

# H-Anim Architecture and Motion Capture

H-Anim WG Meeting  
Web3D BoF at SIGGRAPH

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# Status of H-Anim Revision

- NWIPs
  - ISO/IEC 19774 Humanoid Animation – Part 1: Architecture
  - ISO/IEC 19774 Humanoid Animation – Part 2: Motion Capture
- H-Anim models and motion capture animation
  - H-Anim modeling using a general graphics tool
    - Wrl-to-x3d H-Anim model converter for LOA1, LOA2, and LOA3 H-Anim models
  - H-Anim motion capture animation
    - Joint mapper between motion capture data and an H-Anim model
    - Bvh-to-x3d Interpolators converter
    - H-Anim motion viewer for LOA1, LOA2, and LOA3 H-Anim models
    - H-Anim motion editor with LOA1, LOA2, and LOA3 H-Anim models, and BVH motion capture data

# ISO/IEC 19774 Humanoid Animation V1.0: 2006

- Foreword
- Introduction
- 1. Scope
- 2. Normative references
- 3. Terms and definitions
- 4. Concepts
- 5. Abstract data types
- 6. Object interfaces
- 7. Conformance
- Annexes
  - A. Nominal body dimensions and levels of articulation
  - B. Feature points for the human body
  - C. VRML binding
  - D. X3D binding
  - E. Guidelines for H-Anim in VRML and X3D worlds
- Bibliography

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# Humanoid Animation-Part 1: Architecture

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# Humanoid Animation-Part 2: Motion Capture

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4 Symbols (and abbreviated terms)

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5.12 Exchange of characters from design systems to H-Anim systems

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8 Schema expansion for H-Anim motion definition

9 Use Cases

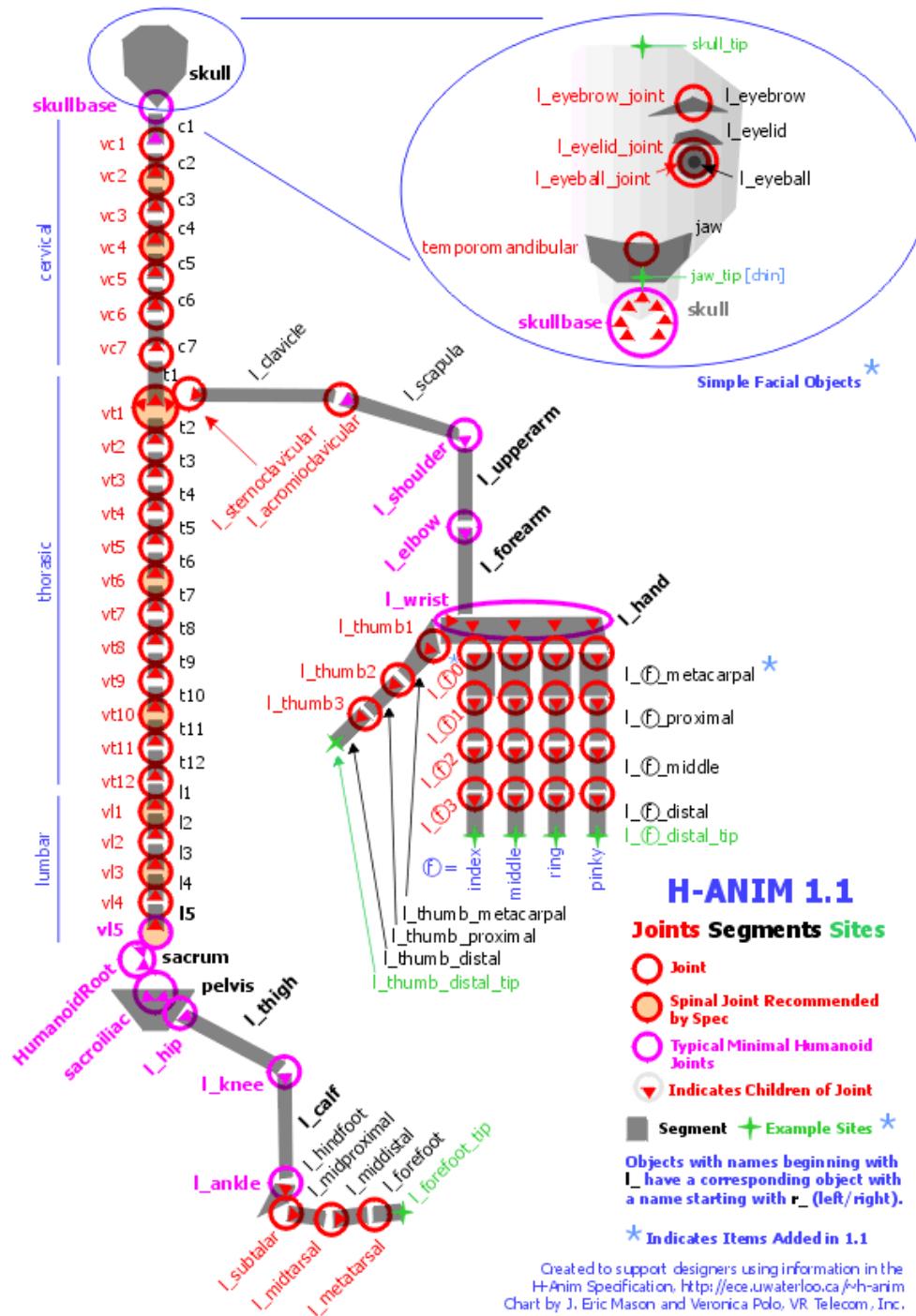
10 Conformance

Annexes

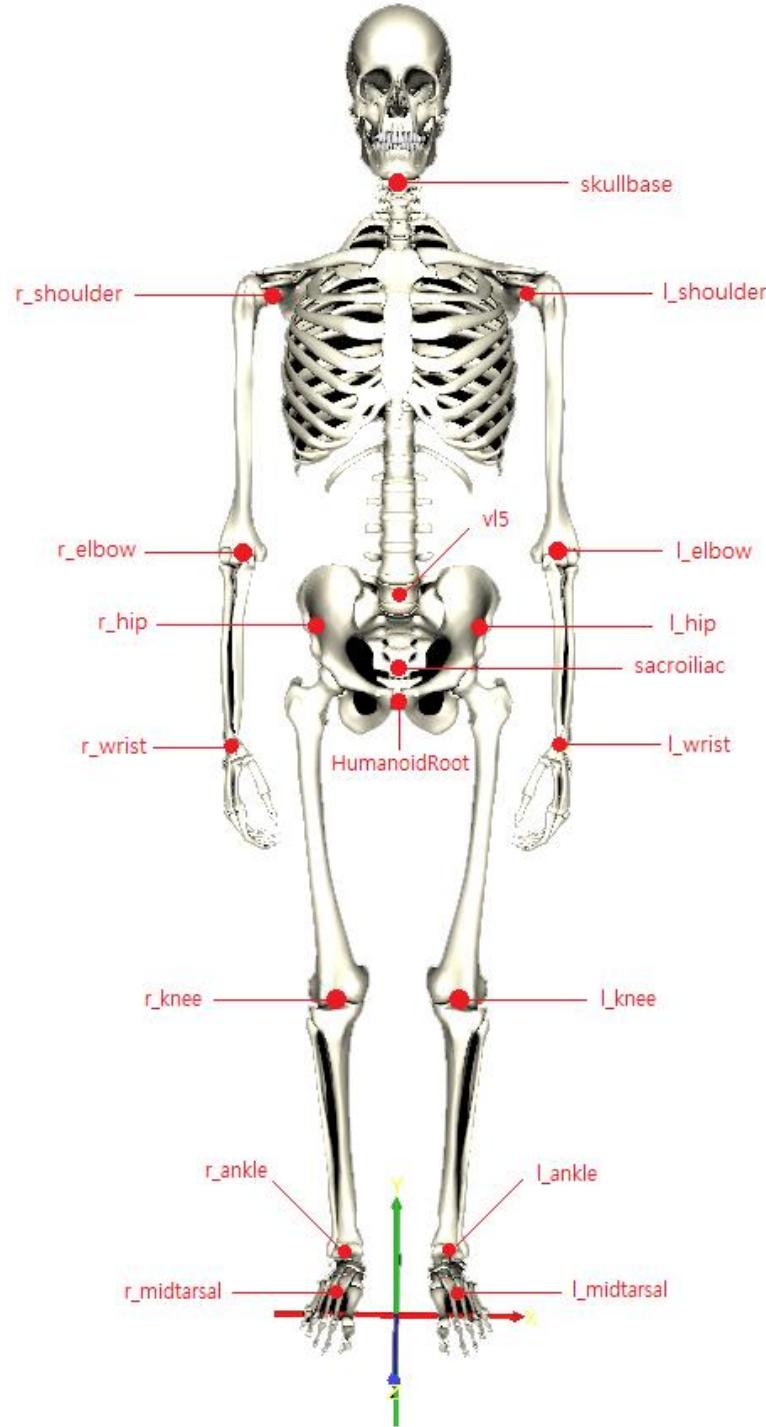
H-Anim Character Modeling Method

Bibliography

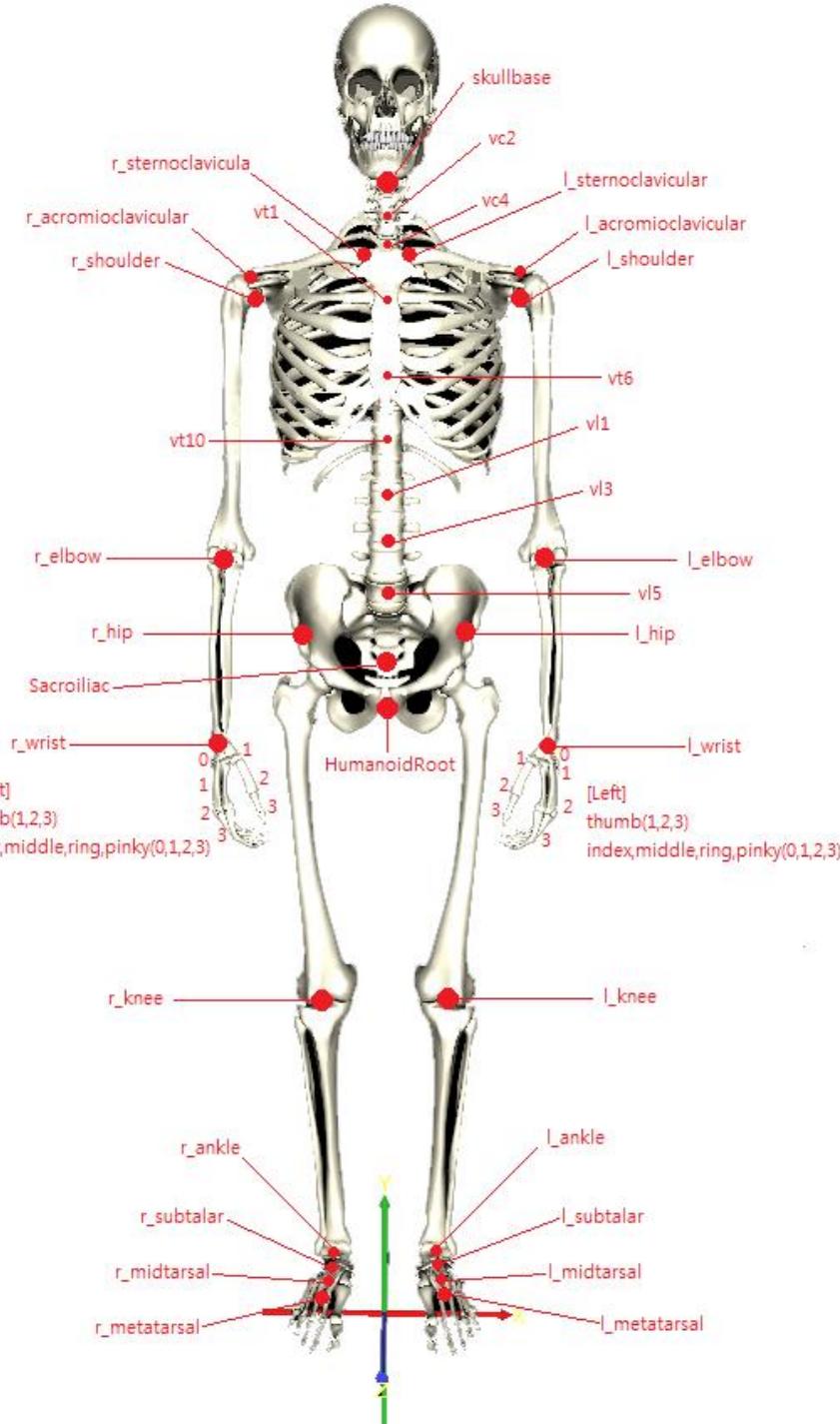
# H-Anim Hierarchy



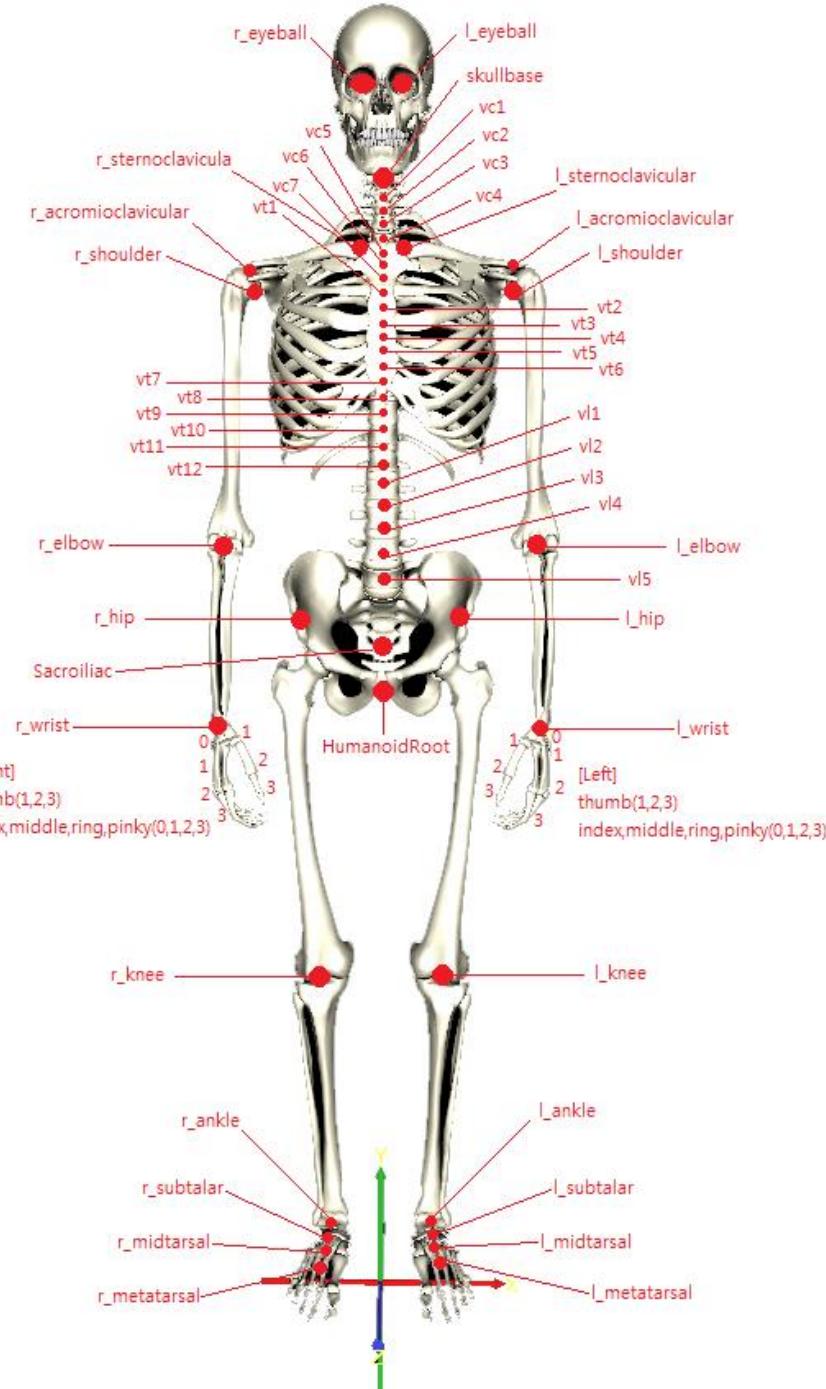
# LOA 1



# LOA 2



# LOA 3



# LOA1 H-Anim Characters (X3D H-Anim)



1.Jin



2.Chul



3.Hyun



4.Young



5.Ju



6.Ga



7.No



8.Da



9.Ru



10.Mi

# LOA2 H-Anim Characters (X3D H-Anim)



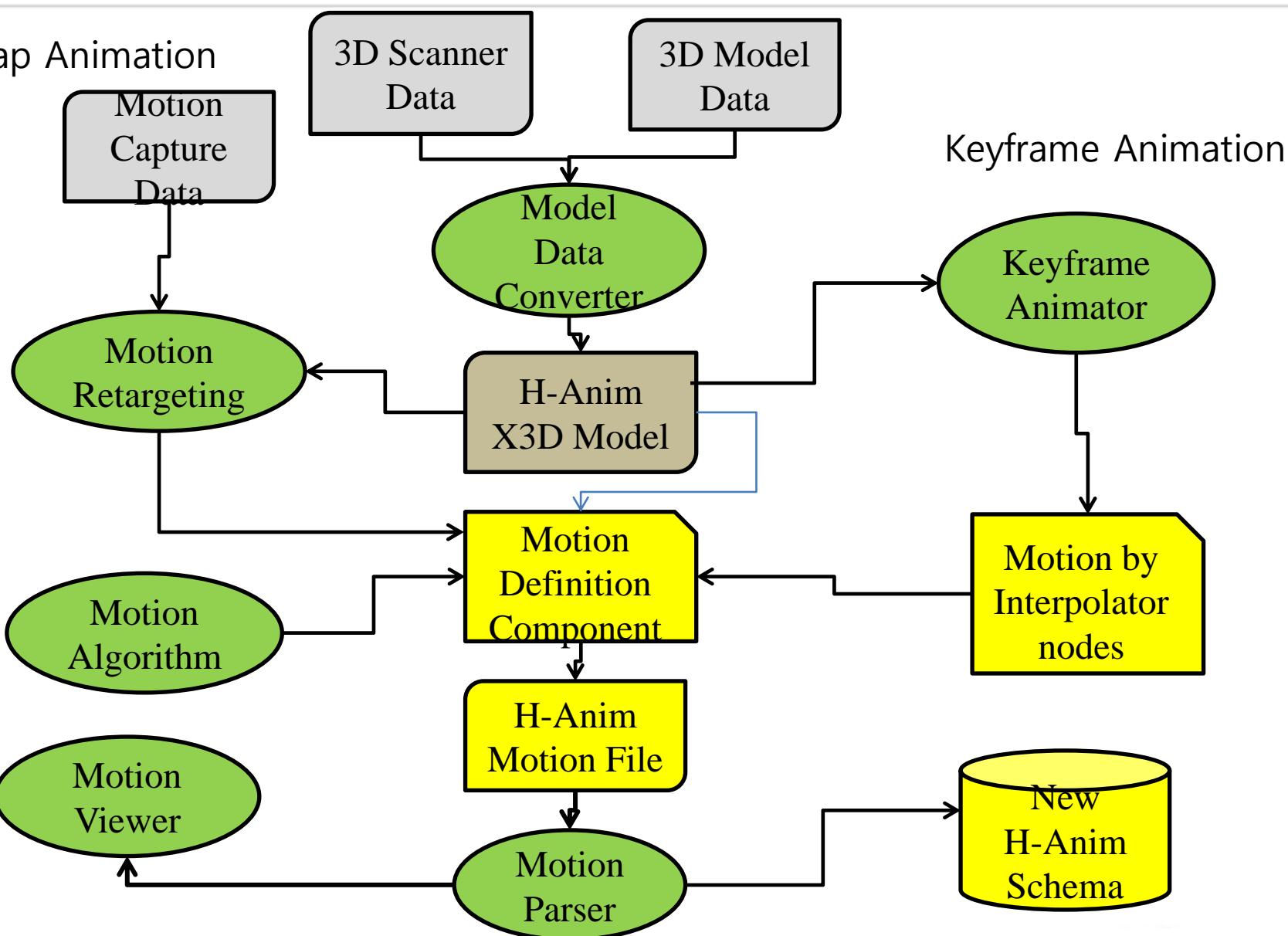
2.Chul



11.Min

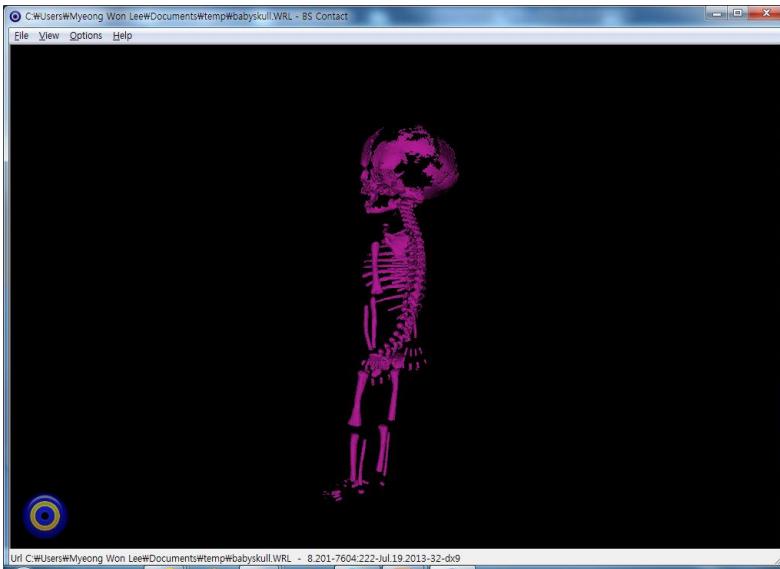
# H-Anim Character Animation Generation

Mocap Animation



# Modeling an H-Anim Character

- ◆ Design using general tools (e.g. 3ds Max)
  - ◆ Model a segment with H-Anim joint name, define center of each joint, integrate segments, and complete an H-Anim human figure
  
- ◆ Design using 3D scanner data
  - ◆ Obtain scanner data , divide each segment,data, provide each segment joint name of H-Anim, provide each center of joint, and integrate segments, and complete an H-Anim human figure



# Mocap and H-Anim LOA1 Joint

Mocap (BVH) Joint Name	H-Anim Joint Name (OLD)
Hips	HumanoidRoot
LeftHip	l_hip
LeftKnee	l_knee
LeftAnkle	l_ankle
RightHip	r_hip
RightKnee	r_knee
RightAnkle	r_ankle
Chest	vl1
LeftCollar	l_sternoclavicular
LeftShoulder	l_shoulder
LeftElbow	l_elbow
LeftWrist	l_wrist
RightCollar	r_sternoclavicular
RightShoulder	r_shoulder
RightElbow	r_elbow
RightWrist	r_wrist
Neck	vc4
Head	Skullbase

H-Anim Joint Name (19774:2006 v1.0)
HumanoidRoot
l_hip
l_knee
l_ankle
r_midtarsal
r_hip
r_knee
r_ankle
vl5
l_shoulder
l_elbow
l_wrist
l_midtarsal
r_shoulder
r_elbow
r_wrist
sacroiliac
Skullbase

# Mocap data example: bvh (1)

HIERARCHY

ROOT Hips

{

OFFSET 0.000000 0.000000 0.000000

CHANNELS 6 Xposition Yposition Zposition Zrotation Xrotation Yrotation

JOINT Chest

{

OFFSET 0.000000 5.613096 0.000000

CHANNELS 3 Zrotation Xrotation Yrotation

JOINT LeftCollar

{

OFFSET 0.003804 10.354579 1.025227

CHANNELS 3 Zrotation Xrotation Yrotation

JOINT LeftShoulder

{

OFFSET 3.922637 0.000000 0.000000

CHANNELS 3 Zrotation Xrotation Yrotation

JOINT LeftElbow

...

# Mocap data example: bvh (2)

## MOTION

Frames: 482

Frame Time: 0.016667

1.662 31.427 60.304 -1.249 -4.859 -3.582 4.463 1.354 0.075 -13.732 3.052 3.999 95.677 1.705 -1.512 5.541 -3.491  
0.339 1.259 -3.022 1.790 6.765 2.405 -4.446 -91.027 -7.187 4.910 -3.633 0.867 0.043 -2.879 0.120 -5.688 -  
1.132 -1.858 0.809 -2.969 -8.472 1.461 -1.304 3.919 -2.045 1.054 9.006 -0.191 2.695 -1.341 -0.615 0.361 4.452  
4.756 0.484 8.095 0.193 -6.340 -0.815 1.224

1.659 31.427 60.307 -1.268 -4.835 -3.588 4.487 1.352 0.080 -13.802 3.059 3.999 95.651 1.737 -1.609 5.541 -3.521  
0.340 1.298 -3.030 1.974 6.795 2.410 -4.418 -90.999 -7.145 4.917 -3.633 0.825 0.043 -2.862 0.151 -5.736 -  
1.141 -1.863 0.806 -2.988 -8.482 1.455 -1.283 3.890 -2.157 1.055 9.042 -0.193 2.781 -1.350 -0.638 0.381 4.430  
4.692 0.484 8.102 0.194 -6.266 -0.819 1.206

1.657 31.428 60.310 -1.287 -4.811 -3.594 4.512 1.349 0.085 -13.872 3.066 3.999 95.624 1.769 -1.707 5.542 -3.550  
0.341 1.337 -3.038 2.159 6.824 2.417 -4.389 -90.970 -7.101 4.924 -3.633 0.783 0.043 -2.845 0.182 -5.783 -  
1.150 -1.869 0.804 -3.006 -8.492 1.449 -1.262 3.860 -2.270 1.055 9.077 -0.196 2.867 -1.358 -0.661 0.401 4.408  
4.628 0.484 8.108 0.194 -6.189 -0.824 1.187

1.654 31.428 60.313 -1.306 -4.787 -3.599 4.536 1.347 0.090 -13.942 3.073 3.999 95.596 1.801 -1.804 5.542 -3.580  
0.342 1.376 -3.046 2.343 6.853 2.423 -4.360 -90.940 -7.056 4.931 -3.633 0.741 0.042 -2.827 0.212 -5.831 -  
1.159 -1.874 0.801 -3.024 -8.503 1.442 -1.241 3.831 -2.383 1.056 9.113 -0.198 2.953 -1.367 -0.684 0.420 4.386  
4.565 0.484 8.113 0.194 -6.107 -0.831 1.167

...

# Motion Definition Using X3D Interpolator

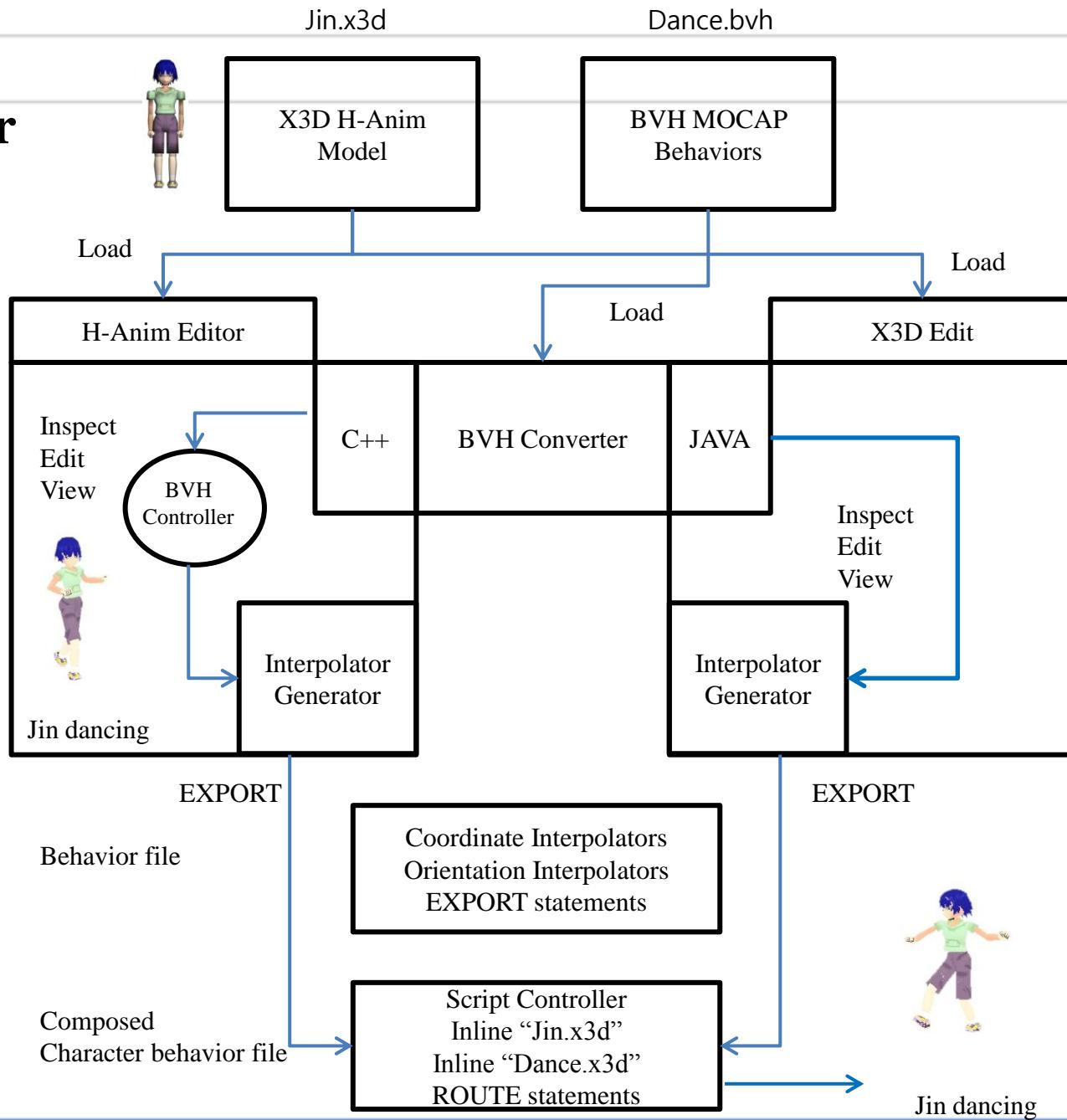
- ◆ Keyframe animation

```
<Group DEF='WalkAnimation'>  
  <TimeSensor DEF='WalkTimer' cycleInterval='1.73' enabled='true' loop='true' />  
  <OrientationInterpolator DEF='Walk_r_metatarsalPitch' key='0 0.2 0.4 0.6 0.7 1' keyValue='0 0 1 0 0 0 1 0 0 0 1 0 0 0  
  1 0 0 0 1 0 0 0 1 0' />  
  <OrientationInterpolator DEF='Walk_r_ankleRotInterp' key='0 0.125 0.2083 0.375 0.4583 0.5 0.6667 0.75 0.7917  
  0.9167 1' keyValue='0 0 1 0 -1 0 0 0.3533 -1 0 0 0.1072 1 0 0 0.2612 1 0 0 0.1268 -1 0 0 0.01793 -1 0 0 0.05824 -1 0 0  
  0.2398 -1 0 0 0.35 -1 0 0 0.3322 0 0 1 0' />  
  <OrientationInterpolator DEF='Walk_r_kneeRotInterp' key='0 0.125 0.2083 0.2917 0.375 0.5 0.6667 0.7917 0.9167 1'  
  keyValue='1 0 0 0.8573 1 0 0 0.8926 1 0 0 0.5351 1 0 0 0.1756 1 0 0 0.1194 1 0 0 0.3153 1 0 0 0.09354 1 0 0 0.08558 1  
  0 0 0.2475 1 0 0 0.8573' />  
  ...  
  <ROUTE fromField='fraction_changed' fromNode='WalkTimer' toField='set_fraction'  
  toNode='Walk_r_ankleRotInterp' />  
  <ROUTE fromField='fraction_changed' fromNode='WalkTimer' toField='set_fraction'  
  toNode='Walk_r_kneeRotInterp' />  
  ...  
  <ROUTE fromField='value_changed' fromNode='Walk_r_ankleRotInterp' toField='rotation' toNode='hanim_r_ankle' />  
  <ROUTE fromField='value_changed' fromNode='Walk_r_kneeRotInterp' toField='rotation' toNode='hanim_r_knee' />  
  ...  
</Group>
```

# BVH to X3D Interpolators Conversion

- ◆ Procedure
  - ◆ 1. Compute cycle time
  - ◆ 2. Compute interpolator key array
  - ◆ 3. Compute time sensor key array
  - ◆ 4. Compute key value array
  - ◆ 5. Convert BVH Euler to X3D SFRotation
    - ◆ Different rotation orders:
      - ◆ BVH: order specified
      - ◆ X3D: x-y-z order
- ◆ Problems
  - ◆ Many repetitive keywords and statements are included: TimeSensor, Interpolators, ROUTE statements ... per each BVH data at a time instant
  - ◆ Conceptually, using interpolators is not appropriate for motion capture data because interpolators are related to generate inbetweening data, but motion capture data have already all parameter data at all frames.

# BVH Converter



# Motion Definition Using Motion Capture Data

- ◆ Definition using X3D Interpolator (1)
  - ◆ Conversion of motion capture data (e.g. bvh) to X3D Interpolator
  - ◆ Bvh to X3D interpolator conversion
    - ◆ Requires conversion between euler angles and SFRotation angles
    - ◆ Requires conversion between the orders of parameter values
- ◆ Definition of a Motion Data Component (2)
  - ◆ Joint node (update)
    - ◆ Define additional fields for motion parameters
  - ◆ Motion node
    - ◆ Define motion captured data for an H-Anim character model
    - ◆ Define the motion node after adjusting the center of each joint to the H-Anim character model

# Joint Node Update (1)

```
Interface Joint {  
    // the same as the existing joint node  
    float[3] bboxCenter 0 0 0  
    float[3] bboxSize -1 -1 -1  
    float[3] center 0 0 0  
    sequence<Object> children []  
    sequence<Object> displacers []  
    sequence<float[3]> llimit []  
    float[4] limitOrientation 0 0 1 0  
    string name ""  
    float[4] rotation 0 0 1 0  
    float[3] scale 1 1 1  
    float[4] scaleOrientation 0 0 1 0  
    float[3] translation 0 0 0  
    sequence<float[3]> ulimit []  
  
    // define additional fields  
    int[2] ChannelsNumber  
    sequence<string> Channels  
}
```

```
HIERARCHY  
ROOT Hips  
{  
    OFFSET 0.000000 0.000000 0.000000  
    CHANNELS 6 Xposition Yposition Zposition Zrotation  
    JOINT Chest  
{  
        OFFSET 0.000000 5.613096 0.000000  
        CHANNELS 3 Zrotation Xrotation Yrotation  
        JOINT LeftCollar  
{  
            OFFSET 0.003804 10.354579 1.025227  
            CHANNELS 3 Zrotation Xrotation Yrotation  
        JOINT LeftShoulder  
{  
            OFFSET 3.922637 0.000000 0.000000  
            CHANNELS 3 Zrotation Xrotation Yrotation
```

- ◆ Fields for receiving motion capture data
  - ◆ Offset → corresponds to "center"
  - ◆ ChannelsNumber
  - ◆ Channels

# Joint Node Update (2)

- ◆ Define additional fields: Offset, Channels, ChannelsNumber (new fields)

```
Interface Joint {  
    ...  
  
    int[2]          ChannelsNumber  
    sequence<string>  Channels  
}
```

- ◆ ChannelsNumber: Number of channels at a joint
- ◆ Channels: Identifiers for channels

- ◆ Example

```
Joint {  
    ...  
  
    ChannelsNumber  [ 1, 3 ]  
    Channels        “ Xrotate  Yrotate  Zrotate ”  
}
```

# Motion Node

## ◆ Definition of Motion Node (a new node)

### ⊕ Define fields: Frames, FrameTime, Transformation Channels

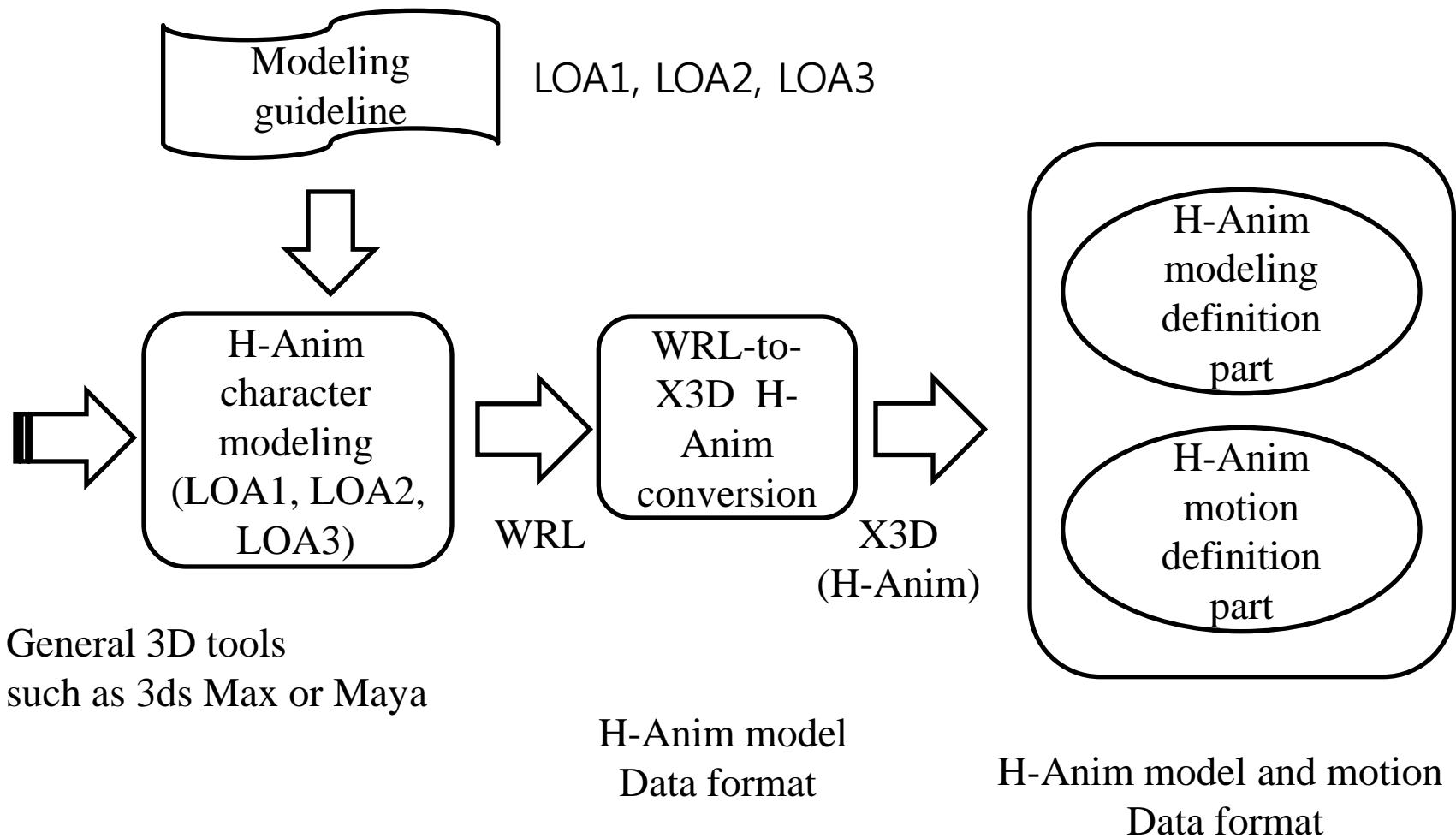
```
Interface Motion {  
    int          Frames  
    float        FrameTime  
    sequence<float> Transformation  
}
```

- ⊕ Frames: Number of frames for an animation sequence
- ⊕ FrameTime: Specifies a sampling rate
- ⊕ Transformation: Transformation values of a joint for each frame

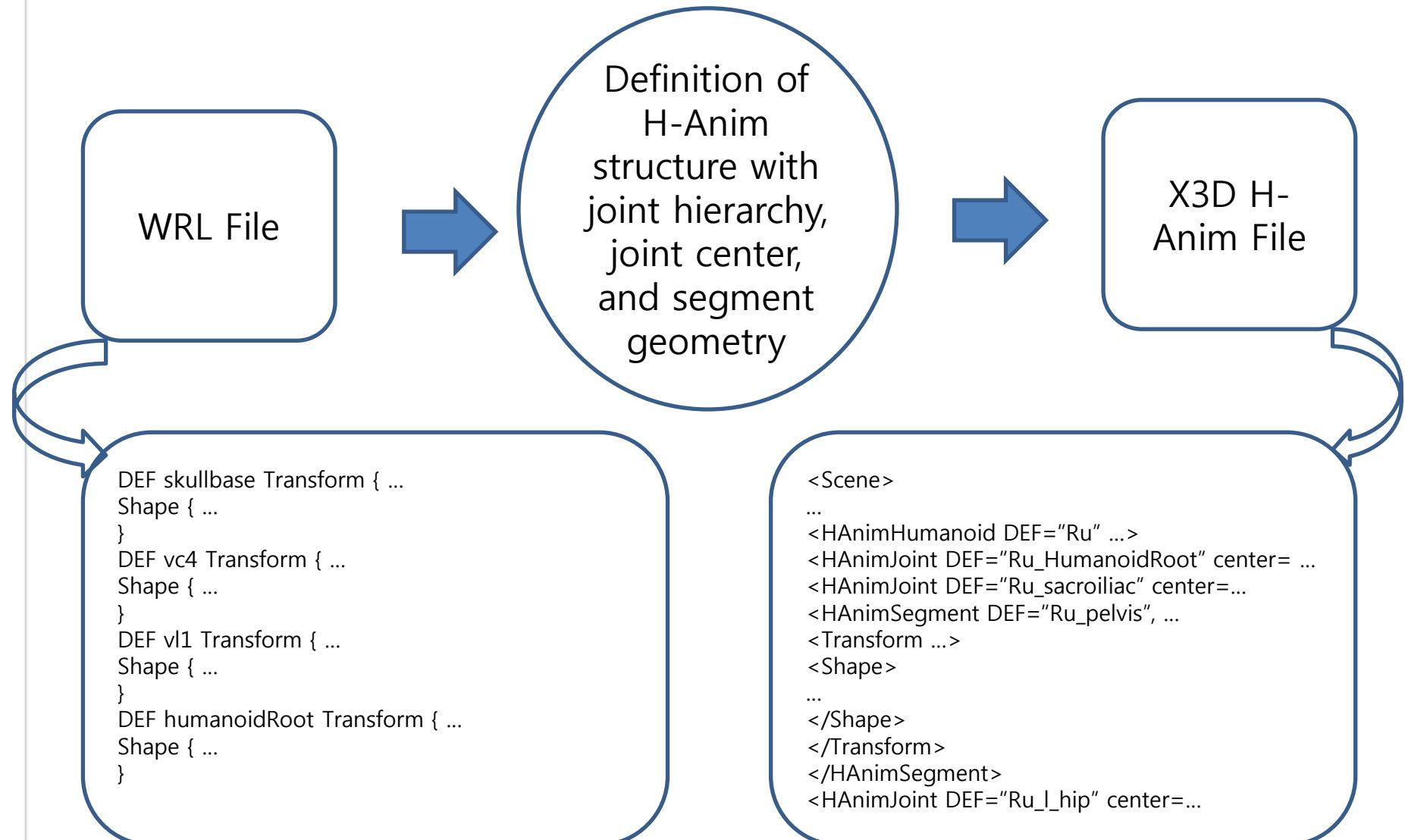
## ◆ Example

```
Motion {  
    Frames      601  
    Frametime   0.033333  
    transformation [ 11.623, 31.312, 64.121, -0.700, -4.023, .....  
                      11.616, 31.313, 64.107, -0.696, -3.954, .....  
                      ..... ]  
}
```

# A Procedure for Modeling an H-Anim Character Using General Graphics Tools



# Conversion Program from WRL to X3D H-Anim (1)



# H-Anim Model with Motion Capture (1) : suggestion

```
<Scene>
  <NavigationInfo speed='1.5' type=""EXAMINE" "ANY"/>
  <Viewpoint centerOfRotation='0 1 0' description='Jin' position='0 1 3'/>
  <HAnimHumanoid DEF='Jin' info=""humanoidVersion=2.0"" name='Jin' scale='0.0225
0.0225 0.0225' version='2.0'>
    <HAnimJoint DEF='Jin_HumanoidRoot' containerField='skeleton'
name='HumanoidRoot'>
      <HAnimJoint DEF='Jin_sacroiliac' center='0.000000 35.830002 -0.707600'
name='sacroiliac'>
        <HAnimSegment DEF='Jin_pelvis' name='pelvis'>
          <Transform translation='0.000000 35.830002 -0.707600'>

<HAnimSegment DEF="hanim_pelvis" name="pelvis" containerField="children"
Offset='0.000000 35.830002 -0.707600' Channels="6, Xposition, Yposition, Zposition,
Zrotation, Xrotation, Yrotation">

  <Shape>
    <Appearance>
      <Material diffuseColor='0.588000 0.588000 0.588000' />
      <ImageTexture DEF='JinTextureAtlas' url=""images/Jin.bmp" "images/Jin.png"
    </Appearance>
      <IndexedFaceSet coordIndex='0 1 2 -1 0 2 3 -1 0 3 4 -1 0 4 5 -1 ...
    <Coordinate point='0.0000 5.4970 0.1424 0.0000 4.7610 -2.8250 ...
    <TextureCoordinate point='0.6211 0.5754 0.7851 0.5720 0.7614 ...
```

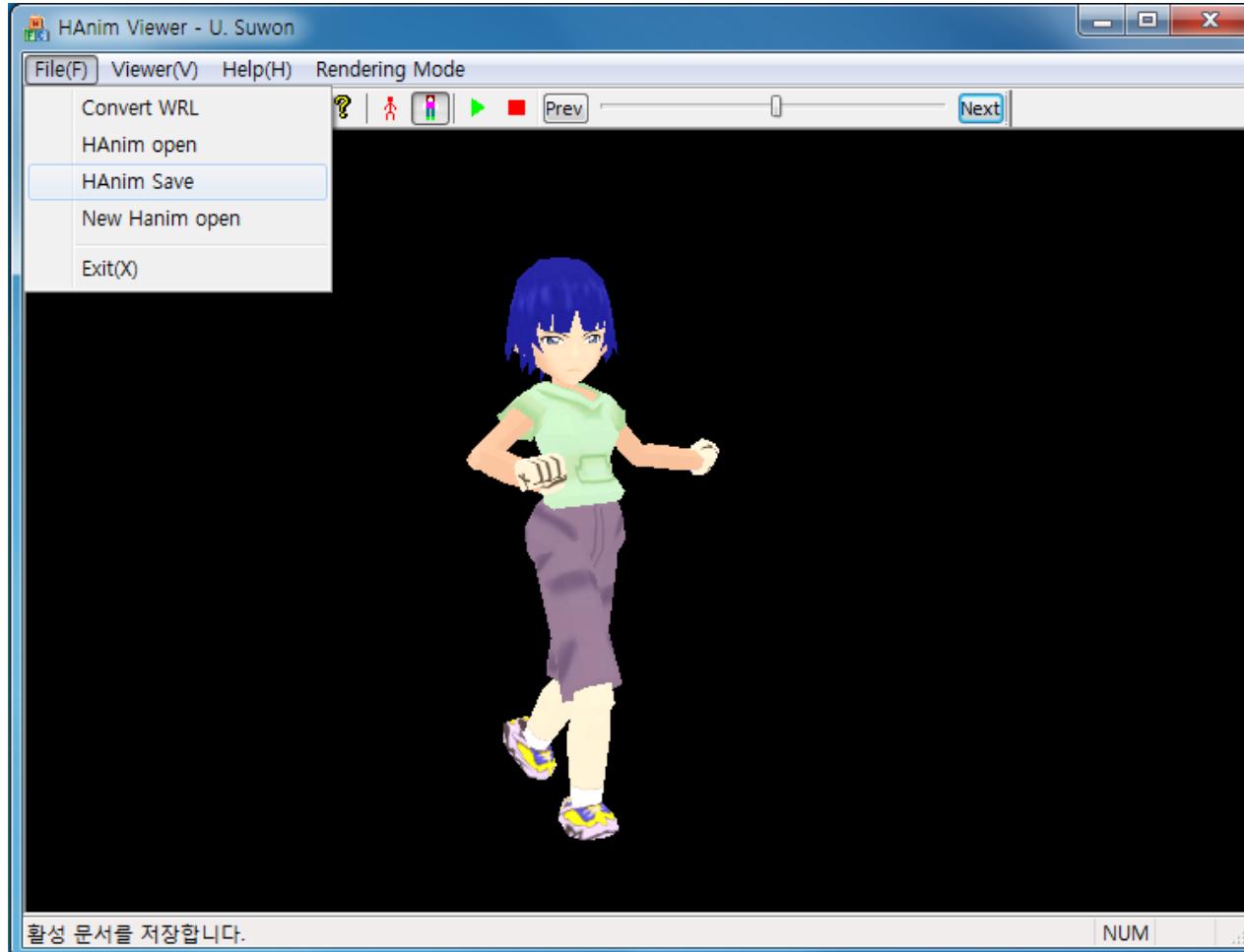
## H-Anim Motion with Motion Capture (2) : suggestion

```
0.0221,0.4411 0.0186,0.5487 0.0186,0.4637 0.1714,0.4708 0.0186"/>
</IndexedFaceSet>
</Shape>
</Transform>
</HAnimSegment>
</HAnimJoint>
</HAnimJoint>
</HAnimJoint>
</HAnimJoint>
...
<HAnimMotion>
<FrameInformation frames = "482" frametime = "0.016667"/>
<SegmentTransform transform =
2.1834 41.2869 79.2237 -1.2490 -4.8590 -3.5820 4.4630 1.3540 0.0750 -13.7320 3.0520
3.9990 95.6770 1.7050 -1.5120 5.5410 -3.4910 0.3390 1.2590 -3.0220 ...
...
5.8060 -2.2160 1.0610 9.5740 -0.2270 0.2010 -3.8550 0.3020 -2.8020 7.0420 4.4960 0.4940
6.9090 0.1390 -8.4900 -0.2720 1.8800 "/>
</HAnimMotion>
</Scene>
</X3D>
```

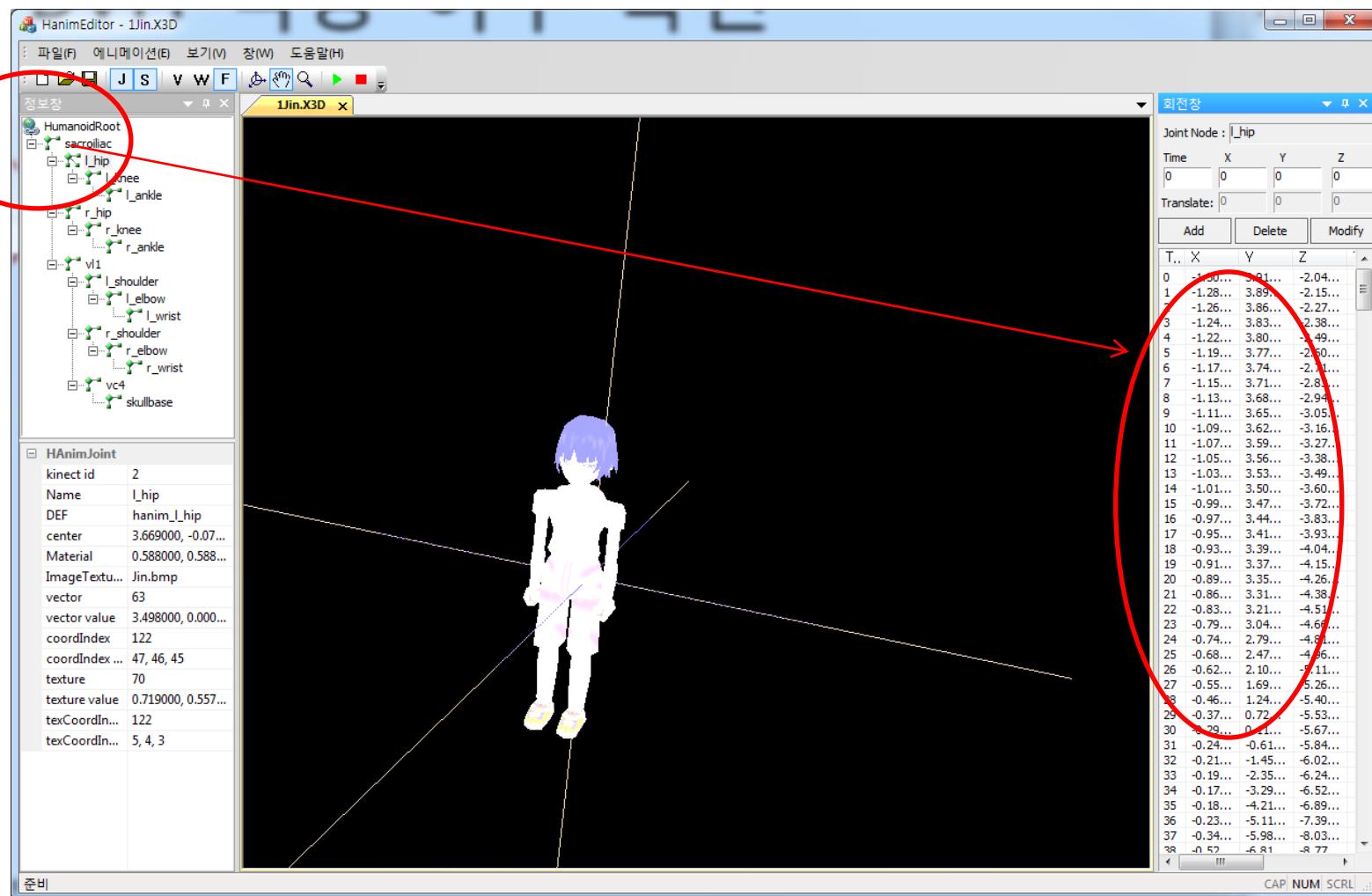
# LOA2 H-Anim Motion Capture Animation



# H-Anim Motion Viewer



# H-Anim Motion Editor

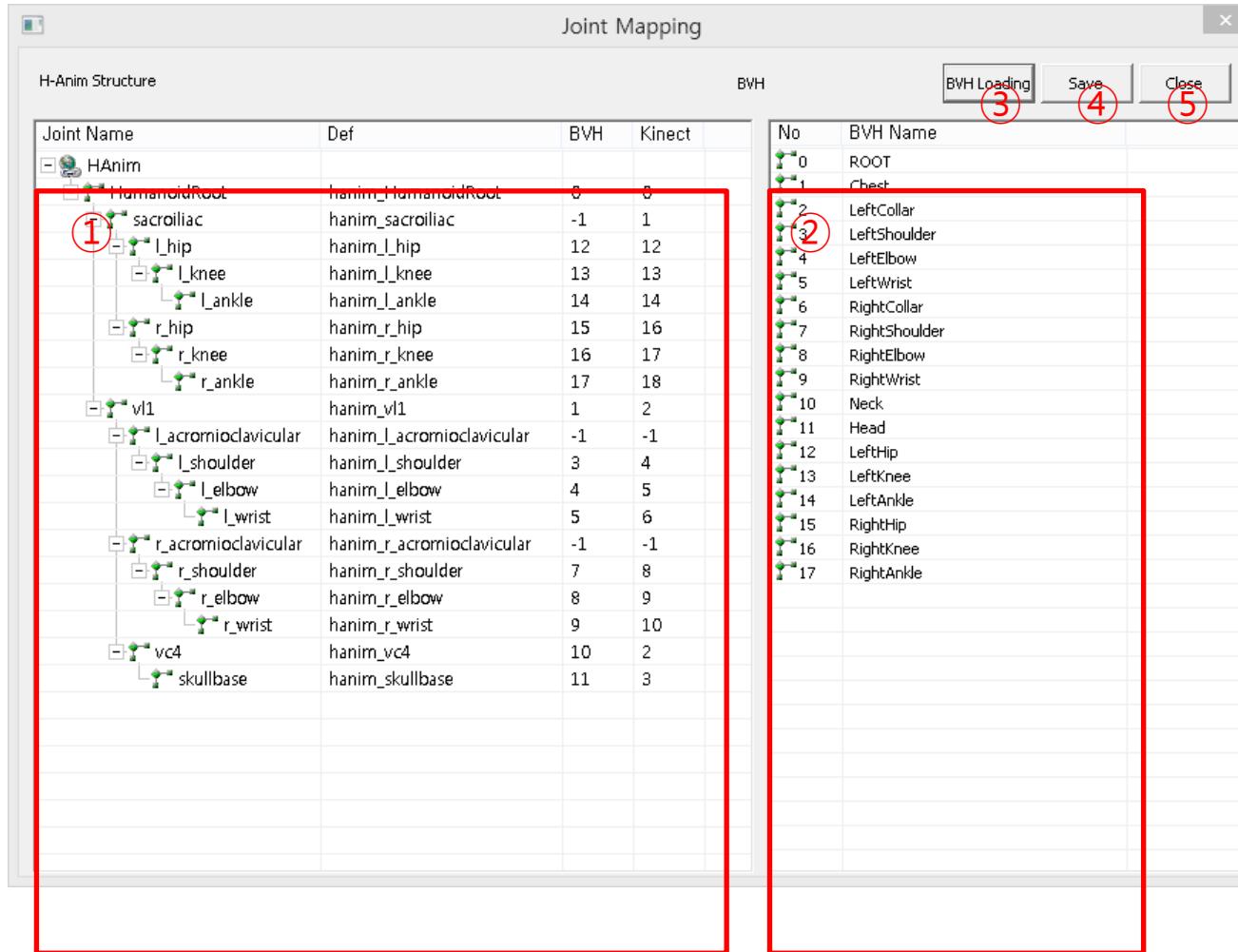


# Kinect Skeleton

```
typedef enum _NUI_SKELETON_POSITION_INDEX
{
    NUI_SKELETON_POSITION_HIP_CENTER,
    NUI_SKELETON_POSITION_SPINE,
    NUI_SKELETON_POSITION_SHOULDER_CENTER,
    NUI_SKELETON_POSITION_HEAD,
    NUI_SKELETON_POSITION_SHOULDER_LEFT,
    NUI_SKELETON_POSITION_ELBOW_LEFT,
    NUI_SKELETON_POSITION_WRIST_LEFT,
    NUI_SKELETON_POSITION_HAND_LEFT,
    NUI_SKELETON_POSITION_SHOULDER_RIGHT,
    NUI_SKELETON_POSITION_ELBOW_RIGHT,
    NUI_SKELETON_POSITION_WRIST_RIGHT,
    NUI_SKELETON_POSITION_HAND_RIGHT,
    NUI_SKELETON_POSITION_HIP_LEFT,
    NUI_SKELETON_POSITION_KNEE_LEFT,
    NUI_SKELETON_POSITION_ANKLE_LEFT,
    NUI_SKELETON_POSITION_FOOT_LEFT,
    NUI_SKELETON_POSITION_HIP_RIGHT,
    NUI_SKELETON_POSITION_KNEE_RIGHT,
    NUI_SKELETON_POSITION_ANKLE_RIGHT,
    NUI_SKELETON_POSITION_FOOT_RIGHT,
    NUI_SKELETON_POSITION_COUNT
}
NUI_SKELETON_POSITION_INDEX;
```

Constant	Description
NUI_SKELETON_POSITION_HIP_CENTER	Center, between hips
NUI_SKELETON_POSITION_SPINE	Spine
NUI_SKELETON_POSITION_SHOULDER_CENTER	Center, between shoulders
NUI_SKELETON_POSITION_HEAD	Head
NUI_SKELETON_POSITION_SHOULDER_LEFT	Left shoulder
NUI_SKELETON_POSITION_ELBOW_LEFT	Left elbow
NUI_SKELETON_POSITION_WRIST_LEFT	Left wrist
NUI_SKELETON_POSITION_HAND_LEFT	Left hand
NUI_SKELETON_POSITION_SHOULDER_RIGHT	Right shoulder
NUI_SKELETON_POSITION_ELBOW_RIGHT	Right elbow
NUI_SKELETON_POSITION_WRIST_RIGHT	Right wrist
NUI_SKELETON_POSITION_HAND_RIGHT	Right hand
NUI_SKELETON_POSITION_HIP_LEFT	Left hip
NUI_SKELETON_POSITION_KNEE_LEFT	Left Knee
NUI_SKELETON_POSITION_ANKLE_LEFT	Left ankle
NUI_SKELETON_POSITION_FOOT_LEFT	Left foot
NUI_SKELETON_POSITION_HIP_RIGHT	Right hip
NUI_SKELETON_POSITION_KNEE_RIGHT	Right knee
NUI_SKELETON_POSITION_ANKLE_RIGHT	Right ankle
NUI_SKELETON_POSITION_FOOT_RIGHT	Right foot
NUI_SKELETON_POSITION_COUNT	Used as an index to terminate a loop. Not used as a position index.

# Joint Mapping Tool



1. H-Anim hierarchy
2. BVH hierarchy
3. BVH load
4. H-Anim save
5. Close

# H-Anim Editor

- Objectives
  - Edit mocap animation
  - Edit hierarchy
  - Edit joint
  - Edit segment
  - Generate human animation using Kinect data

## In-progress and future work

- LOA1, LOA2, LOA3 model converter: wrl-to-x3d hanim
- LOA1, LOA2, LOA3 Joint mapping tool
- LOA1, LOA2, LOA3 Bvh to X3D interpolator conversion
- LOA1, LOA2, LOA3 H-Anim motion viewer
- LOA1, LOA2, LOA3 H-Anim motion editor
- Future work
  - Skin modeling and animation with motion capture