Procedural Skeletons: Kinematic Extensions to CGA-Shape Grammars

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- Procedural modeling
- Grammars
- Articulated objects
Procedural modeling

- ↑ Abstraction
- ↓ Design costs
- ↓ Artistic skills
- ↑ Reusability

- ↑ Domain knowledge
- ↓ Local control
- ↑ Formal theory
- ↓ Reconstruction

CityEngine, Pascal Müller
Nature vs. Urbanism

- Elements
- Survival
- Jagged
- Long evolution

- Regular
- Short term
- Planarity
- Batch changes

Rome Rebuild, Pascal Müller
Split grammars

- Sets of shapes instead of symbols
- Large amount of rules and attributes
- Attribute propagation
- Rule selection
- Image based reconstruction
  - Symmetries
  - Visual editing
- [Wonka et al. 2003]
CGA grammars

- Scope to oriented bounding boxes
  - transformation rules
  - splits and repetition
  - absolute and relative scaling
  - component splits

- Sequential
- Occlusion
- Snapping

[Müller et al. 2006]
[Lipp et al. 2008]
Procedural modeling of cities

CityEngine, Pascal Müller

Martin Ilčík
Poses and Expressions

- Pose
- Expression
- Semantics
- Relations
- Functionality
Poses and Expressions

- Pose
- Expression
- Semantics
- Relations
- Functionality
<table>
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Poses and Expressions

- Pose
- Expression
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Poses and Expressions

- Pose
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Excavator Example - Basis
Excavator Example - Basis
Excavator Example - Motor
Excavator Example - Cabin
Excavator Example - Cabin
Excavator Example - Chassis
Excavator Example - Arm
Excavator Example - Shovel
Excavators
Excavators
Excavators
Excavators
Excavators
Pose description

- Kinematic Shapes
- Rigid bodies
- Bones
  - Parent link
  - Children links
Pose description

- Kinematic Shapes
- Rigid bodies
- Bones
  - Parent link
  - Children links
- Joint
Pose description

- Kinematic Shapes
- Rigid bodies
- Bones
  - Parent link
  - Children links
- Joint
  - Default pose
Pose description

- Kinematic Shapes
- Rigid bodies
- Bones
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- Joint
  - Default pose
  - Limited transformations
Pose description

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Pose description

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- Bones – **Automatic**
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Pose description

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- Rigid bodies
- Bones – **Automatic**
  - Parent link
  - Children links
- Joint – **Kinematic Rules**
  - Default pose
  - Limited transformations
  - Current transformation
Starting configuration
Sequential split
Parallel split

NO CHILDREN ALLOWED DURING A PARALLEL SPLIT
Component split
Properties

- Kinematic independence
Grammar Example

BuildingRoot →
   Subdiv("Y", 3.5){Basement|Floor}

Floors → Repeat("Y", 3a){Floor}
Grammar Example

BuildingRoot →
   Subdiv("Y", 3.5){Basement|Floor}

Floors → Repeat("Y", 3a){Floor}

Floor →
   Comp("sidefaces"){FloorFacade}

FloorFacade →
   Repeat("Y", 1.5a){WindowPane}
Grammar Example

BuildingRoot →
    Subdiv(“Y”, 3.5){Basement|Floor}

Floors → Repeat(“Y”, 3a){Floor}

Floor →
    KinematicRotation(RotLimits,CurrentRot)
    Comp(“sidefaces”){FloorFacade}

FloorFacade →
    Repeat(“Y”, 1.5a){WindowPane}
Grammar Example
Conclusions

- Poses enrich semantics
  - Rule based
- Simple extension to CGA
  - Integration
  - Interactivity
- Rigging for free
  - Post-processing
Future Work

- Connectivity preservation
- Mass and stability
- Deformations
- Animation
- IK

Martin Ilčík
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