Tutorial and Workshop
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Agenda

- Intro to H-Anim Concepts
- H-Anim Nodes
- Demos: Authoring and Applications for H-Anim Characters
- Future Directions and Issues

Introduction to H-Anim Concepts

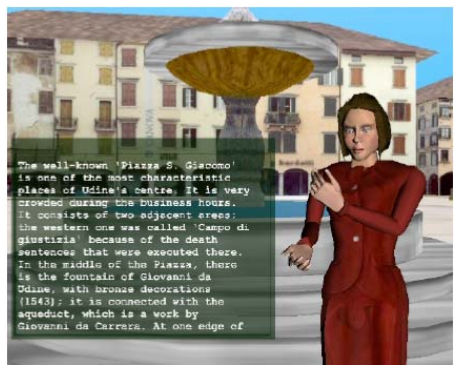
- Purpose
- Goals
- Hierarchy
- Levels of Articulation (LoA)
- Modeling

Purpose

- Support the Creation of Interchangeable Humanoids, Behaviors, and Animations
- Support the Development of Authoring Tools for Modeling and Animating Humanoids
- Examples of Applications
  - Games & Entertainment
  - Ergonomic Studies
  - Education and Training

Virtual Humans in Learning, Education, and Training

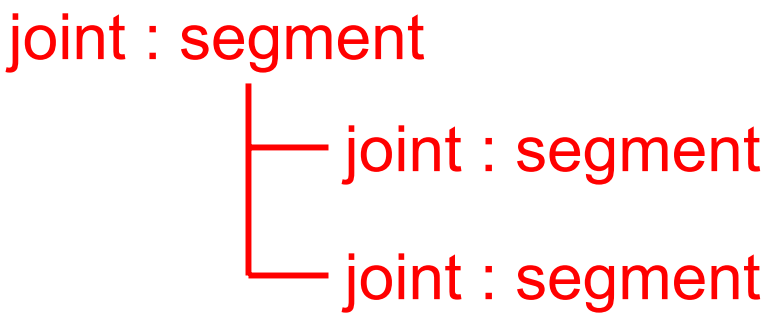
- Demonstration of procedures
- Presentations
- Role-playing actors
- Interpreters



Goals

- **Compatibility:** Humanoids should work in any compliant browser.
- **Flexibility:** No assumptions are made about the types of applications that will use humanoids.
- **Simplicity:** When in doubt, leave it out. The specification can always be extended later.

Hierarchy of Joints and Segments



- Implicit assumptions & approximations:
  - Joints approximated by rotations about points.
  - Major deformations of body surface are caused by rotations about these joints.

Hierarchy (LOA 1)

```
HumanoidRoot : sacrum
  sacroiliac : pelvis
  |    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
  vl5  : l5
     skullbase : skull
     l_shoulder : l_upperarm
     |      l_elbow : l_forearm
     |        l_wrist : l_hand
     r_shoulder : r_upperarm
            r_elbow : r_forearm
              r_wrist : r_hand
```

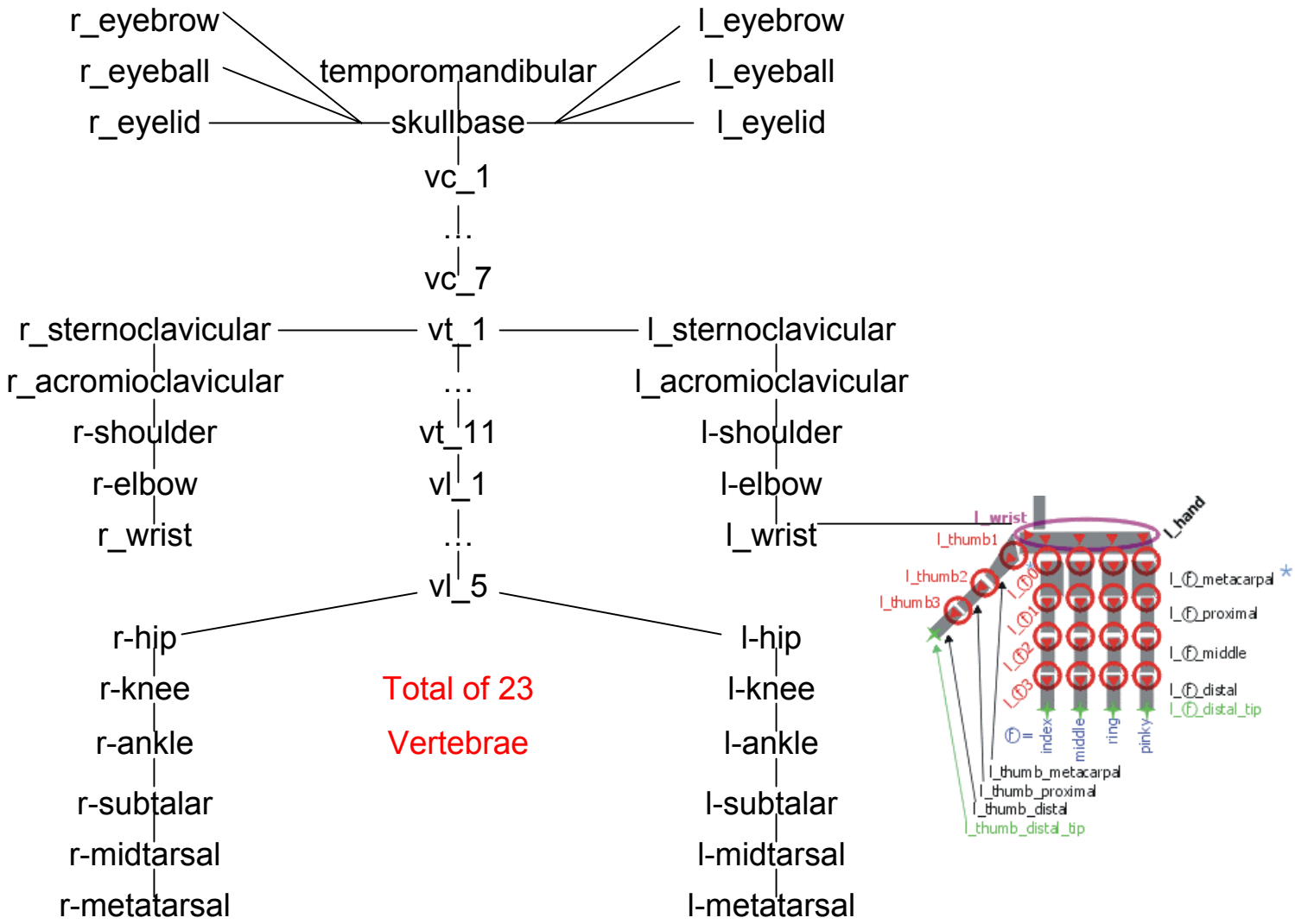
"vee-el-5", not "vee-15"

joint : segment

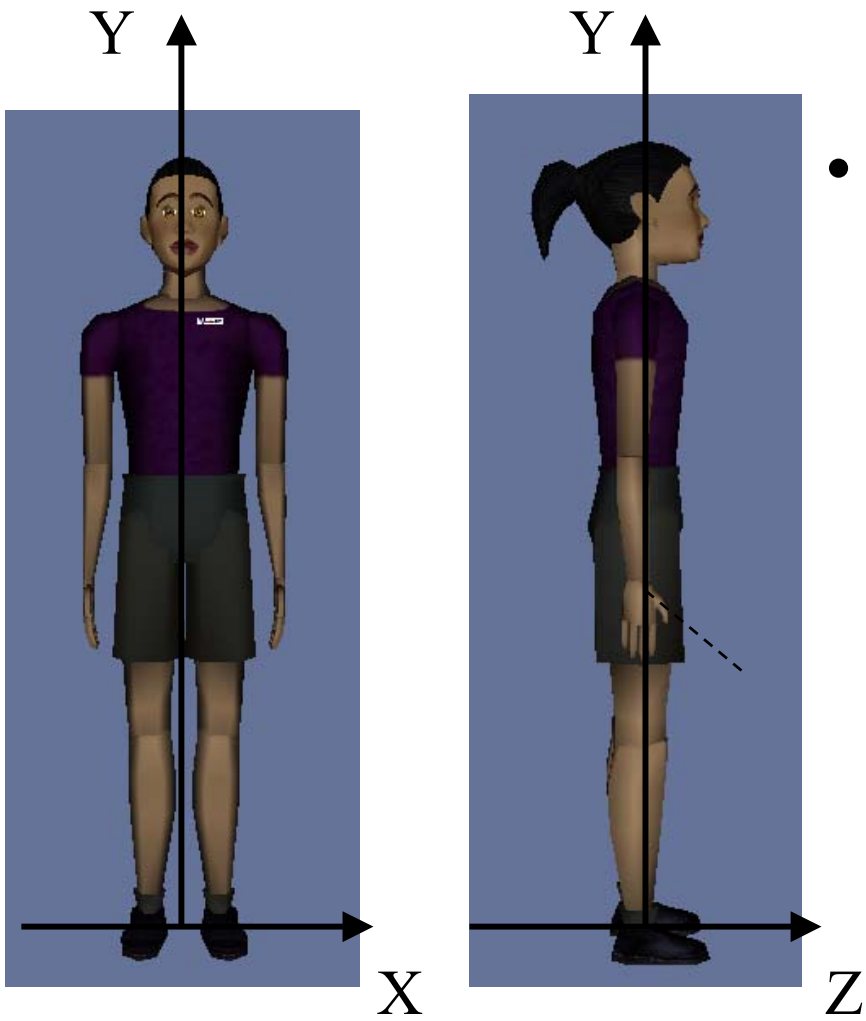
Levels of Articulation

	LoA 0	LoA 1	LoA 2	LoA 3
Description	Humanoid Root Only	Typical Simple Model w/ Fixed Hands	Typical Complex Model w/ Articulated Hands	Complex Model with Articulated Hands & Spine (24 Vertebrae)
Joints	1	18	71	89

Complete H-Anim Hierarchy of Joints



Modeling



- Rest Position
  - Standing
  - Arms at side
  - Fingers down
  - Thumbs at 45 deg.
  - Eyes Ahead and Open
  - Eyebrows neutral
  - Mouth Closed

H-Anim Nodes

- Basic Nodes
  - Humanoid
  - Joint
  - Segment
- Advanced Nodes
  - Sites
  - Displacers

H-Anim Spec describes the Abstract Model & VRML Implementation.
H-Anim Component of X3D Spec describes X3D Implementation.

Humanoid Node (Abstract Spec)

interface Humanoid {

float[3]	bboxCenter
float[3]	bboxSize
float[3]	center
sequence<string>	info
sequence<Object>	joints
string	name
float[4]	rotation
float[3]	scale
float[4]	scaleOrientation
sequence<Object>	segments
sequence<Object>	sites
sequence<Object>	skeleton
sequence<Object>	skin
sequence<float[3]>	skinCoord
sequence<float[3]>	skinNormal
float[3]	translation
string	version
sequence<Object>	viewpoints

}

Humanoid Node (VRML Syntax)

PROTO Humanoid [

field	SFVec3F	bboxCenter		0 0 0
field	SFVec3F	bboxSize		-1 –1 –1
exposedField	SFVec3F	center		0 0 0
exposedField	MFString	info		[ ]
exposedField	MFNode	joints	[ ]	
exposedField	SFString	name	“ ”	
exposedField	SFRotation	orientation	0 0 1 0	
exposedField	SFVec3f	scale	1 1 1	
exposedField	SFRotation	scaleOrientation	0 0 1 0	
exposedField	MFNode	segments		[ ]
exposedField	MFNode	sites	[ ]	
exposedField	MFNode	skeleton	[ ]	
exposedField	MFNode	skin	[ ]	
exposedField	SFNode	skinCoord	NULL	
exposedField	SFNode	skinNormal	NULL	
exposedField	SFVec3f	translation	0 0 0	
exposedField	SFString	version	“2.0”	

Humanoid Node (X3D Bindings)

HAnimHumanoid [

SFVec3f	[in,out]	center	0 0 0	(-∞,∞)
MFString	[in,out]	info	[ ]	
MFNode	[in,out]	joints	[ ]	[HAnimJoint]
SFNode	[in,out]	metadata	NULL	[X3DMetadataObject]
SFString	[in,out]	name	""	
SFRotation	[in,out]	rotation	0 0 1 0	(-∞,∞)|[-1,1]
SFVec3f	[in,out]	scale	1 1 1	(0,∞)
SFRotation	[in,out]	scaleOrientation	0 0 1 0	(-∞,∞)|[-1,1]
MFNode	[in,out]	segments	[ ]	[HAnimSegment]
MFNode	[in,out]	sites	[ ]	[HAnimSite]
MFNode	[in,out]	skeleton	[ ]	[HAnimJoint]
MFNode	[in,out]	skin	[ ]	[X3DChildNode]
SFNode	[in,out]	skinCoord	NULL	[X3DCoordinateNode]
SFNode	[in,out]	skinNormal	NULL	[X3DNormalNode]
SFVec3f	[in,out]	translation	0 0 0	(-∞,∞)
SFString	[in,out]	version	""	
MFNode	[in,out]	viewpoints	[ ]	[Viewpoint]
SFVec3f	[]	bboxCenter	0 0 0	(-∞,∞)
SFVec3f	[]	bboxSize	-1 -1 -1	[0,∞) or −1 −1 −1

]

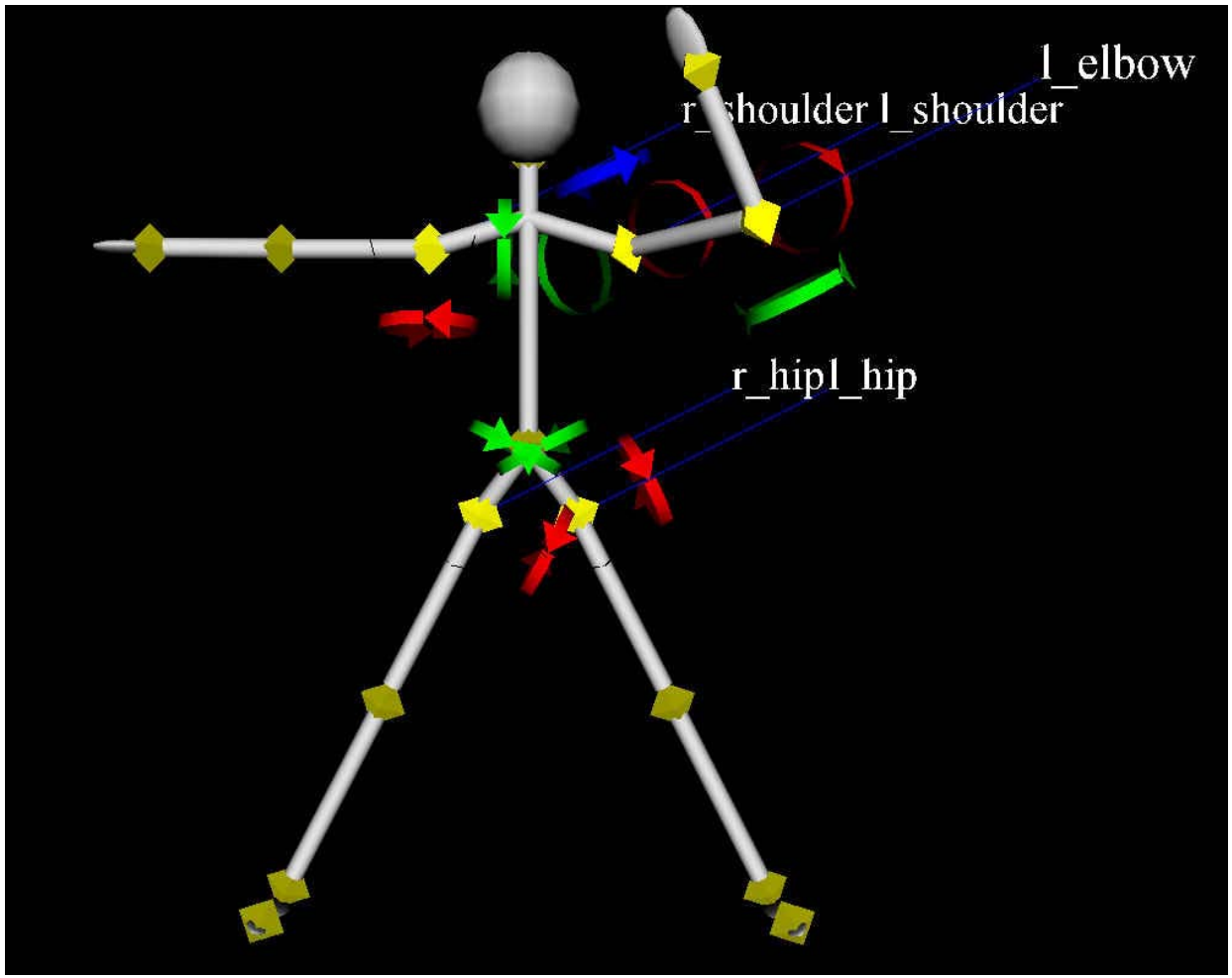
Humanoid Node (XML Syntax)

<HAnimHumanoid

DEF=""	ID	
USE=""	IDREF	
age=""	SFString	
authorEmail=""	SFString	
authorName=""	SFString	
center="0 0 0"	SFVec3f	[in, out]
copyright=""	SFString	
creationDate=""	SFString	
gender=""	SFString	
height=""	SFString	[init]
humanoidVersion=""	SFString	
info=""	MFString	[in, out]
name=""	SFString	[in, out]
rotation="0 0 1 0"	SFRotation	[in, out]
scale="1 1 1"	SFVec3f	[in, out]
scaleOrientation="0 0 1 0"	SFRotation	[in, out]
translation="0 0 0"	SFVec3f	[in, out]
usageRestrictions=""	SFString	
version="1.1"	SFString	[in, out]
weight=""	SFString	[in, out]
containerField="children"	NMTOKEN	
class=""	string	

/>

Stickboy Demo



Joint Node

PROTO Joint [

exposedField	SFVec3F	center	0 0
0 exposedField	MFNode	children	[ ]
exposedField	MFFloat	llimit	[ ]
exposedField	SFRotation	llimitOrientation	0 0 1 0
exposedField	SFString	name	“ ”
exposedField	SFRotation	rotation	0 0 1 0
exposedField	SFVec3f	scale	1 1 1
exposedField	SFRotation	scaleOrientation	0 0 1 0
exposedField	SFNode	skinCoordIndex	[ ]
exposedField	MFNode	skinCoordWeight	[ ]
exposedField	MFFloat	stiffness	[0 0 0]
exposedField	SFVec3f	translation	0 0 0
exposedField	MFNode	ulimit	[ ]

]

Segment Node

PROTO Segment [

field	SFVec3F	bboxCenter		0 0 0
field	SFVec3F	bboxSize		-1 –1 –1
exposedField	SFVec3F	centerOfMass		0 0 0
exposedField	MFNode	children	[ ]	
exposedField	SFNode	coord	NULL	
exposedField	MFNode	displacers		[ ]
exposedField	SFFloat	mass	0	
exposedField	MFFloat	momentsOfIntertia		[0 0 0 0 0 0 0 0 0]
exposedField	SFString	name	“ ”	
exposedIn	MFNode	addChildren		
exposedIn	MFNode	removeChildren		

]

Seamless Character Demo

- Skin deformation new with H-Anim 200x.
- Each joint influences subset of skin vertices.
  - Approach commonly used in real-time gaming.
  - Can exhibit foreshortening (“sausage link”, “soda straw” effects for large motions)

Overcoming Limitations of Blending Method: “Mini-Bones”

Three “mini-bones” with vertex interpolation.

Standard bones with vertex interpolation.

Site Node

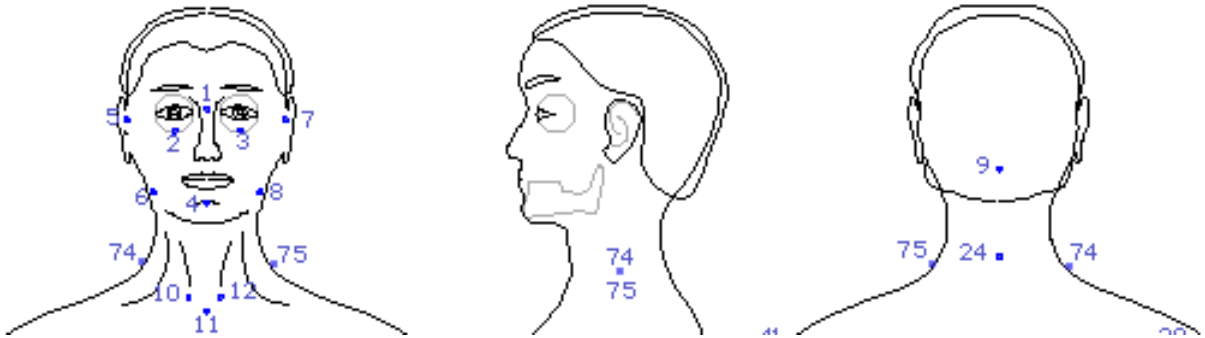
- Purpose
  - “end effector” for Inverse Kinematics
  - attachment point for clothing, jewelry, etc.
  - location for a virtual camera in the reference frame of a **Segment** object (e.g., eyepoint of humanoid)

PROTO Site [

exposedField	SFVec3F	center	0 0 0
exposedField	MFNode	children	[ ]
exposedField	SFString	name	“ ”
exposedField	SFRotation	rotation	0 0 1 0
exposedField	SFVec3f	scale	1 1 1
exposedField	SFRotation	scaleOrientation	0 0 1 0
exposedField	SFVec3f	translation	0 0 0
exposedIn	MFNode	addChildren	
exposedIn	MFNode	removeChildren	

]

Suggested Feature Point Names - 1



Position index	H-Anim feature point name
1	sellion
2	r_infraorbitale
3	l_infraorbitale
4	supramenton
5	r_tragion
6	r_gonion
7	l_tragion
8	l_gonion
9	nuchale
10	r_clavicale
11	suprasternale
12	l_clavicale
74	r_neck_base
75	l_neck_base

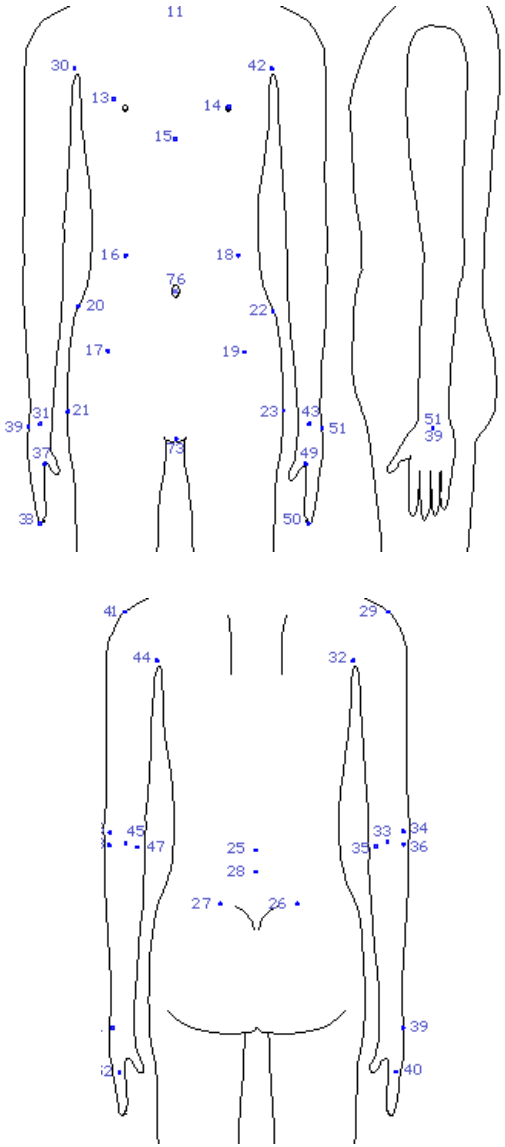
Site Names are adapted from:

CAESAR—Digitally Defining the Human Body*, SAE International, 2003.

http://www.sae.org/technicalcommittees/caesarhome.htm

* - Civilian American and European Surface Anthropometry Resource

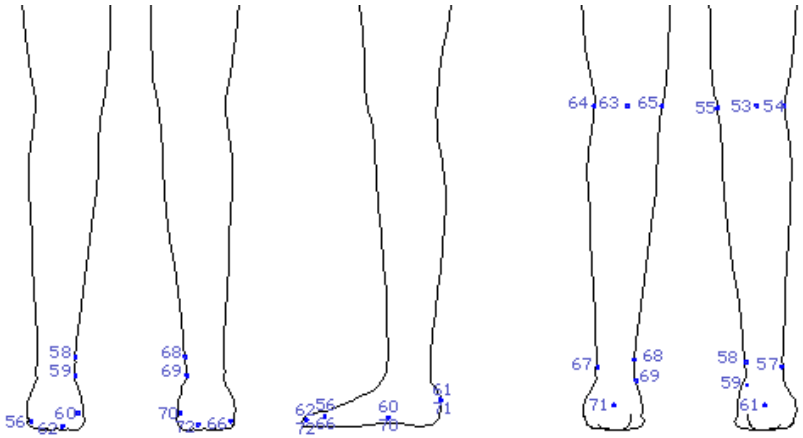
Suggested Feature Point Names - 2



	H-Anim feature point name
13	r_thelion/bustpoint
14	l_thelion/bustpoint
15	substernale
16	r_rib10
17	r_asis
18	l_rib10
19	l_asis
20	r_iliocristale
21	r_trochanterion
22	l_iliocristale
23	l_trochanterion
24	cervicale
25	rib10_midspine
26	r_psis
27	l_psis
28	waist_preferred_post

	H-Anim feature point name
29	r_acromion
30	r_axilla_ant
31	r_radial_styloid
32	r_axilla_post.
33	r_olecranon
34	r_humeral_lateral_epicn
35	r_humeral_medial_epicn
36	r_radiale
37	r_metacarpal_pha2
38	r_dactylion
39	r_ulnar_styloid
40	r_metacarpal_pha5
41	l_acromion
42	l_axilla_ant
43	l_radial_styloid
44	l_axilla_post.
45	l_olecranon
46	l_humeral_lateral_epicn
47	l_humeral_medial_epicn
48	l_radiale
49	l_metacarpal_pha2
50	l_dactylion
51	l_ulnar_styloid
52	l_metacarpal_pha5

Suggested Feature Point Names - 3



Note: Data scanned from 4,400 American, Canadian, Dutch, and Italian subjects is available from the CAESAR project.

Tools for converting to H-Anim are being developed by the U.S. National Institute of Standards and Technologies (NIST).

	H-Anim feature point name
53	r_knee_crease
54	r_femoral_lateral_epicn
55	r_femoral_medial_epicn
56	r_metatarsal_pha5
57	r_lateral_malleolus
58	r_medial_malleolus
59	r_sphyrion
60	r_metatarsal_pha1
61	r_calcaneous_post.
62	r_digit2
63	l_knee_crease
64	l_femoral_lateral_epicn
65	l_femoral_medial_epicn
66	l_metatarsal_pha5
67	l_lateral_malleolus
68	l_medial_malleolus
69	l_sphyrion
70	l_metatarsal_pha1
71	l_calcaneous_post.
72	l_digit2

Displacer Node

- Purpose
  - identify specific groups of vertices within a mesh (either segment or skin field of humanoid node).
  - simulate muscle actions not associated with joints
    - eyebrows, lips, breathing, …
  - provide “hints” as to the direction in which each vertex should move.

PROTO Displacer [
exposedField MFInt32 coordIndex [ ]
exposedField MFVec3f displacements [ ]
exposedField SFString name “ ”
]

Facial Animation

- Basic Facial Expressions can be modeled using H-Anim Face Joints

skullbase : skull
l_eyelid_joint : l_eyelid
r_eyelid_joint : r_eyelid
l_eyeball_joint : l_eyeball
r_eyeball_joint : r_eyeball
l_eyebrow_joint : l_eyebrow
r_eyebrow_joint : r_eyebrow
temporomandibular : jaw

- More complex facial animations and lip-synch may use displacers or other approaches to simulate 40+ muscles of the face.

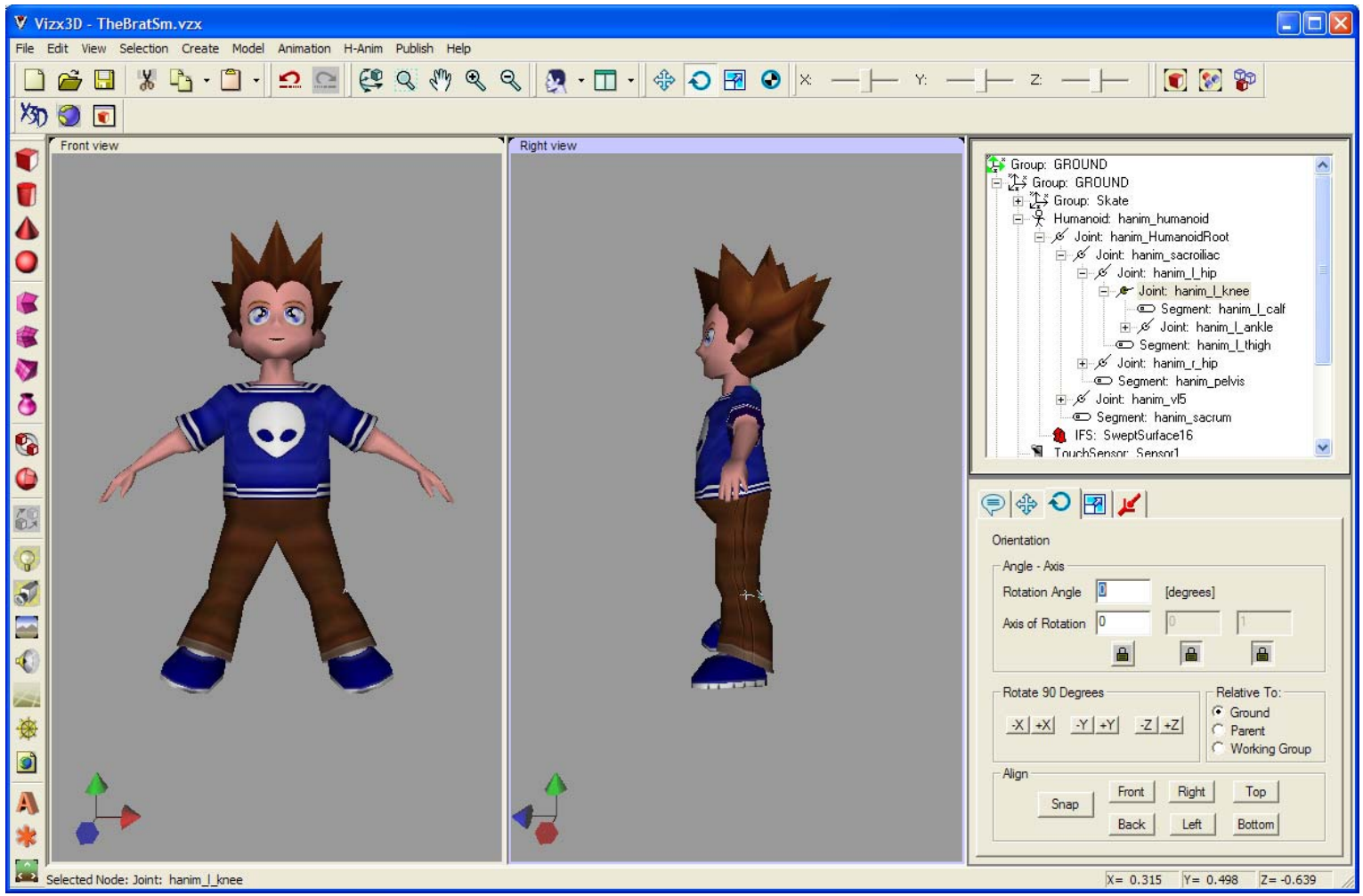
Sites Demo


File Options View
HS AA FS
Time Line
Right Hand
Left Hand
Front
Right

How do I get/create H-Anim characters?

- X3D / H-Anim Authoring Tools
  - Virtock VizX3D (www.vizx3d.com)
  - Milk Shape (www.smeenk.com)
  - X3D Edit (www.web3d.org)
- CAESAR Data and Conversion Tools
  - NIST (ovrt.nist.gov)
- Conventional 3D Modeling & Animation SW (3D Studio Max, Maya)
  - Export VRML, Convert to H-Anim
- H-Anim Web Site (www.h-anim.org/Models/)
  - Examples for public use

Demonstration: VizX3D



Demonstration: Vcommunicator Studio

References

- **X3D & Related Specifications**
  - Humanoid Animation (H-Anim) Specification
    - ISO / IEC FCD 19774:200x
    - abstract representation for modeling three dimensional human figures
  - X3D Draft Specifications
    - ISO / IEC FDIS 19775:200x (Architecture and Base Components) > H-Anim Component
    - ISO / IEC FCD 19776:200x (X3D Encodings)
  - X3D Schema & DTD
  - VRML97 Specification
    - base functionality and text encoding for VRML
    - External Authoring Interface.

All specifications are available at www.web3d.org

Moving Forward: Open Issues

- Library and interchange standard for common animations
- Specification and implementation of higher-level actions
  - Inverse Kinematics: Pointing, Touching, Grasping
  - Facial expression and gaze direction
  - Speech and lip-synch
- Improved seamless mesh algorithms
- Open Discussion