AI and Animation

Artificial Intelligence for Interactive Media and Games

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Paper at AIIDE’08

- Lightweight Procedural Animation with Believable Physical Interaction

- Ian Horswill
- Northwestern University
  - Electrical Engineering and Computer Science Dept.
  - Radio, Television and Film Dept.
- http://twigblog.wordpress.com
AI and Animation

- What have they got to do with each other?
- Why is it hard to make them work together?

Q&A with Alex Champandard
  - AiGameDev.com, Oct 28, 2008
AI and Animation

- "In a lot of ways, the next step for AI is... Animation," "Which is to say that AI has developed to a point where a lot of the big problems that we're solving are not really AI problems at all, they're animation problems.

- "The example that I give to a lot of people is that we have yet to see an AI, or any kind of character in a videogame, that can walk up to a table and pick a pencil off the table. We literally don't know how to do that, because it's such an incredibly complicated process.

Damian Isla, Head AI Programmer, Bungie
Eurogamer.net, July 2008
Twig – Ian Horswill

- Lightweight
- Procedural Animation with
- Believable
- Physical Interactions
Examples

Lightweight Procedural Animation with Believable Physical Interaction

Lightweight

- C# in XNA 3.0
- runs easily at 60Hz on 1.6 GHz single-core laptop
  - unoptimized rendering
- simple server RPC and script interface
- open source
- work in progress
Lightweight Procedural Animation with Believable Physical Interaction

Procedural Animation

- vs. motion capture
- for applications where
  - all possible complex interactions cannot be planned at authoring time
  - even with blending
  - e.g., interactive drama
- general, extensible toolkit for autonomous characters
Believable vs. Realistic

- A character is **believable** if an audience accepts it as if it were alive.
- A character is **realistic** if it matches actual reality.

[Joe Bates, CACM 1994]

- Twig is designed for versatility and believability, rather than physical realism
  - avoids complicated modeling and control
  - while still maintaining believability

Physical Interaction

- current behavioral repertoire
  - hold, hold-for-use
  - write
  - walk, sit, stand up
  - gesture
  - approach, fight, attach
  - pain withdrawal reflex
  - gaze control
  - speak (with or without turn taking)
  - hug, reach, grapple, drag

- “easily” extensible to more actions
Architecture

- motion controllers
- simplified physics simulation

Simplified Physics Simulation

- based on Hitman engine
- point masses (nodes)
- massless connecting rods
  - rendered as cylinders (meshes?)
  - constrain distance between nodes
- Verlet integration
  - all dynamic information captured in node positions in two adjoining frames
  - no need to explicitly represent (angular) momentum, etc.
- constraint satisfaction
Constraint Satisfaction

- position-based physics work well with constraint satisfaction approach
- when constraint violated, just make small position adjustment to re-satisfy constraint
  - does not conserve E or M
  - very cheap
  - looks good incrementally

Collision Handling

- handle similarly to constraint violations
  - compute penetration depth
  - back nodes out of overlap
- tactile sensing
  - compute kinetic energy of collision
  - if over threshold, register as "pain" (cf. pain reaction behavior)
Controllers to Physics Interface

- primarily though nodes
- ballistic control
  - set target position of node and desired time
  - node moves along path constrained by rods, etc. (does inverse kinematics)
  - used primarily for limb motions (reaching, stepping)
- set velocity and acceleration per node
- lock node in position (e.g., with ground)

Motion Controllers

- inspired by robotics and behavior trees
- low-level
  - posture
  - gait
  - gaze
- higher-level
  - grabbing
  - hugging
  - grappling
  - etc.
Posture Controller

- apply forces to
  - base of spine to move it over midpoint of feet
  - top of spine to
    - move over base of spine
    - move center of mass over midpoint of feet
  - pelvis to turn toward walking vector
  - shoulders to turn toward gaze direction

Gait Controller

- direction and speed set by higher level
- set the ground-plane velocity of the pelvis to the walk vector
- when a foot is sufficiently far behind the pelvis
  - move the foot node (ballistically) to a point in front of pelvis
  - in walking direction
- constraint satisfaction system moves the knee so
  - doesn’t bend backward
  - doesn’t bend sideways
Gaze Controller

- gaze target set by higher level “attention” system
- point the “front” of the face toward current gaze target
- currently turns head instantaneously
  - unrealistic
  - but a good cue w current faceless bodies

Grabbing Control

- create an invisible zero-length rod
  - from the hand node
  - to the designated target object node
- object attached to end of arm
  - but swings free
Hugging Controller

- reaching and approaching target
- join hands when contact made with target’s torso

Conclusion: What’s It Good At?

- rough & ready character behavior
- relatively expressive motion
- believability
- authoring
- AI-friendly
Conclusions: What’s It Bad At?

- accurate simulation (conservation violations)
- photorealism
- complicated collision volumes, terrain, etc.
- path planning