



AI and Animation

Artificial Intelligence for Interactive Media and Games

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IMGD 400X (B 08)

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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>



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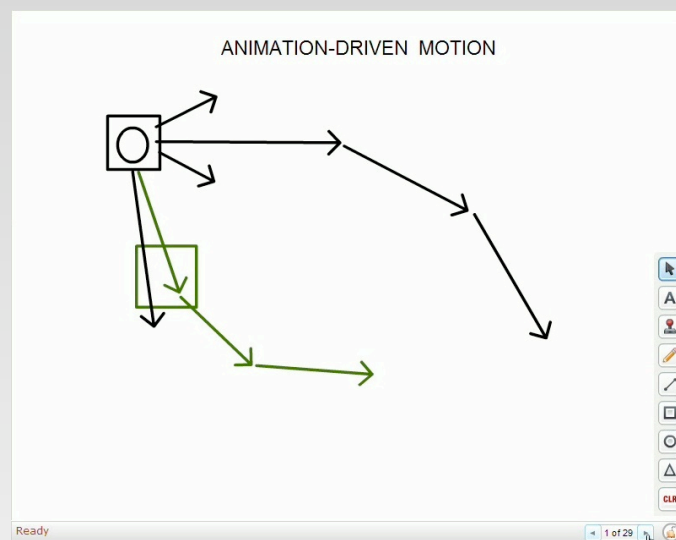
AI and Animation

- 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

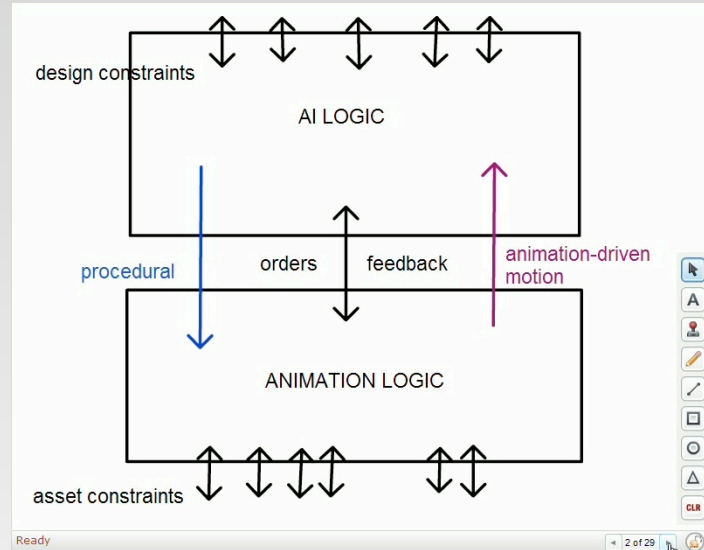


- <http://aigamedev.com/premium/qa/animation-interface-blend-trees>

AI and Animation



AI and Animation



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



AI and Animation



Shortcuts

Community

Summits

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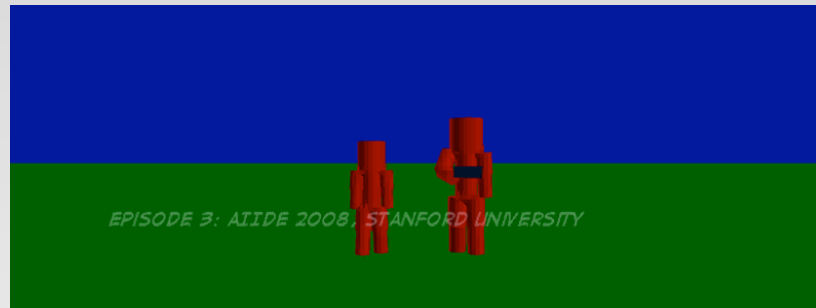
Animating Intentionality in a Complex World: Integrating AI and Animation
Speaker: [Alex J. Champandard](#) (Editor & Consultant, AiGameDev.com), [Christian Gyrling](#) (Programmer, Naughty Dog Inc.)
Date/Time: Monday (March 23, 2009) 11:15am – 12:30pm
Track: [AI Summit](#)
Format: [75-minute Lecture](#)
Experience Level: All

Session Description
 As leading-edge games push the number of animations for a single agent into the thousands, significant challenges arise in allowing the AI to express themselves and give real performances in a physically constrained world. With this level of complexity, AI animation selection evolves into a new beast where AI, biomechanics, collision detection, and art become intertwined, resulting in significant engineering and artistic challenges. This lecture will examine these challenges and suggest strategies and architectures that can guide games into this rapidly evolving space.

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

script fragment

```

Bryan: say "They're doing medical experiments on us?" Michael
Bryan: hold script
Bryan: goto camera 3.6 &
Bryan: say "You bastards!" camera
Michael: goto Bryan 0.25 (-1 0 0) &
Thug: goto Bryan 0.5 (0 0 0) &
Michael: say "Quiet!" Bryan
Michael: say "They'll hear you!" Bryan
Bryan: say "I'm not some lab animal!" Michael
Thug: say "I'm with AAA!\nCome with me" Bryan
Bryan: lookat Thug
Bryan: say "I know my rights!" Thug
Bryan: say "IRB would never sign off on this!" Michael
Thug: hold Bryan
Michael: say "It's run by Alberto Gonzales now." Bryan &
Bryan: fight Thug
pause 0.5
Bryan: say "Widgets of the world unite!" Thug
Thug: goto offstage &
Bryan: drop script
Bryan: "Soylent green!\nIt's made out of pixels!" Bryan
titles: fadetoblack 2

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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.

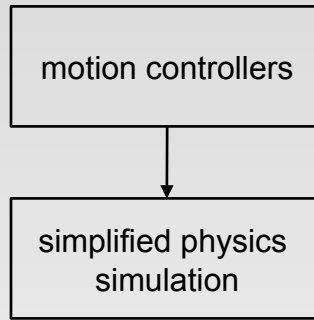
[Joe Bates, CACM 1994]

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

Physical Interaction

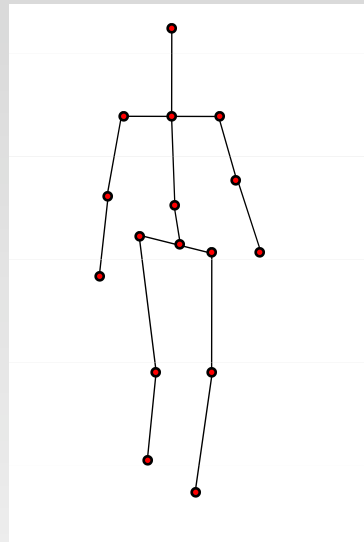
- current behavioral repertoire
 - hold, hold-for-use
 - write
 - walk, sit, stand up
 - gesture
 - approach, fight, attach
 - pain withdrawal reflex
 - gaze control
 - speak (with or without turn taking)
 - hug, reach, grapple, drag
- “easily” extensible to more actions

Architecture



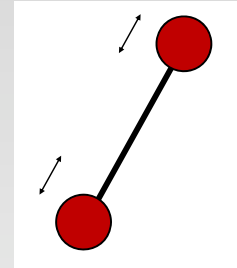
Simplified Physics Simulation

- based on *Hitman* engine
- point masses (nodes)
- massless connecting rods
 - rendered as cylinders (meshs?)
 - 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

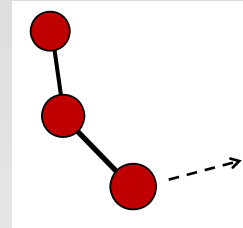


Collision Handling

- 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 through 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)

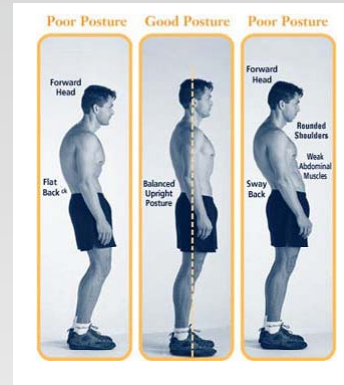


Motion Controllers

- 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

