



AVALANCHE STUDIOS

Physics Meets Animation
Character Stunts in Just Cause 2

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Talk Overview



Motion Control

Animation + Physics +IK

Parametric Animation

Effectors / Manipulators

Just Cause 2 : Requirements



- Huge open world
- Fast-paced, over-the-top action
- Reactive environment
- High level of responsiveness
- Large number of game mechanics
- Large number of vehicles



Freedom!

Concept Video



Motion Control



Fast-paced Motion Transitions



Motion States - Root Node Update

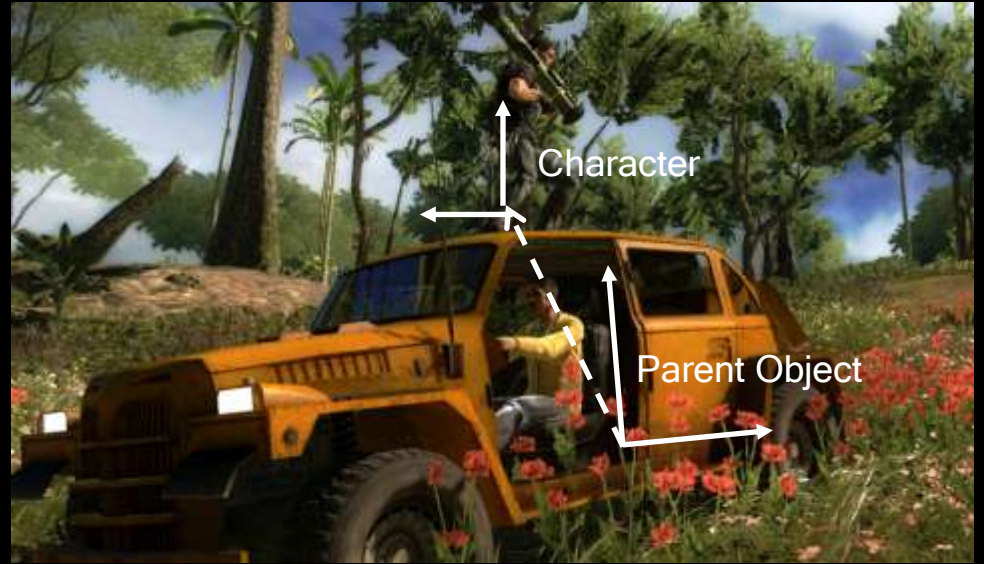
- Desired motion:
 - Procedurally driven
 - Animation driven
 - Parented (Attached)
- External influences:
 - Collisions
 - Gravity





Parented Motion

- Exists in Local Space
- Animation = change in offset





Rigid Body Proxy

- Control physical effects
- Ragdoll : hard to control
- Single rigid body representation
- Constrained to other objects



Recoil

**Animation /
Physics /
IK**



Pre-visualization





Ragdoll / Animation / IK Control Flow

Sample Animation Pose

Foot / Hand IK attachment

Update ragdoll

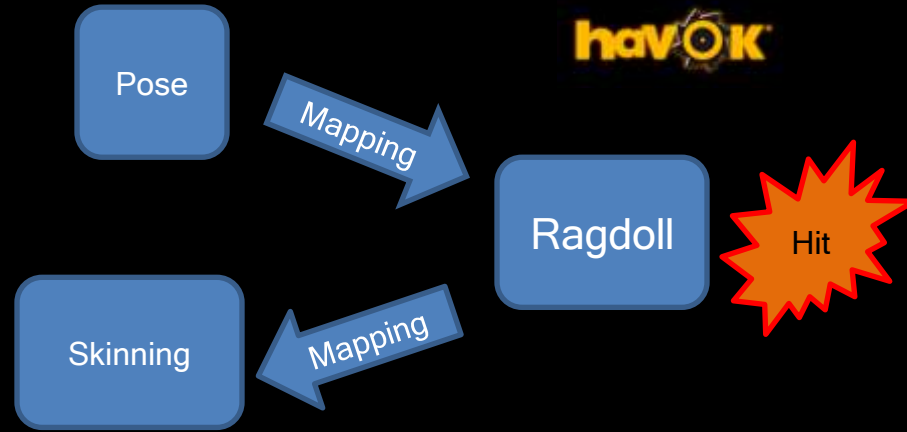
Physics Update

Aim constraints

Skinning



Pose Driving



- Drive ragdoll towards animation pose (using impulses / joint motors)
- Not a keyframed ragdoll - can still respond to collisions

3.4.4.4.4.4.4.4.4.4

07.11px

Frame: 31821 | View: 0De: 14m: 22s: 8518 bytes: 1243
cam | pos[80.7 203.8 40.9]
cam | frnz[81.5 203.9 40.1]
RHP: fly

0



Transition from Ragdoll to Animated

1. Compare orientation with a number of Get-Up start frames
2. Drive ragdoll towards the closest start frame
3. When close to target pose, start the animation and blend to it





Spinning Ragdolls

- Extreme explosion reactions
- Apply extra impulses to ragdoll bones
- Vector field
 - > Get an axis perpendicular to explosion
 - > Evenly spread impulses to achieve rotation
 - > Synchronized swimmers!!
- Randomness
 - > Vary the axis within a 45 degree cone

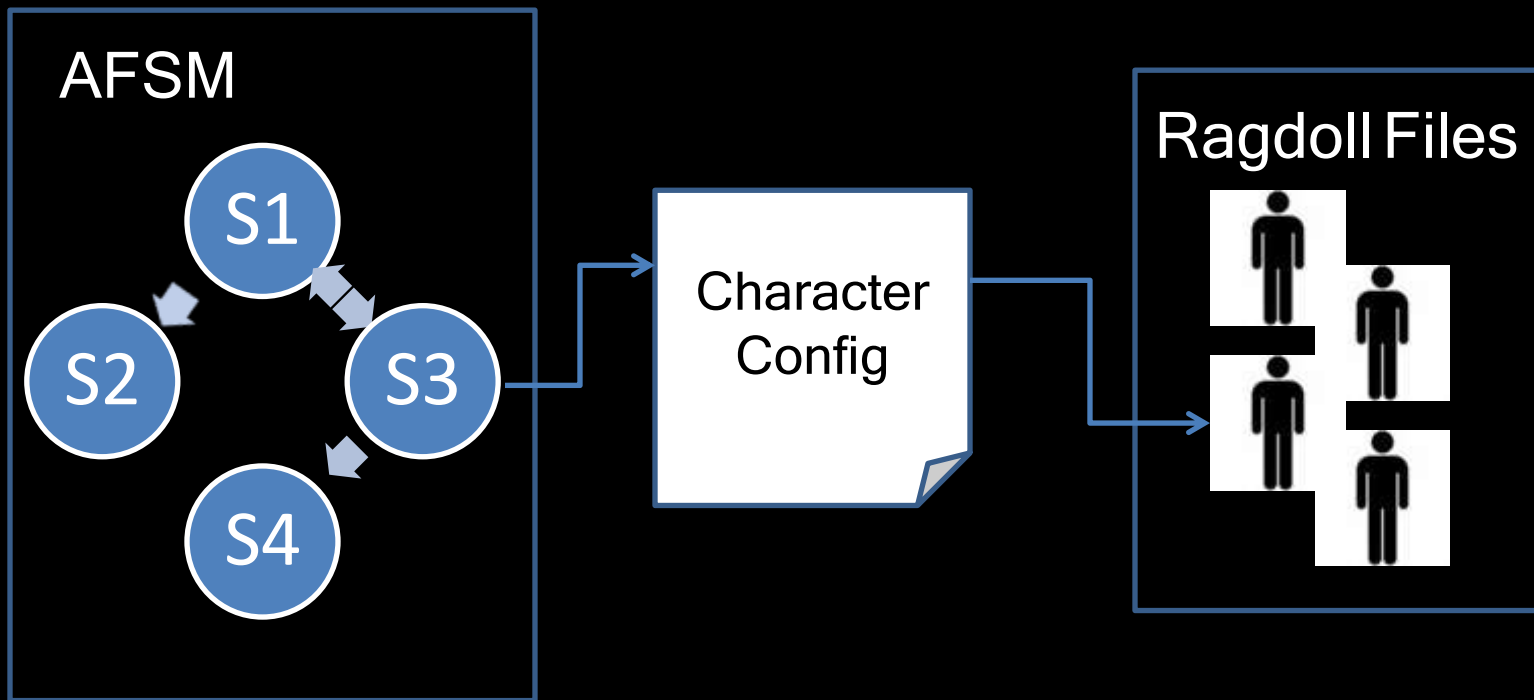




22%



Authoring Ragdoll / Character setup



Authoring Ragdoll / Character setup



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Physics Driven Animation





Ragdolls and parent motion

Ragdoll pros

- React to parent
- Collision handling

Ragdoll cons

- Feeling of intention and awareness
- Poor momentum transfer





Traditional Link Between Physics and Animation

- State Machine:

“Series of discrete states where events cause state transitions”

- Example:

- Guy hangs from a jeep door
- Faster jeep turns , the more he loses control
- Continuous changes - no discrete event

- Discrete events are not suitable for continuous states



Physics Driven Animation

- Smart blend states
- Physics values drive blending
- Continuous values give smooth motion
- Non-repetitive behavior!



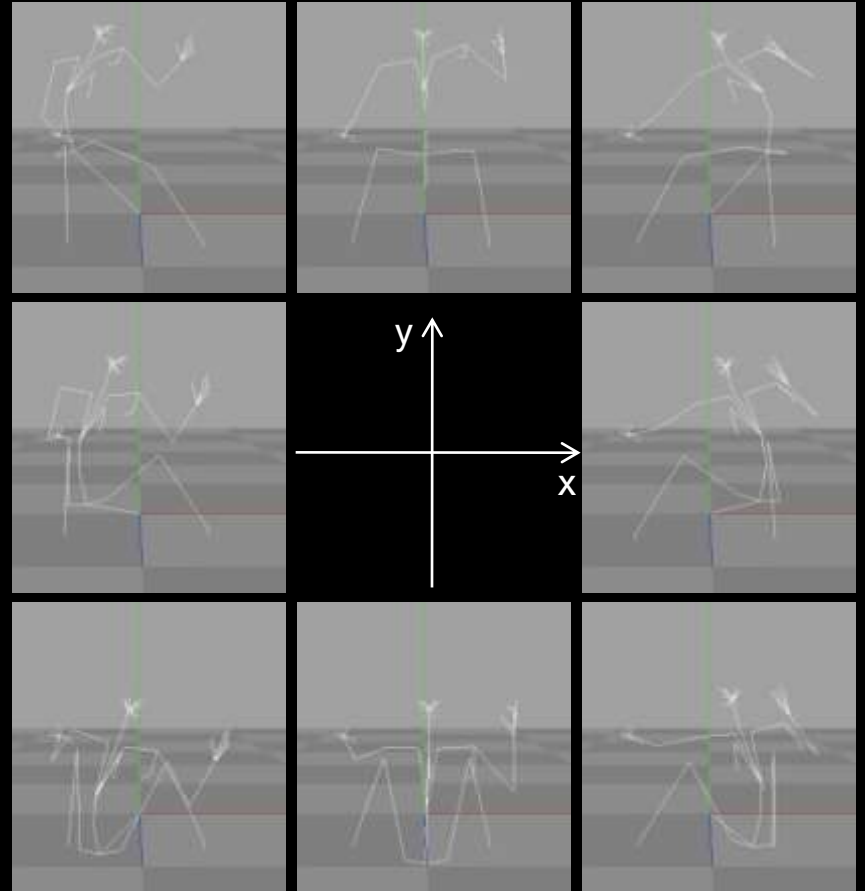
“Parametric Blends”





How does it work?

- All poses are baked into two animations
 - Upper row from left to right
 - Lower row from left to right
- Middle row is the result of blending
- Project parent's angular velocity onto..
 - X-axis to determine blend weight
 - Y-axis to determine sample time



Ragdoll Only

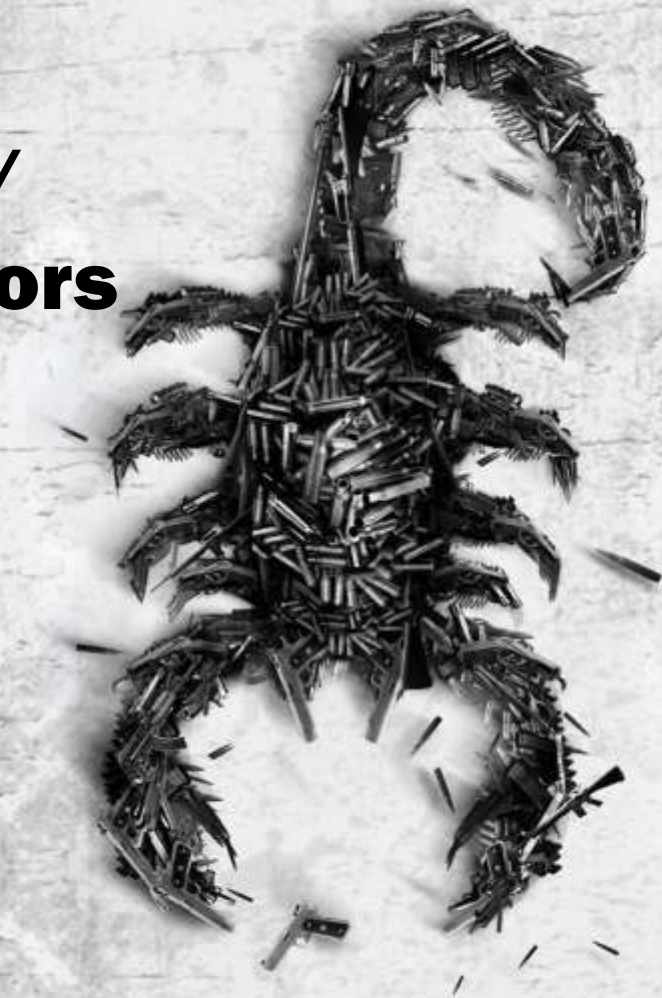


...One Step Further

- Multiple parameterizations create variation
- Parachuting has the following inputs:
 - Acceleration, velocity and gamepad input
- Riding motorcycle has the following inputs:
 - Suspension length rate of change
 - Speed
 - Orientation
 - Gamepad input

Physics Driven Animation

Effectors / Manipulators





Animation Driven Impulses

- Wanted data driven physical effectors
- Animations contain annotations, e.g:
 DOWNWARD-IMPULSE-LIGHT
 DOWNWARD-IMPULSE-HEAVY



- Impulses applied to parent or target body
- E.g. foot down event, enter vehicle, some cling positions



Motorbike Tilt

- Let the player feel in control of the driver
- You control the player's lean on the bike, affecting C.O.M.
- Makes it easier to tip backwards
- Also allows for leaning forwards / backwards in air

The Almighty Grapple



- Physical constraint
- Can 'tie' nearly any two physics objects together
- Custom impulses applied: e.g. yanking, wall tether, dual tether two enemies, etc.
- Shorten the constraint to draw things together

Animation Driven Impulses

Findings

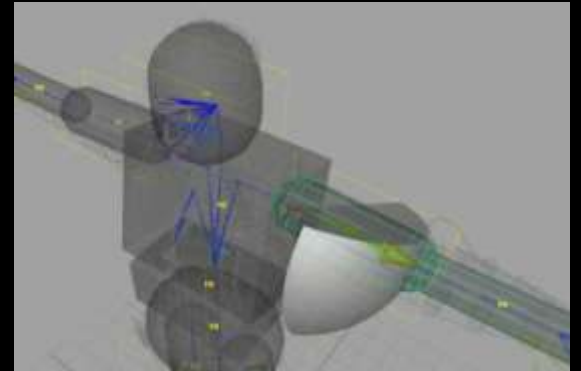




Problems we faced / Tips

Ragdoll Stability:

- Requires constant maintenance
- Animation poses must not violate constraint limits
 - Use different ragdolls to suit the context
- QA unfamiliar with problem domain
- Monitor edge cases : have a fallback





Problems we faced / Tips

Ragdoll Driving:

- Varied quality at different speeds

Blending:

- Noisy physics signal - filter

Dependencies:

- Difficult to tweak without side effects

Thanks!



CEDEC

Yuki & Yuriko

Just Cause 2 Team

Avalanche Studios

Eidos

Square Enix

Havok

Q & A

