X3DOM

+

H-Anim

Bullet Physics

An introduction to x3dom – physics and making a ragdoll using hanim

2015

Alexandros-Apollon Rodopoulos
TEI of Crete MCLAB

SCOPE

- *Kinesiology*
- *Introduce H-Anim*
- *Bullet Physics / Ammo.js*
- *Exploit H-Anim*

Kinesiology

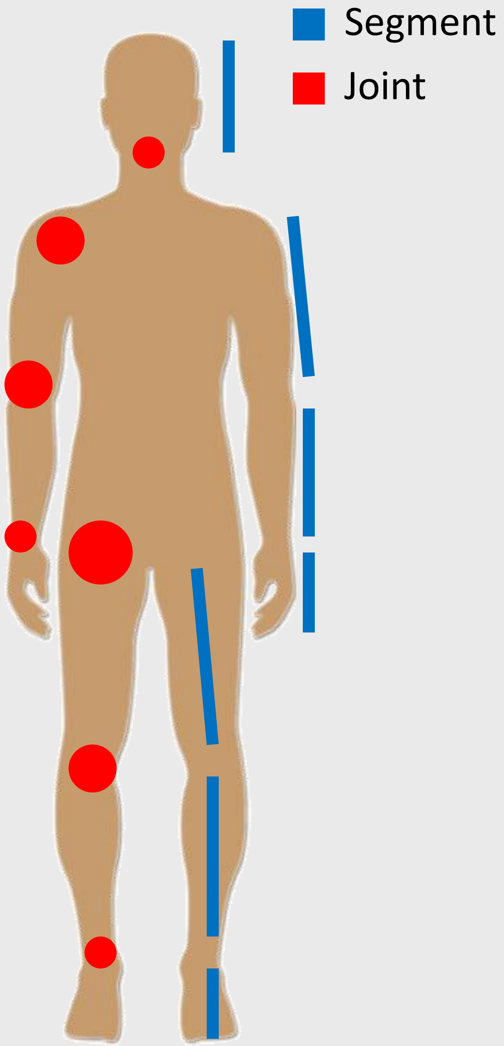
- Is the study of human and animal movement
- Three major systems:
  - Nervous System
  - Skeletal System
  - Muscular System

Kinesiology

Skeletal System

- Joints and Segments
- Some attributes of them

Joints	Segments
DoF	Mass
Limits	Length
Type of joint	Center of mass
	Inertia



designed by Freepik.com

H-Anim

- **Compatibility** *(is a standard to representing humanoids in VRML97)*

- **Flexibility** *(allowing to create a humanoid with a different tool and animated with other)*

- **Simplicity** *(it makes a lot easier the use of models and sharing)*

H-Anim

In order to simplify the creation of humanoids they developed **five** new nodes:

- Joint Node
- Segment Node
- Site Node
- Displacer Node
- Humanoid Node

H-Anim

Joint Node

- **Represents** the joint in the body
- Gives rotation and motion to segments
- Can only be child of another Joint node

Fields	Information
name	Must exists, standard name
llimit	Optional, lower joint limits
ulimit	Optional, upper joint limits
…others …	….

H-Anim

Segment Node

- **Represents** the segment in the body
- Can have Shapes or Transform nodes

Fields	Information
name	Must exists, standard name
mass	Optional, the mass of the segment
centerOfMass	Optional, center of mass
…others …	….

H-Anim

Site Node

- **Defines** an “end effector” location
- An attachment point for accessories (*jewelry*)
- Location for a virtual camera (*through eyes*)

Fields	Information
name	Must exists , "_tip" suffix appended
children	Stores any accessories to the segment
translation	Defines the location of end effector
…others…	….

H-Anim

Displacer Node

- **Identifies** specific groups of vertices (eyebrows)
- Represents particular muscular action
- Complete configuration of vertices in a Segment

Fields	Information
name	Must exists , "_feature" suffix or “_action” for motion
…others…	….

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H-Anim

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Humanoid Node

- **Stores** human-readable data
- Can be used for positioning in space

Fields	Information
name	Must be present, for identification
version	Version of specification that follows
info	Information's about the author and the model
…others…	….

H-Anim

Basic Modeling

- The humanoid must be in a standing position
- Facing +Z, +Y Up and +X to the humanoid’s left
- Origin (0,0,0) located at ground level between the feet

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H-Anim Hierarchy-Names

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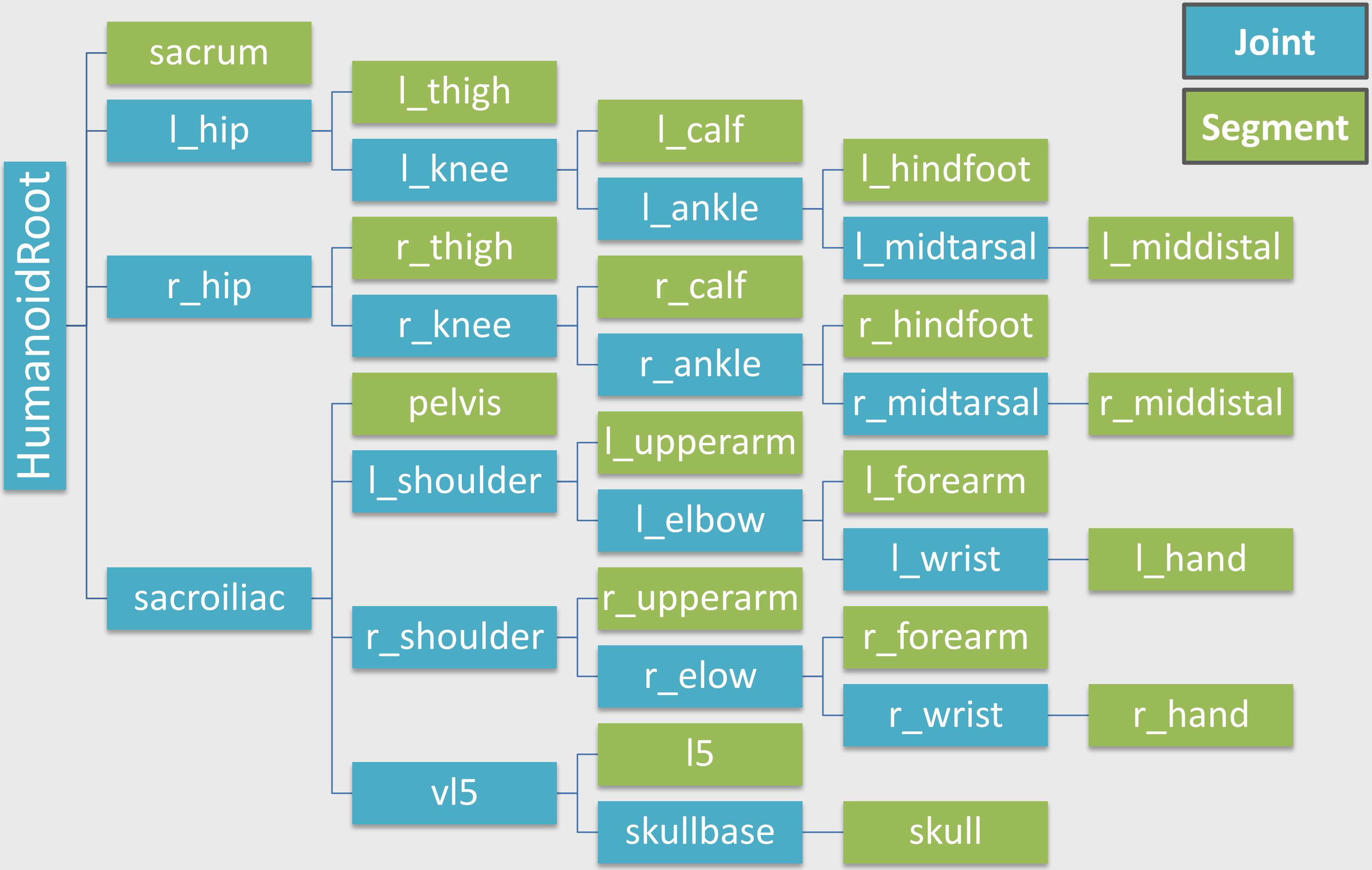


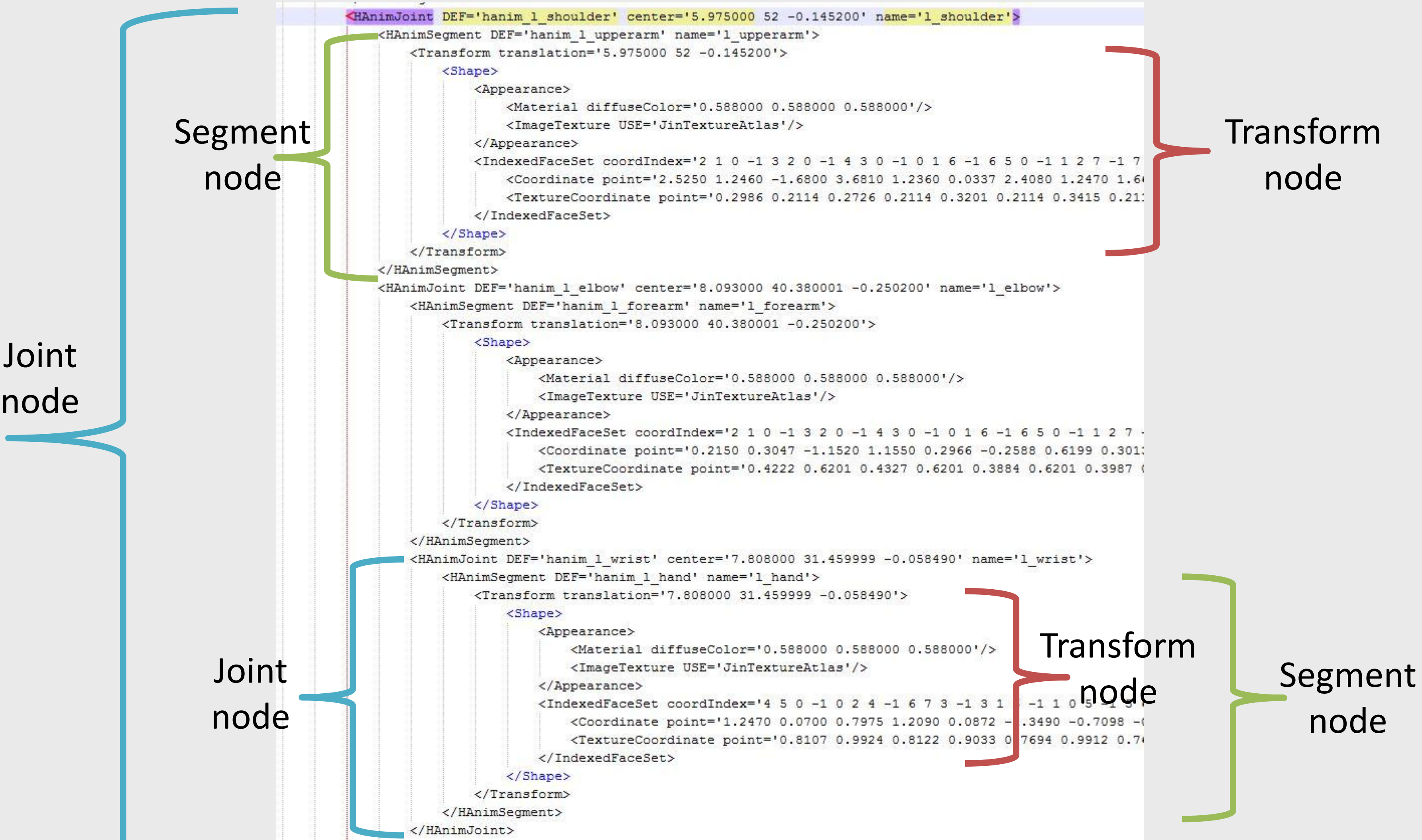
Joint

Segment

- HumanoidRoot
  - sacrum
  - l_hip
    - l_thigh
    - l_knee
      - l_calf
      - l_ankle
        - l_hindfoot
        - l_midtarsal
          - l_middistal
  - r_hip
    - r_thigh
    - r_knee
      - r_calf
      - r_ankle
        - r_hindfoot
        - r_midtarsal
          - r_middistal
  - sacroiliac
    - pelvis
    - l_shoulder
      - l_upperarm
      - l_elbow
        - l_forearm
        - l_wrist
          - l_hand
    - r_shoulder
      - r_upperarm
      - r_elow
        - r_forearm
        - r_wrist
          - r_hand
    - vl5
      - l5
      - skullbase
        - skull

H-Anim

H-Anim in **X3DOM:**



```
<HAnimJoint DEF='hanim_l_shoulder' center='5.975000 52 -0.145200' name='l_shoulder'>
    <HAnimSegment DEF='hanim_l_upperarm' name='l_upperarm'>
        <Transform translation='5.975000 52 -0.145200'>
            <Shape>
                <Appearance>
                    <Material diffuseColor='0.588000 0.588000 0.588000'/>
                    <ImageTexture USE='JinTextureAtlas'/>
                </Appearance>
                <IndexedFaceSet coordIndex='2 1 0 -1 3 2 0 -1 4 3 0 -1 0 1 6 -1 6 5 0 -1 1 2 7 -1 7
                    <Coordinate point='2.5250 1.2460 -1.6800 3.6810 1.2360 0.0337 2.4080 1.2470 1.6
                    <TextureCoordinate point='0.2986 0.2114 0.2726 0.2114 0.3201 0.2114 0.3415 0.21
                </IndexedFaceSet>
            </Shape>
        </Transform>
    </HAnimSegment>
    <HAnimJoint DEF='hanim_l_elbow' center='8.093000 40.380001 -0.250200' name='l_elbow'>
        <HAnimSegment DEF='hanim_l_forearm' name='l_forearm'>
            <Transform translation='8.093000 40.380001 -0.250200'>
                <Shape>
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                        <Coordinate point='0.2150 0.3047 -1.1520 1.1550 0.2966 -0.2588 0.6199 0.301
                        <TextureCoordinate point='0.4222 0.6201 0.4327 0.6201 0.3884 0.6201 0.3987
                    </IndexedFaceSet>
                </Shape>
            </Transform>
        </HAnimSegment>
        <HAnimJoint DEF='hanim_l_wrist' center='7.808000 31.459999 -0.058490' name='l_wrist'>
            <HAnimSegment DEF='hanim_l_hand' name='l_hand'>
                <Transform translation='7.808000 31.459999 -0.058490'>
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                            <TextureCoordinate point='0.8107 0.9924 0.8122 0.9033 0[illegible]7694 0.9912 0.7
                        </IndexedFaceSet>
                    </Shape>
                </Transform>
            </HAnimSegment>
        </HAnimJoint>
```

Segment node

Transform node

Joint node

Joint node

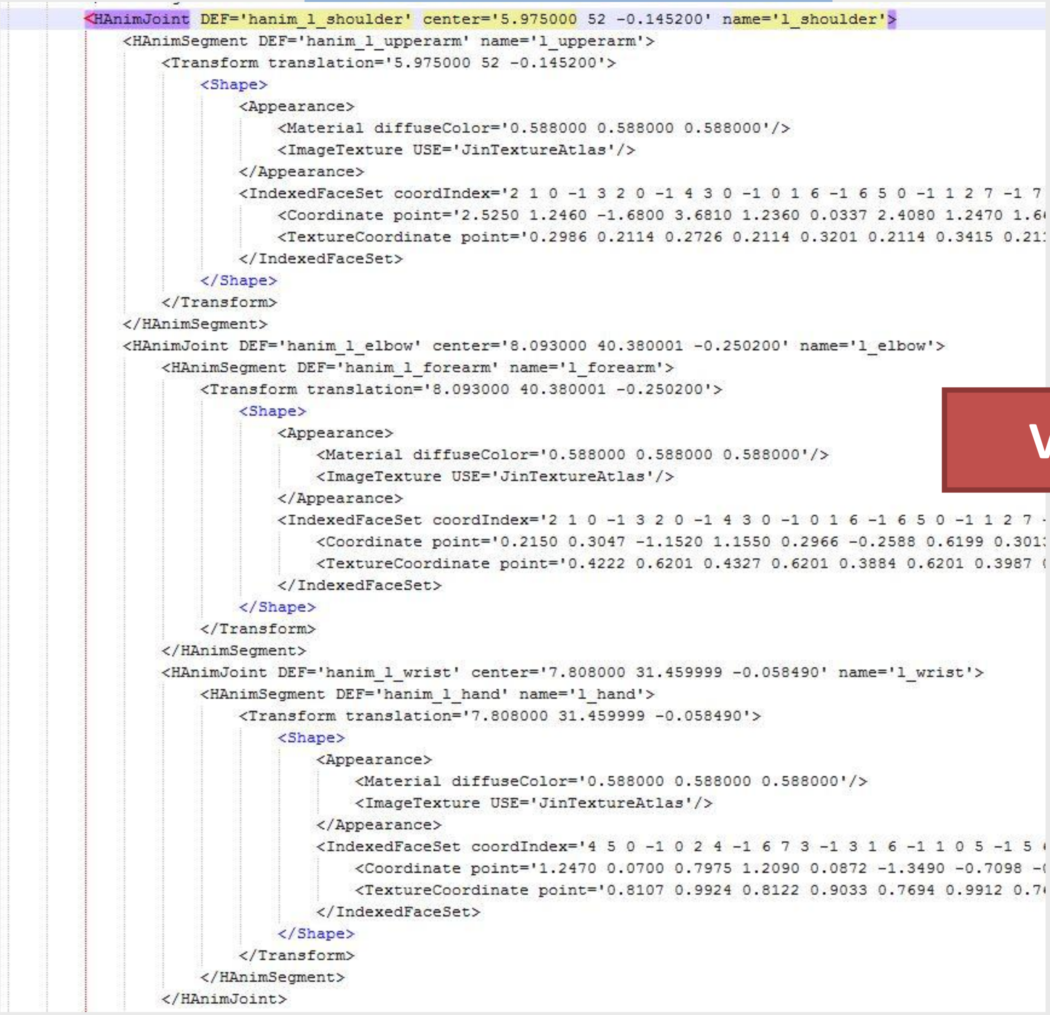
Transform node

Segment node

H-Anim

H-Anim in **X3DOM:**

xhtml Code



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                        <Coordinate point='0.2150 0.3047 -1.1520 1.1550 0.2966 -0.2588 0.6199 0.301
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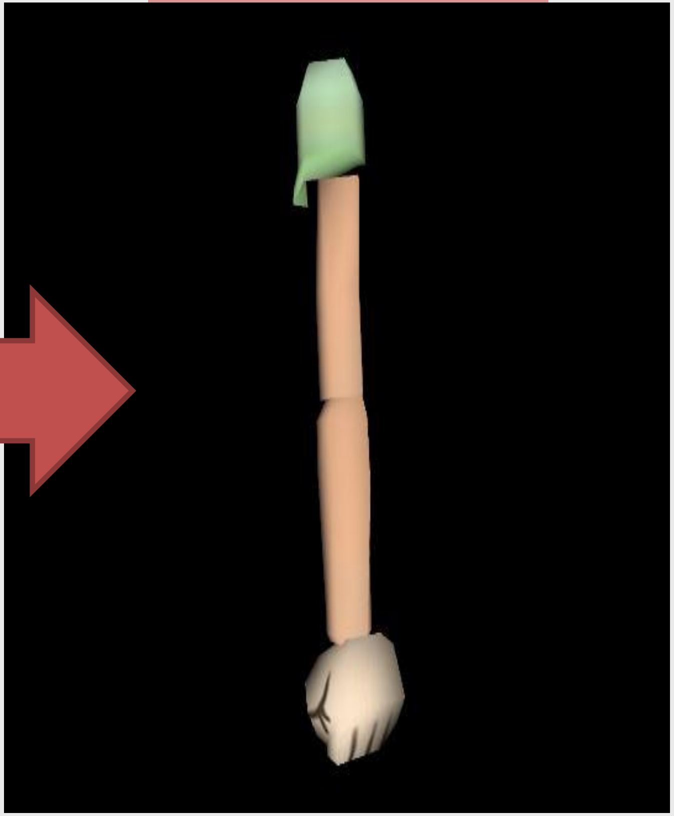
                            <ImageTexture USE='JinTextureAtlas'/>
                        </Appearance>
                        <IndexedFaceSet coordIndex='4 5 0 -1 0 2 4 -1 6 7 3 -1 3 1 6 -1 1 0 5 -1 5 
                            <Coordinate point='1.2470 0.0700 0.7975 1.2090 0.0872 -1.3490 -0.7098 -
                            <TextureCoordinate point='0.8107 0.9924 0.8122 0.9033 0.7694 0.9912 0.7
                        </IndexedFaceSet>
                    </Shape>
                </Transform>
            </HAnimSegment>
        </HAnimJoint>
```

Visual

X3D Scene



Bullet Physics

- Is a **physics engine** giving us simulation
- Is written in C, C++
- **Free** and **open-source** software

Features	About
Simulation	Collision detection, soft and rigid body dynamics
Collision shapes	Sphere, box, cylinder, cone, convex hull

Bullet Physics

Ammo.js

- The direct port of Bullet physics to JavaScript (*for web using*)

Collider Shapes	Constraining Methods
btSphereShape	btPoint2PointConstraint
btBoxShape	btSliderConstraint
btCylinderShape	btGeneric6DofConstraint
btConeShape	btUniversalConstraint
btConvexHullShape	btHingeConstraint
btCapsuleShape	btConeTwistConstraint

Bullet Physics

BulletPhysics.js

- Is an implementation of **rigid body physics** for **X3DOM**
- Enables **real-time** physics simulation in X3D scenes

X3D-Bullet Physics

- Pairing **Ammo.js** with **BulletPhysics.js** (*Collidable Shapes*)

X3D Collidable Shapes	Ammo.js Collider Shapes
Sphere	btSphereShape
Box	btSphereShape
Cylinder	btCylinderShape
Cone	btConeShape
IndexedFaceSet	btConvexHullShape
“Not exist”	btCapsuleShape

X3D-Bullet Physics

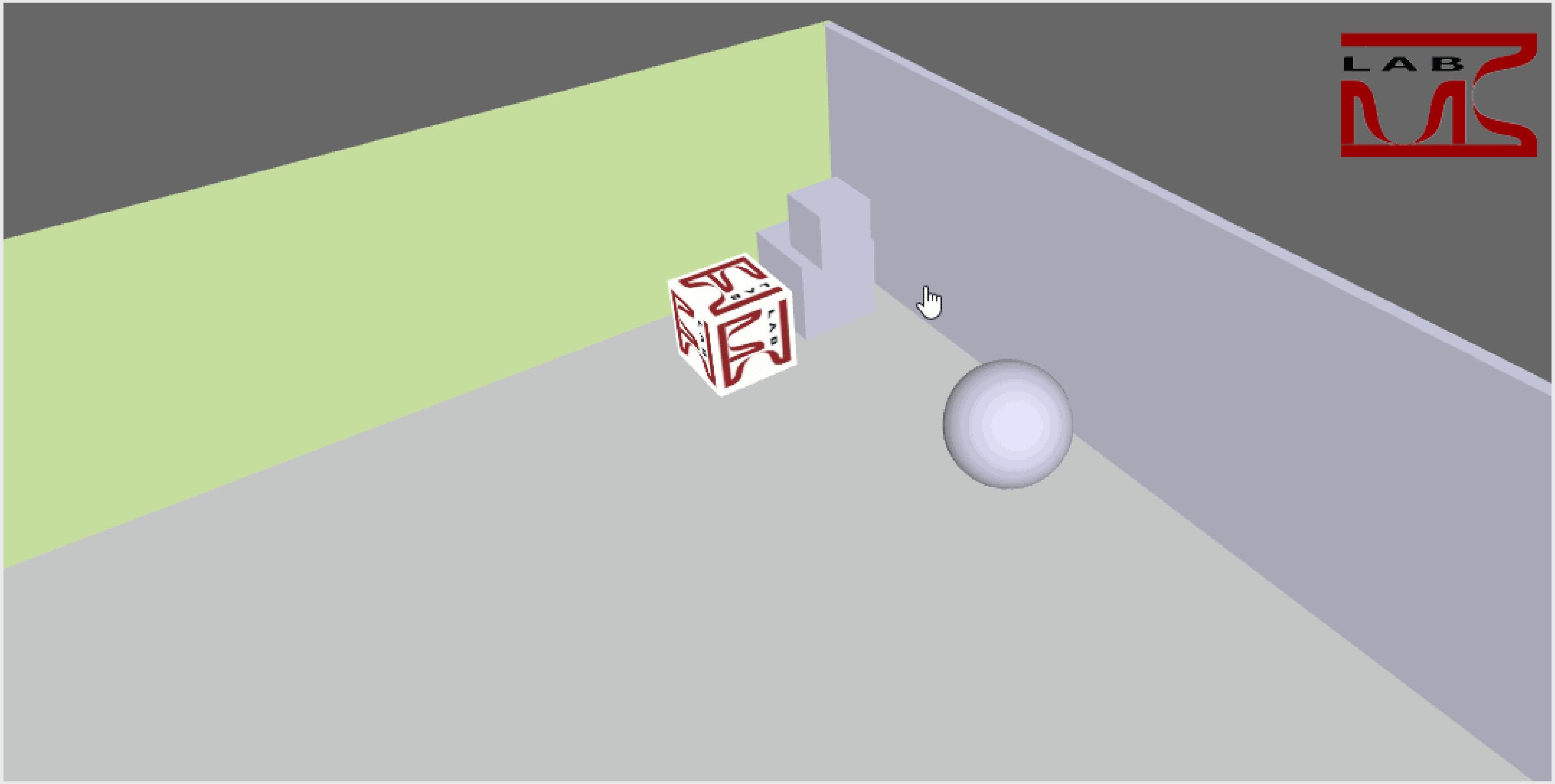
- Pairing **Ammo.js** with **BulletPhysics.js** (*Constrains-Joints*)

X3D Joints Types	Ammo.js Constraining Methods
BallJoint	btPoint2PointConstraint
SliderJoint	btSliderConstraint
MotorJoint	btGeneric6DofConstraint
UniversalJoint	btUniversalConstraint
SingleAxisHingeJoint	btHingeConstraint
DoubleAxisHingeJoint	btHingeConstraint

X3D-Bullet Physics

Demo 1:

Create a simple scene with rigid bodies



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X3D-Bullet Physics

Transform Node (*appears in X3D Scene "visual"*)

```
<Transform DEF='Floor' translation='0 -5 0' center='0 0 0'
rotation='0 0 1 0'>
```

Name of transform and location

```
    <Shape>
        <Appearance>
            <Material diffuseColor='0.87 0.87 0.87'
            emissiveColor='0.1 0.1 0.1' specularColor='0.1 0.1 0.1'/>
```

Colors or texture image

```
        </Appearance>
        <Box size='200 5 150'/>
```

Size of box (X,Y,Z)

```
    </Shape>
</Transform>
```

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X3D-Bullet Physics

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CollidableShape Node (*Physics part I*)

```
<CollidableShape DEF='SHAPE-Floor' containerField='children'
enabled='true' rotation='0 0 1 0'  translation='0 -5 0'>

    <Transform USE='Floor' containerField='physics'/>

        <Shape containerField='Shape'>

            <Box size='200 5 150'/>

        </Shape>

</CollidableShape>
```

Set with the same attributes from Transform and USE it

RigidBody Node (*Physics part II*)

```
<RigidBodyCollection DEF='BODY_COLLECTION'
containerField='children' enabled='true'
gravity='0 -9.8 0' >
```

Collection of rigid bodies

Defines gravity

Add rigid body inside

```
    <RigidBody DEF='BODY_Floor'
    containerField='bodies' enabled='true'
    fixed='true' mass='0' useGlobalGravity='true'>
```

Defines attributes

If fixed=true, then can’t be use mouse on it

If mass=0 gravity doesn’t affect

```
        <CollidableShape USE='SHAPE-Floor'
        containerField='geometry' enabled='true'/>
```

USE an exist collidable shape

```
    </RigidBody>

</RigidBodyCollection>
```

X3D-Bullet Physics

CollisionSensor Node (*Physics part III*)

```
<CollisionSensor DEF='COLLISION-OUTPUT' enabled='true'>
```

Sense the collisions of rigid bodies

```
    <CollisionCollection DEF='COLLISION-JOINTS-Group'
    bounce='0.1' containerField='collidables'
    minBounceSpeed='1.0' appliedParameters='BOUNCE'
    enabled='true' >
```

Setting the attributes and behaviors

```
        <CollidableShape USE='SHAPE-Floor'
        containerField='collidables' enabled='true'/>

    </CollisionCollection>
```

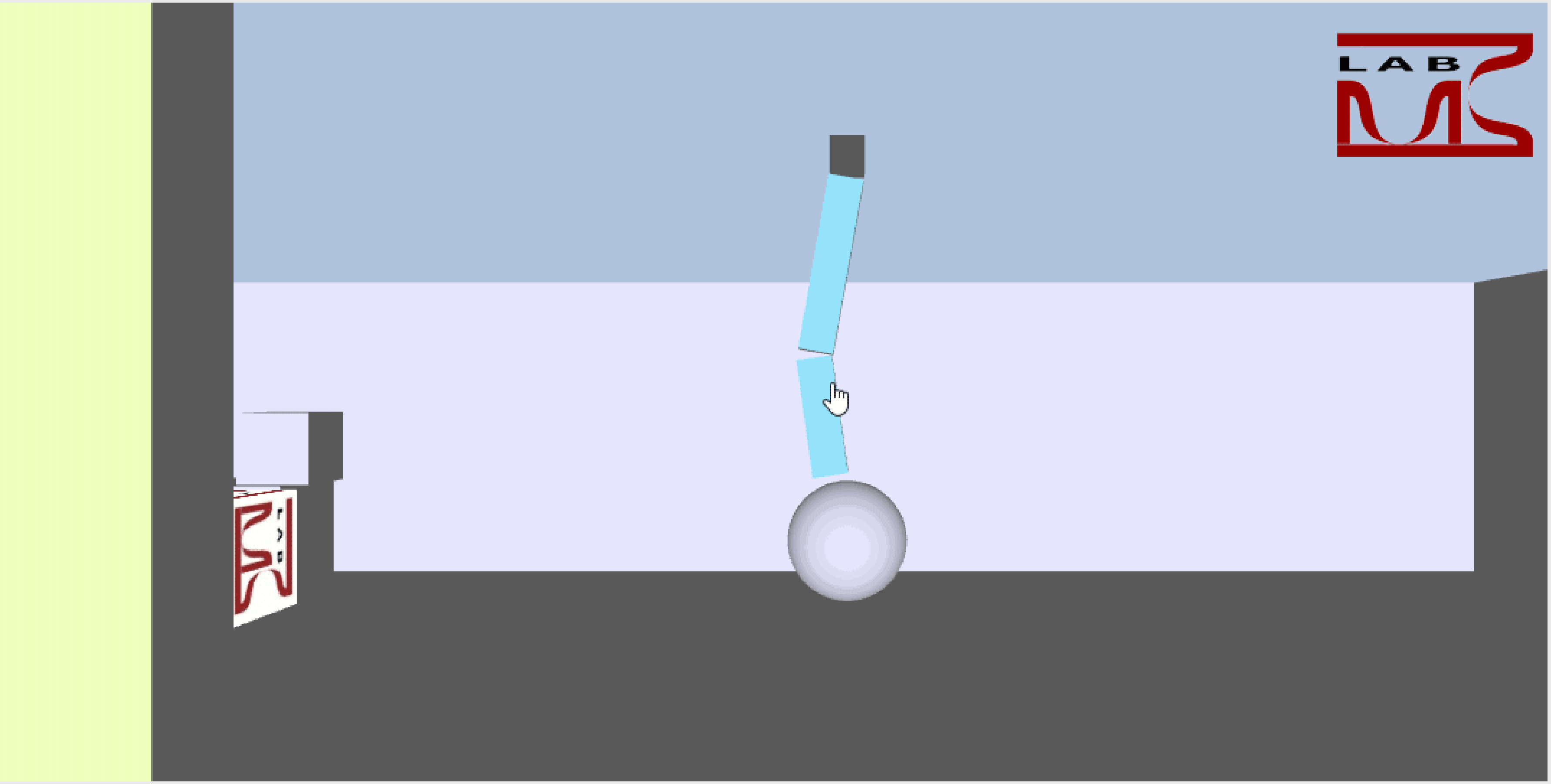
USE of collidable shape and enabled it

```
</CollisionSensor>
```

X3D-Bullet Physics

Demo 2:

Adding a simple hinge joint in the scene



X3D-Bullet Physics

Joint Node (*hinge constraint*)

```
<RigidBodyCollection DEF='BODY_COLLECTION'
containerField='children' enabled='true' gravity='0 -9.8 0' >
```

Includes joints

Setting attributes anchorPoints of rigid bodies (depend from their size)

```
    <SingleAxisHingeJoint anchorPoint1='0 1.5 0' anchorPoint2='0
    -8 0' maxAngle='90' minAngle='-90' axis='0 0 1'
    containerField='joints'>
```

Setting limits and axis of rotation

```
        <RigidBody USE='BODY_pendulum0' containerField='body1'/>

        <RigidBody USE='BODY_pendulum1' containerField='body2'/>

    </SingleAxisHingeJoint>

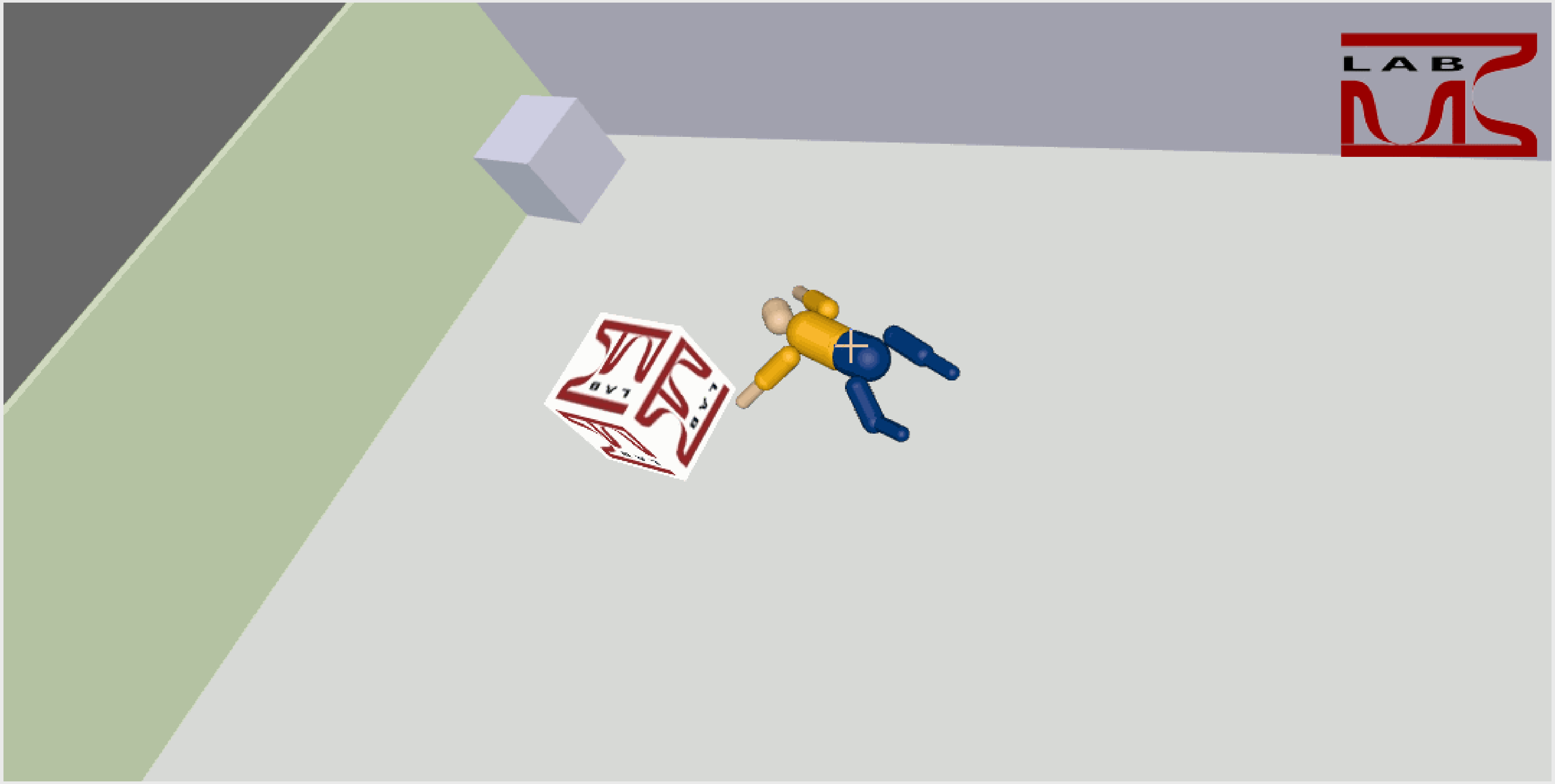
</RigidBodyCollection>
```

USE rigid bodies as body1 and body2

X3D-Bullet Physics

Demo 3:

Create a basic ragdoll



X3D-Bullet Physics

Ragdoll

- In order to simulate human motion we implemented a new joint
- **ConeTwistJoint** is useful for limbs like the upper arm or the upper leg

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X3D-Bullet Physics

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ConeTwistJoint

Attributes	About
anchorPoint1	Specifies origin of body1
anchorPoint2	Specifies origin of body2
euler1	Specifies angle of body1
euler2	Specifies angle of body2
swingSpan1	The limit on the Z rotation axis in degrees
swingSpan2	The limit on the Y rotation axis in degrees
twistSpan	The limit on the X rotation axis in degrees

X3D-Bullet Physics

Creating a **ragdoll** using H-Anim prototype:

- Create **dynamically** ragdolls from file
- More **realistic**

Benefits	Details
Dynamic	Dynamic creation of humanoids
Accurate	More accurate calculations
Fast	Faster than the normal way

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X3D-Bullet Physics

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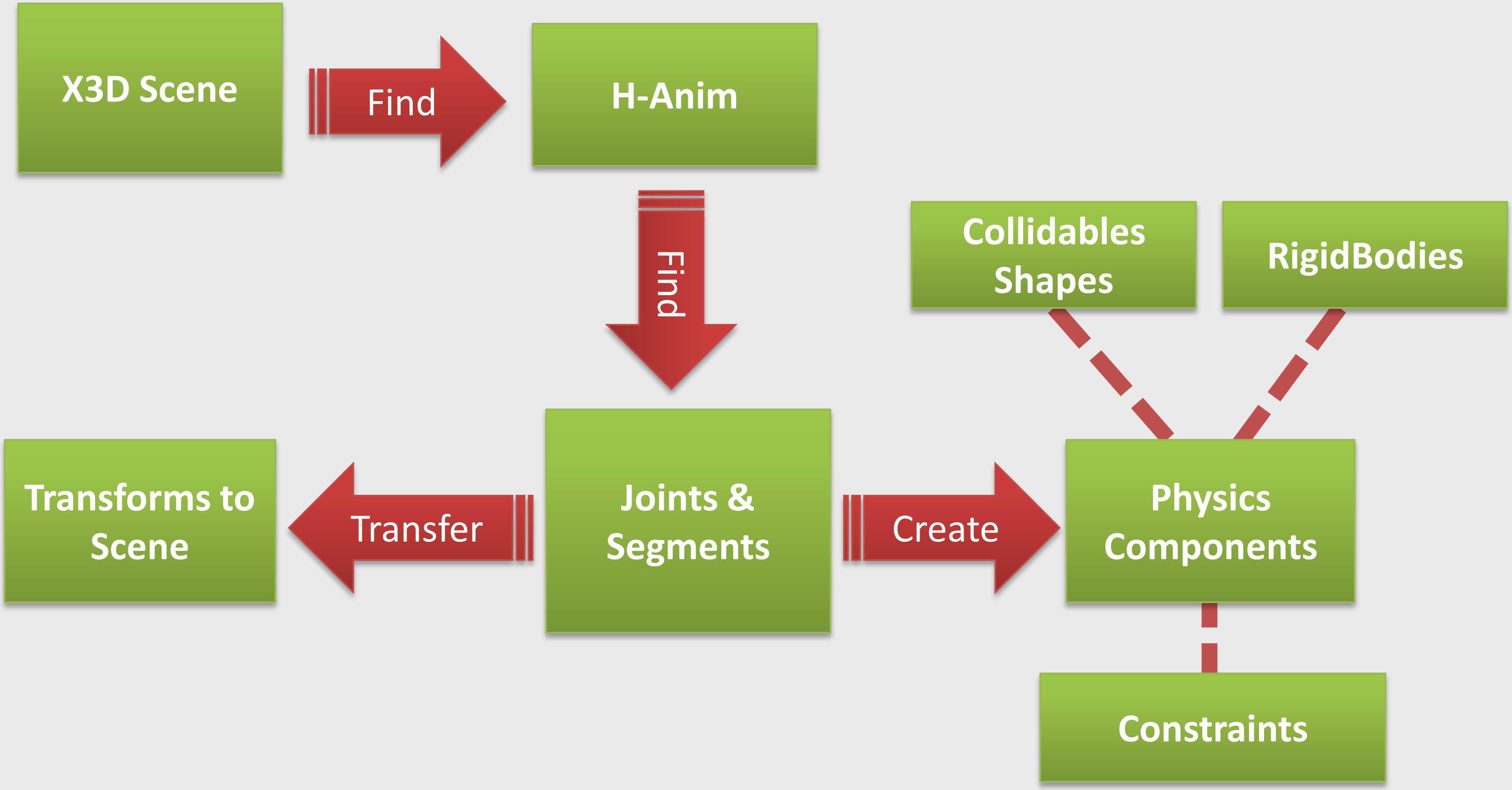
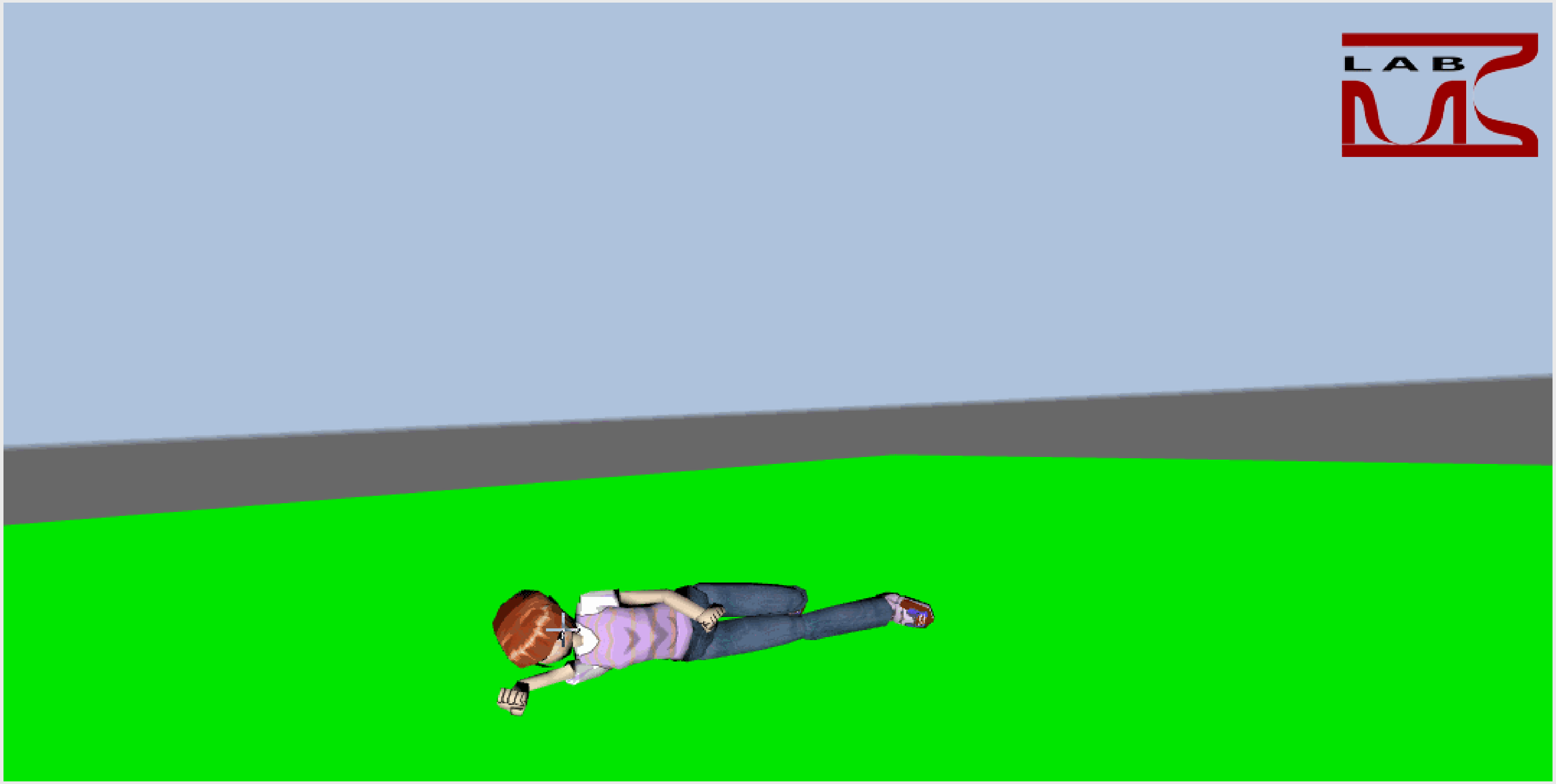
We developed a **JavaScript**, for that work



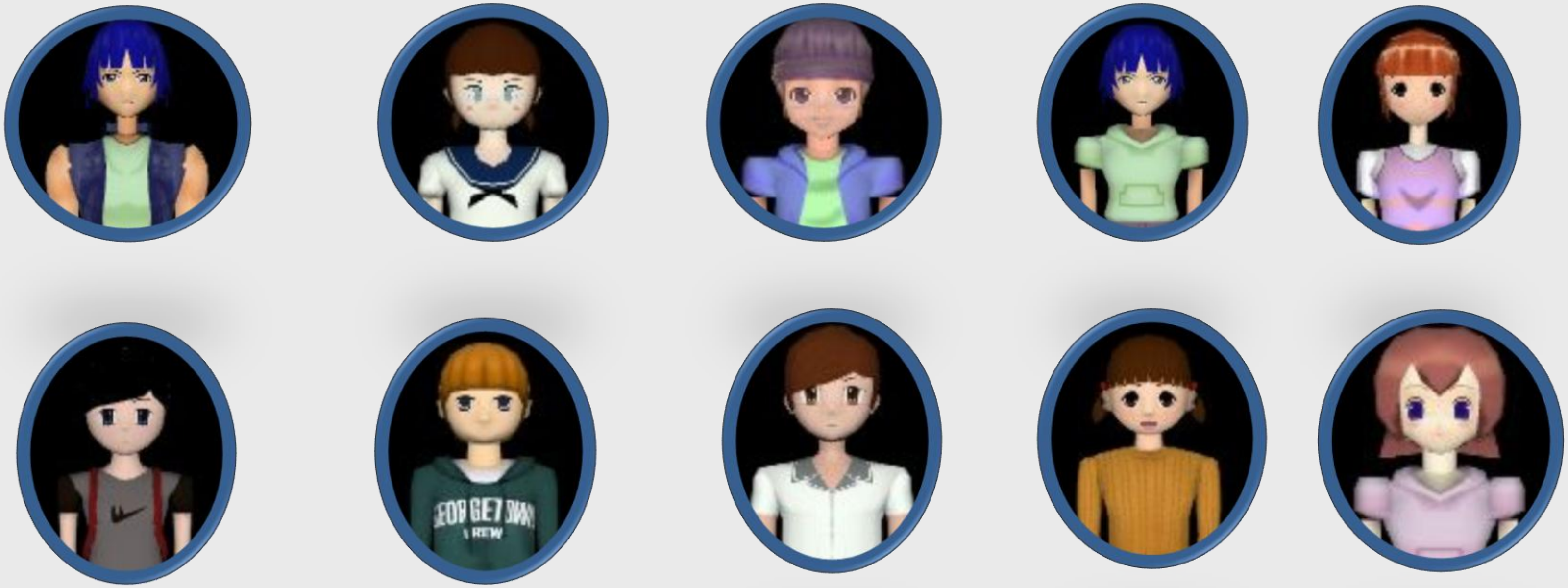
X3D-Bullet Physics

H-Anim based ragdoll:



X3D-Bullet Physics

We can support **several** models from **H-Anim** examples



Thanks!