CS-184: Computer Graphics

Lecture #17: Introduction to Animation

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Introduction to Animation

- Generate perception of motion with sequence of image shown in rapid succession
  - Real-time generation (e.g. video game)
  - Off-line generation (e.g. movie or television)
Introduction to Animation

- Key technical problem is how to generate and manipulate motion
  - Human motion
  - Inanimate objects
  - Amorphous objects
  - Control
Introduction to Animation

- Technical issues often dominated by aesthetic ones
- Violation of realism desirable in some contexts
- Animation is a communication tool
  - Should support desired communication
  - There should be something to communicate
Introduction to Animation

From Parent, p.15
Introduction to Animation

For more detailed diagram, see Kerlow p.54
Introduction to Animation

- **Key-frame animation**
  - Specification by hand

- **Motion capture**
  - Recording motion

- **Procedural / simulation**
  - Automatically generated

- **Combinations**
  - e.g. mocap + simulation
Key-framing (manual)

- Requires a highly skilled user
- Poorly suited for interactive applications
- High quality / high expense
- Limited applicability

From Learning Maya 2.0
Motion Capture (recorded)

- Markers/sensors placed on subject
- Time-consuming clean-up
- Reasonable quality / reasonable price
- Manipulation algorithms an active research area

Figure 1.1: Optical motion capture systems work by tracking retroreflective markers placed on the body. Since these systems require "active" markers that emit an infrared pulse which uniquely identifies every marker, they are especially useful for capturing non-metallic objects, allowing for high-dimensional motion capture systems to be used with infrared cameras. This enables the system to distinguish between different markers and accurately track their movements. However, due to the need for calibration, optical systems can be more expensive and resource-intensive compared to other methods. In summary, optical motion capture is a powerful tool for capturing complex movements, offering a high level of accuracy and detail.
Motion Editing

Arikan, Forsyth, O’Brien, SIGGRAPH 2002
Motion Editing

Arikan, Forsyth, O’Brien, SIGGRAPH 2002
Model Construction

Kirk, O’Brien, Forsyth, CVPR 2005
Simulation

- Generate motion of objects using numerical simulation methods

\[ x^{t+\Delta t} = x^t + \Delta t \, v^t + \frac{1}{2} \Delta t^2 \, a^t \]
Simulation

- Perceptual accuracy required
- Stability, easy of use, speed, robustness all important
- Predictive accuracy less so
- Control desirable
Simulation

Feldman, Arikan, O’Brien, SIGGRAPH 2003
What to do with animations?

- Video tape
- Digital video
- Print it on yellow sticky notes
Video Tape

- **Analog tape formats**
  - VHS/SVHS
  - Beta SP
  - 3/4” U-matic

- **Digital tape formats**
  - Digi Beta
  - DV Tape
  - DVD (yes, I know DVDs are not tapes)
NTSC Standard

- Used by DVD, DV, and VHS
- 720x486 resolution (sort of)
- 1.33 aspect ratio
- Limited color range
- 30 frames per second (sort of 29.97)
- Interlaced video
- Overscan regions
Digital Video

- Wide range of file formats
  - QuickTime
  - MS Audio/Visual Interleaved (AVI)
  - DV Stream
  - Bunch ‘o images

- Some formats accommodate different CODECs
  - Quicktime: Cinepak, DV, Sorenson, DivX, etc.
  - AVI: Cinepak, Indeo, DV, MPEG4, etc.

- Some formats imply a given CODEC
  - MPEG
  - DV Streams
Digital Video

- Nearly all CODECs are lossy
  - Parameter setting important
  - Different type of video work with different CODECs
  - Compressors not all equally smart
  - Compression artifacts are cumulative in a very bad way

- Playback issues
  - Bandwidth and CPU limitations
  - Hardware acceleration
  - Missing CODECs (avoid MS CODECs and formats)
Path to Tape

- Not much of an issue any longer
  - Cheap ( < $100 ) devices can give good amateur quality output
  - Pro quality also cheap ( < $5000 )
  - Beware many cheap solutions over use compression
  - Good analog tape decks still expensive
Editing

- **Old way:**
  - Multiple expensive tape decks
  - Slow
  - Difficult
  - Error prone

- **New way:**
  - Non-linear editing software
    - Premiere, Final Cut Pro, others...
  - Beware compressed solutions
  - May take a long time for final encoding
Motion Blur

- Fast moving things look blurry
  - Human eye
  - Finite exposure time in cameras

- Without blur: strobing and aliasing

- Blur over part of frame interval
  - Measured in degrees (0..360)
  - 30 tends to often look good
Motion Blur

- Easy to do in a sampling framework
- Interpolation is an issue
Motion Blur

- Velocity based blur often works poorly