successive positions along the motion-path and set the successive block of pixel values to color-table entries.
- Set the pixels at the first position of the object to “on” values and set the pixels at other positions to the background color.
- Animation is accomplished by changing the color-table values so that the object is “on” at successive positions of the motion path as the preceding position is set to background intensity



Key-frame systems

From the specified two or more key frames, the key-frame systems generate sets of in-betweens.

Motion paths, can be

- given with a kinematical description as a set of spline curves.
- physically based by specifying the forces acting on the objects to be animated.

Given the animation paths, we can interpolate the position of individual objects between any two times.

With the application of complex object transformations, the shapes of objects may change over time. Eg: clothes, facial features etc.,

Key-frame systems

If all surfaces are described with polygon meshes, the number of edges per polygon can change from one frame to the next.

Consequently, the total number of line segments can be different in different frames.

Morphing

Morphing, a shortened form of metamorphosis is a transformation of an object from one form to another.

Morphing methods can be applied to any motion or transition involving a change in shape and thus they yield evolving shapes.

Uses linear interpolation for generating the in-betweens.

Object shapes are described by polygons.

Given two key-frames for an object transformation,

- adjust the object specification in one of the frames such that the number of polygon edges (or the number of vertices) in two frames is the same.

Morphing

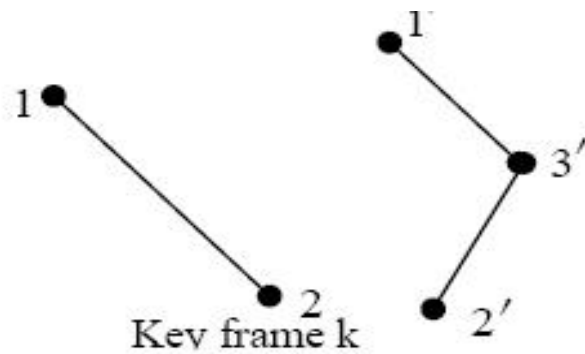


Fig. 1

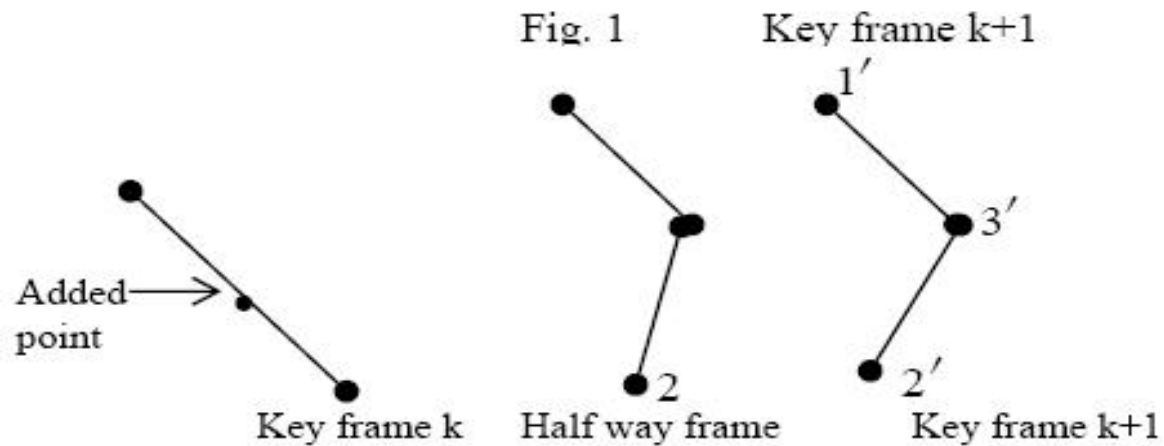


Fig. 2 Linear interpolation

Morphing

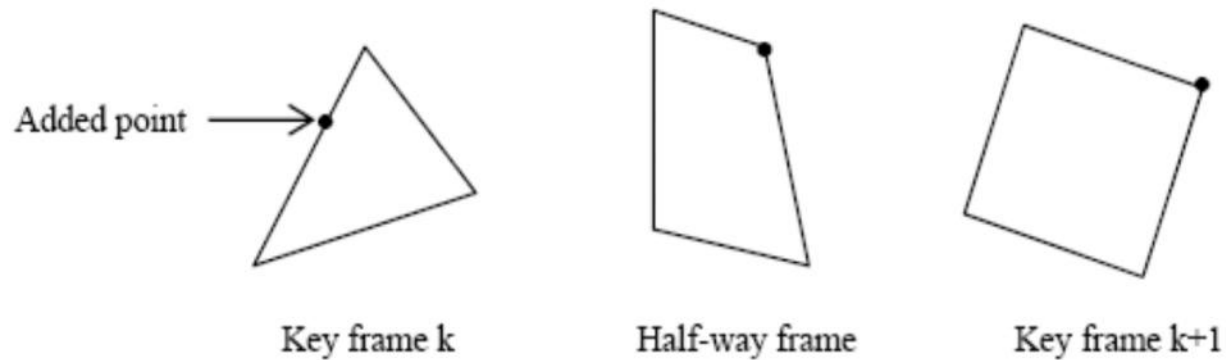


Fig.3
Linear interpolation for transforming a
triangle into quadrilateral

Morphing

We can equalize either edge count or vertex count

Equalizing Edge count:

Let L_k and L_{k+1} denote the number of line segments in two consecutive frames. We define,

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

$$N_e = L_{\max} \bmod L_{\min} \quad N_s = \text{int}\left(\frac{L_{\max}}{L_{\min}}\right)$$

Preprocessing is accomplished by

- 1) Dividing N_e edges of keyframe_{min} into N_s+1 sections
- 2) Dividing the remaining lines of keyframe_{min} into N_s sections

Eg: $L_k = 15$ and $L_{k+1} = 11$ we would divide 4 lines of keyframe_{k+1} into 2 sections each. The remaining lines of keyframe_{k+1} are left intact.

Morphing

Equalizing the vertex count: let parameters V_k and V_{k+1} denote the vertices

$$V_{\max} = \max(V_k, V_{k+1}) \quad V_{\min} = \min(V_k, V_{k+1})$$

$$N_{ls} = (V_{\max} - 1) \bmod (V_{\min} - 1) \quad N_p = \text{int} \left(\frac{V_{\max} - 1}{V_{\min} - 1} \right)$$

Preprocessing using vertex count is performed by

1. Adding N_p points to N_{ls} line sections of keyframe_{min}
2. Adding $N_p - 1$ points to the remaining edges of keyframe_{min}

For the triangle to quadrilateral examples, $V_k = 3$ and $V_{k+1} = 4$.

Both N_{ls} and N_p are 1 from Eqns.

we would add one point to one edge of keyframe_k.

No points would be added to the remaining lines of keyframe_{k+1}.

Simulating Accelerations

we use time interpolation to specify the animation paths between key frames and produce realistic displays of different speed changes.

Curve fitting techniques used to specify the animation paths between keyframes.

Given the vertex positions at the key frames, we can fit the positions with linear or nonlinear paths.

But to simulate accelerations, we need to adjust the time spacing for the in-betweens.

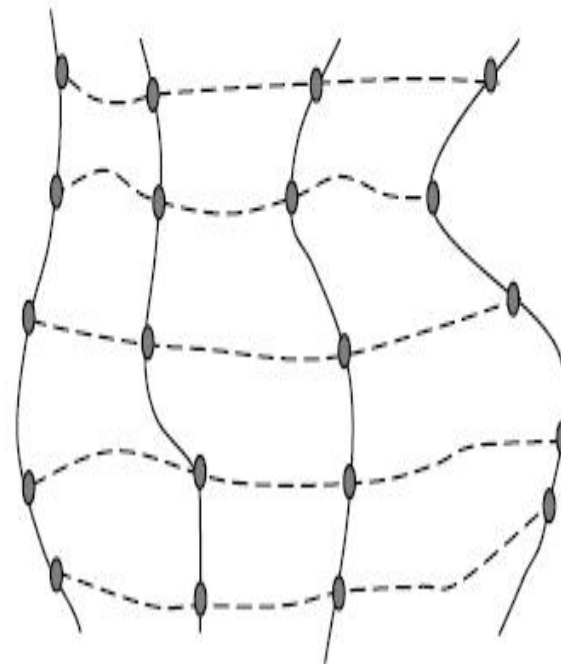
First, we consider constant speed (zero acceleration) using equal time-interval spacing for the in-betweens

Simulating Accelerations

Let there be n in-betweens for key frames at times t_1 and t_2

We now divide the time interval between key frames into $(n+1)$ sub intervals, yielding an in-between spacing of

$$\Delta t = \frac{t_2 - t_1}{n + 1}$$



Key frame k In-between Key frame k+1 Key frame k+2

Fig. 4: Fitting key frame vertex positions with non linear splines

Simulating Accelerations

We can calculate the time for any in-between by the interpolation as

$$t_{Bj} = t_1 + j \Delta t, \quad j = 1, \dots, n \dots (6)$$

Then, determine the values for coordinate positions, color, and other physical parameters.

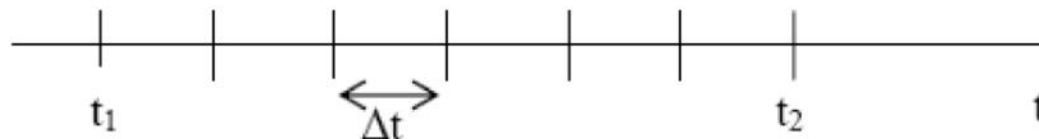


Fig. 5 :
In-between positions for motion at constant speed

Simulating Accelerations

To produce realistic displays of speed changes particularly at the beginning and at the end of a motion sequence, Non zero accelerations are used

Model the start-up and slow-down portions of an animation path with spline or trigonometric functions.

To model an increasing speed (positive acceleration), the time spacing between frames has to be increased so that greater changes in position occur as the object moves faster.

We can obtain an increasing interval size with the function

$$1 - \cos \theta \quad 0 < \theta < \pi/2$$

The time for the j th in-between can be calculated from the above function as

$$t_{bj} = t_1 + \Delta t \left[1 - \cos \frac{j\pi}{2(n+1)} \right], \quad j = 1, 2, \dots, n$$

Simulating Accelerations

We can model decreasing speed (deceleration) with \sin , using the angle in the range $0 < \theta < \pi/2$.

The time spacing of an in-between in this case is defined as

$$t_{bj} = t_1 + \Delta t \sin \frac{j \pi}{2(n+1)} \quad j = 1, 2, \dots, n$$

Can model a combination of increasing-decreasing speed by first increasing the in-between time spacing, then decreasing this spacing.

A function to accomplish these time changes is

$$\frac{1}{2} (1 - \cos \theta) \quad 0 < \theta < \pi/2$$

- The time for the j -th in-between is now calculated as:

$$t_{bj} = t_1 + \Delta t \left\{ \frac{1 - \cos [j\pi/(n+1)]}{2} \right\} \quad j = 1, 2, \dots, n$$

Motion Specifications

Several ways in which the motions of objects can be specified in an animation system.

Define motion directly or in a more abstract or general approach.

- 1) Direct motion specification
- 2) Goal Directed systems
- 3) Kinematics and Dynamics.

Direct motion specification

The most straightforward method of defining a motion sequence is the direct specification of motion parameters.

The specification consists of rotation angles and translation vectors.

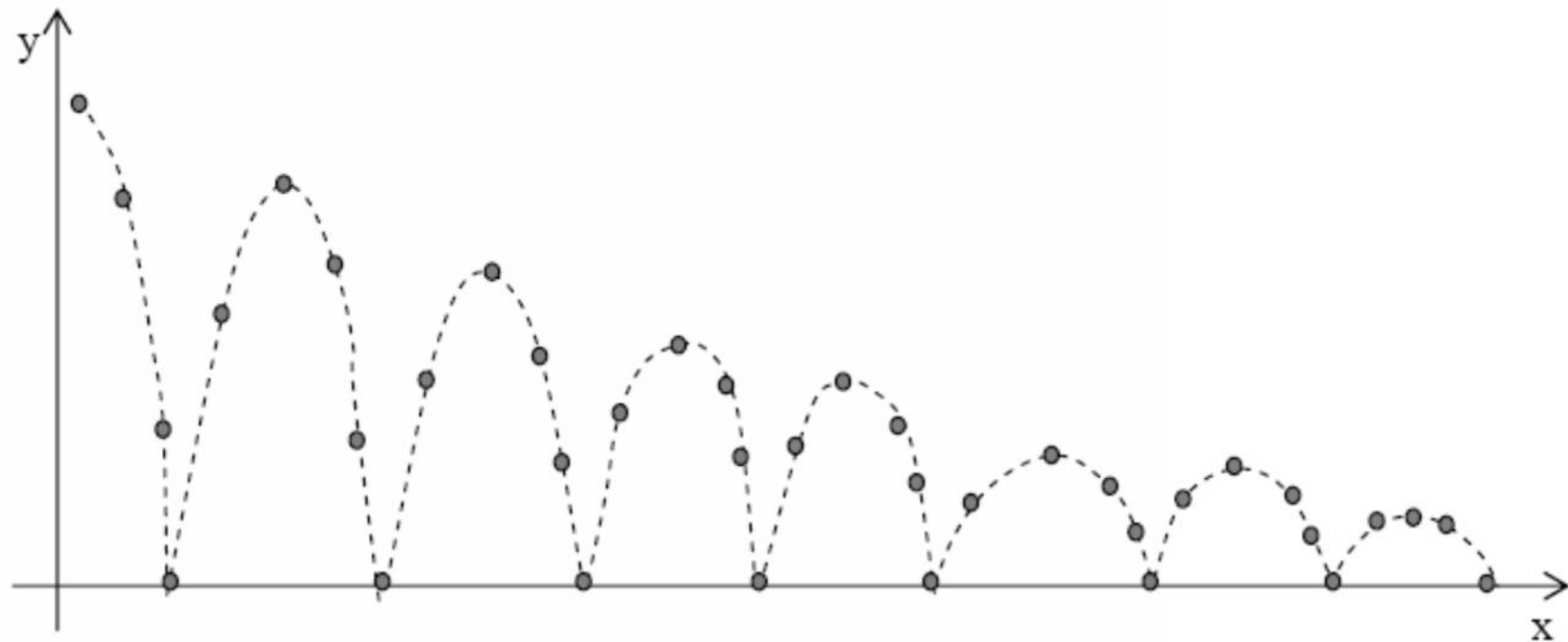
Then geometric transformation matrices are applied to transform coordinate positions.

Alternatively, use an approximation equation to specify certain kinds of motions.

Approximate the path of bouncing ball with a damped, rectified sine curve

$$y(x) = A|\sin (wx + \phi_0)|e^{-kx}$$

A- initial amplitude, w –angular frequency, ϕ_0 – phase angle, k- damping constant



$$-y(x) = A|\sin (wx+ 0)|e^{-kx}$$

Constraint based and Goal directed system

Specify the motions that are to take place in general terms that abstractly describe the actions.

Called as goal directed 'coz they determine the specific motion parameters given the goals of animation.

Ex: specify - want an object to “walk” to run” to a particular destination.

Input directives are then interpreted in terms of component motions that will accomplish the specified task.

Human motions, can be defined as a hierarchical structure of sub motions for the torso, limbs etc.,

Kinematics and Dynamics

We can also construct animation sequences using either kinematics, which refers to positions, velocities and acceleration of points without reference to forces that cause motion.

For constant velocity we infer the motions by giving initial position and velocity vector for each object.

Eg: If velocity is specified as $(3,0,-4)$ km/sec then

- Direction – straight line path
- Speed (magnitude) is 5 km/sec

If acceleration is also specified, speed-ups slowdowns and curved motion paths can be generated.

Inverse Kinematics: we specify the initial and final positions of objects at specified times and the motion parameters are computed by the system.

Kinematics and Dynamics

Dynamics: Requires specification of forces that produce the velocities and accelerations.

Physically based modeling: Descriptions of object behavior under the influence of forces.

Eg of forces: Gravitational, electro magnetic, friction and other mechanical forces.

Object motions are obtained from force equations.

Eg: Newton's second law , $F = ma$.

Inverse Dynamics: Obtain forces given the initial and final positions of objects and type of motion.