CMSC 435
Introductory Computer Graphics
Animation
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Terminology
• Storyboard
• Keyframe
• Inbetween
• Procedural animation
Fundamental Principles of Traditional Animation

- John Lasseter, Siggraph ‘87
Squash and Stretch

• Defining the rigidity and mass of an object by distorting its shape during an action
• Ex:
  – Ball flattening during bounce
  – Facial animation -- cheeks squash during smile
• Keys
  – Volume constant
  – Different materials respond differently
  – Need not deform
  – Use stretching to eliminate strobing from fast action
• Method
  – Can use scale to conserve volume (up in one dimension down in others)
Timing

• Spacing actions to define weight and size of object and the personality of characters

• Ex:
  – Tow head positions, right and left
  – No inbetweens --> hit by tremendous force
  – One inbetween --> hit by brick, rolling pin, etc
  – Two inbetweens --> nervous tic
  – Three inbetweens --> dodging object
  – Four inbetweens --> visually following interesting object
  – Five inbetweens --> stretches sore muscle
Timing (cont)

• Keys
  – Action shouldn’t be so fast it can’t be followed
  – Timing defines size and weight of object
  – Timing appropriate to emotional state

Anticipation

• The preparation for an action
• Ex:
  – Pull back foot to kick ball
  – Luxo: big lamp looks off stage before Jr.’s entrance
• Keys
  – Direct attention to upcoming action
  – Anticipation can allow faster action
Staging

• Presenting an idea so that it is unmistakably clear
• Ex:
  – Luxo: action to side for clarity
  – Luxo: only one lamp really moves at a time (avoid upstaging)
Follow Through/Overlapping Action

- The termination of an action and establishing its relationship to the next action
- Ex:
  - Hand throwing ball continues past release point
  - To open door, reach for door before you finish walking
- Keys
  - Figure animation: lead and drag points
  - An action should never be brought to a complete stop before the next begins
Slow In and Out

• The spacing of the inbetween frames to achieve subtlety of timing and movement
• Ex:
  – Moving from place to place: start and end slow
• Keys
  – Think about continuity of second and third order motion
  – Timing chart
Arcs

- The visual path of action for natural movement
- Ex:
  - Thrown ball
- Keys
  - Arc movements are more natural than straight lines
Exaggeration

• Accentuate the essence of an idea via the design and the action
• Ex:
  – Luxo: movement exaggerated from real physics, also sounds
• Keys
  – Maintain balance -- can’t just exaggerate one, can’t exaggerate all

Secondary Action

• Action that results directly from another action
• Ex:
  – Luxo: cord movement
  – Facial expression
• Keys
  – Needs to be subordinate to primary action
Appeal

• Creating a design or action that the audience enjoys watching

• Ex:
  – Luxo Jr: scaled like child -- relatively big head, rods same diameter, but shorter

• Keys
  – Avoid twins -- limbs in same position
  – Personality of characters (batting motions of two lamps)
  – Identify and express emotional state (Luxo hops)
Character Animation

• Concepts
  – Hierarchical model
  – Forward kinematics
  – Inverse kinematics
  – Constraints
  – Motion capture
Physics-based Animation

• Generally: simulating the laws of physics to predict motion
• Common applications:
  – Fluids, gas
  – Cloth, hair
  – Rigid body motion
• Approach: model change as differential equations

Autonomous Objects/Groups

• Generally: create complex group behavior by defining relatively simple individual behavior
• Common applications:
  – Flocks, crowds
  – Particle systems
• Approach: leverage AI techniques