Computer Animation

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CS 4810: Graphics

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Overview

• Some early animation history
  o http://web.inter.nl.net/users/anima/index.htm
  o http://www.public.iastate.edu/~rlleew/chrnearl.html

• Computer animation
Thaumatrope

- Why does animation work?
- Persistence of vision
- 1824 John Ayerton invents the *thaumatrope*
- Or, 1828 Paul Roget invents the *thaumatrope*
Thaumatrope

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Phenakistoscope

• Invented independently by 2 people in 1832
• Disc mounted on spindle
• Viewed through slots with images facing mirror
• Turning disc animates images
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Zoetrope (1834)

- Images arranged on paper band inside a drum
- Slits cut in the upper half of the drum
- Opposite side viewed as drum rapidly spun
- Praxinoscope is a variation on this
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Mutoscope (1895)

- Coin-operated “flip-book” animation
- Picture cards attached to a drum
- Popular at sea-side resorts, etc.
Animation History

- Animation and technology have always gone together!
- Animation popular even before movies
- Movies were big step forward!
- “Humorous Phases of Funny Faces” (1906)
Key Developments

- Plot
- Creation of animation studios
- Getting rid of “rubber-hose” bodies
- Inking on cels

“Steamboat Willie”
Walt Disney (1928)

“Felix the Cat”
Pat Sullivan (1919)

“Gertie the Dinosaur”
Windsor McCay (1914)
Key Developments

- Max Fleischer invents rotoscoping (1921)
Fleischer’s Rotoscope
Key Developments

- Max Fleischer invents rotoscoping (1921)
Key Developments

• “Flowers and Trees” (1932) uses color!
• “Snow White” (aka “Disney’s Folly”) released 1937
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• Computer animation
Computer Animation

• What is animation?
  o Make objects change over time according to scripted actions

• What is simulation?
  o Predict how objects change over time according to physical laws
3-D and 2-D animation

Homer 3-D

Homer 2-D
Outline

• Principles of animation
• Keyframe animation
• Articulated figures
Principles of Traditional Animation

• Squash and Stretch
• Timing
• Anticipation
• Staging
• Follow Through and Overlapping Action
• Straight Ahead Action and Pose-to-Pose Action
• Slow In and Out
• Arches
• Exaggeration
• Secondary action
• Appeal

http://www.anticipation.info/texte/lasseter/principles.html
Principles of Traditional Animation

Squash and Stretch
• Defining the rigidity and mass of an object by distorting its shape during an action.

http://www.anticipation.info/texte/lasseter/principles.html
Principles of Traditional Animation

Timing

• Spacing actions to define the weight and size of objects and the personality of characters.
  o Heavier objects accelerate slower
  o Lethargic characters move slower
  o Etc.

http://www.anticipation.info/texte/lasseter/principles.html
Principles of Traditional Animation

Anticipation

• The preparation for an action.
  • Muscle contraction prior to extension
  • Bending over to lift a heavy object
  • Luxo’s dad responds to Luxo Jr. off screen before Luxo Jr. appears.

http://www.anticipation.info/texte/lasseter/principles.html
Principles of Traditional Animation

Staging

• Presenting an idea so that it is unmistakably clear.
  - Keeping the viewer’s attention focused on a specific part of the scene.
  - Luxo Jr. moves faster than his dad, and so we focus on him.
Principles of Traditional Animation

Follow Through and Overlapping Action

• The termination of an action and establishing its relationship to the next action.
  o Loose clothing will “drag” and continue moving after the character has stopped moving.
  o The way in which an object slows down indicates its weight/mood.

http://www.anticipation.info/texte/lasseter/principles.html
Principles of Traditional Animation

Straight Ahead Action and Pose-to-Pose Action

- The two contrasting approaches to the creation of movement.
  - **Straight Ahead Action:**
    - Action is drawn from the first frame through to the last one.
    - Wild, scrambling actions where spontaneity is important.
  - **Pose-to-Pose Action:**
    - Poses are pre-conceived and animator fills in the in-betweens.
    - Good acting, where the poses and timing are all important.

http://www.anticipation.info/texte/lasseter/principles.html
Principles of Traditional Animation

Slow In and Out
• The spacing of in-between frames to achieve subtlety of timing and movements.

http://www.anticipation.info/texte/lasseter/principles.html
Principles of Traditional Animation

Arfs

• The visual path of action for natural movement.
  o Make animation much smoother and less stiff than a straight line for the path of action

http://www.anticipation.info/texte/lasseter/principles.html
Principles of Traditional Animation

Exaggeration

• Accentuating the essence of an idea via the design and the action.

http://www.anticipation.info/texte/lasseter/principles.html
Principles of Traditional Animation

Secondary Action
• The Action of an object resulting from another action.
  • The rippling of Luxo Jr.’s cord as he bounces around the scene.

http://www.anticipation.info/texte/lasseter/principles.html
Principles of Traditional Animation

Appeal

• Creating a design or an action that the audience enjoys watching.
  o Charm
  o Pleasing design
  o Simplicity
  o Communication
  o Magnetism
  o Etc.

http://www.anticipation.info/texte/lasseter/principles.html
Keyframe Animation

- Define character poses at specific time steps called “keyframes”
Keyframe Animation

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

- Inbetweening:
  - Linear interpolation - usually not enough continuity

H&B Figure 16.16
Keyframe Animation

- Inbetweening:
  - Cubic spline interpolation - maybe good enough
    » May not follow physical laws
Keyframe Animation

- Inbetweening:
  - Cubic spline interpolation - maybe good enough
    » May not follow physical laws
Keyframe Animation

• Inbetweening:
  - Kinematics or dynamics

Rose et al. ‘96
Outline

- Principles of animation
- Keyframe animation
- Articulated figures
Articulated Figures

- Character poses described by set of rigid bodies connected by "joints"
Articulated Figures

• Well-suited for humanoid characters

Rose et al. '96
Articulated Figures

- Inbetweening
  - Interpolate angles, not positions, between keyframes

![Good arm](image1)

![Bad arm](image2)

Watt & Watt
Example: Walk Cycle

- Articulated figure:
Example: Walk Cycle

- Hip joint orientation:
Example: Walk Cycle

- Knee joint orientation:
Example: Walk Cycle

- Ankle joint orientation:
Example: Walk Cycle

http://www.ischool.utexas.edu/~luna73/architecture/
Summary

• Principles of animation
• Keyframe animation
• Articulated figures