Online Interactive 4D Character Animation

Marco Volino, Peng Huang and Adrian Hilton

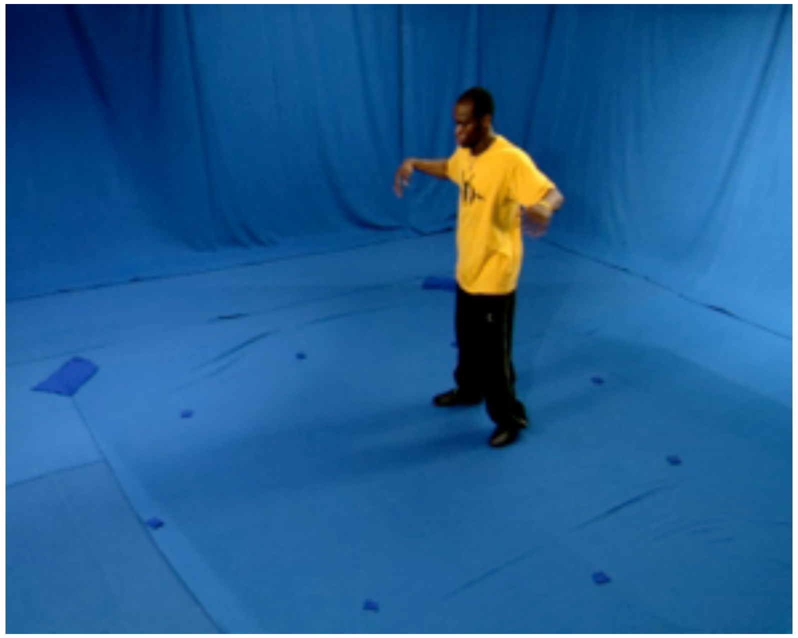
Web3D 2015

Outline

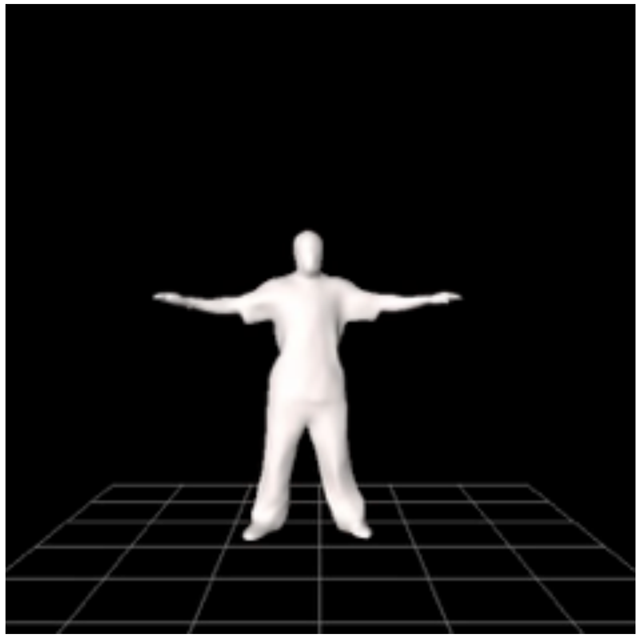
- **4D Performance Capture -** 3D Reconstruction, Alignment, Texture Maps
- **Animation** - Parametric Motion and Surface Motion Graphs
- WebGL - Javascript-based Character Animation Engine and WebGL Renderer
- **Results and Conclusions**

4D Performance Capture

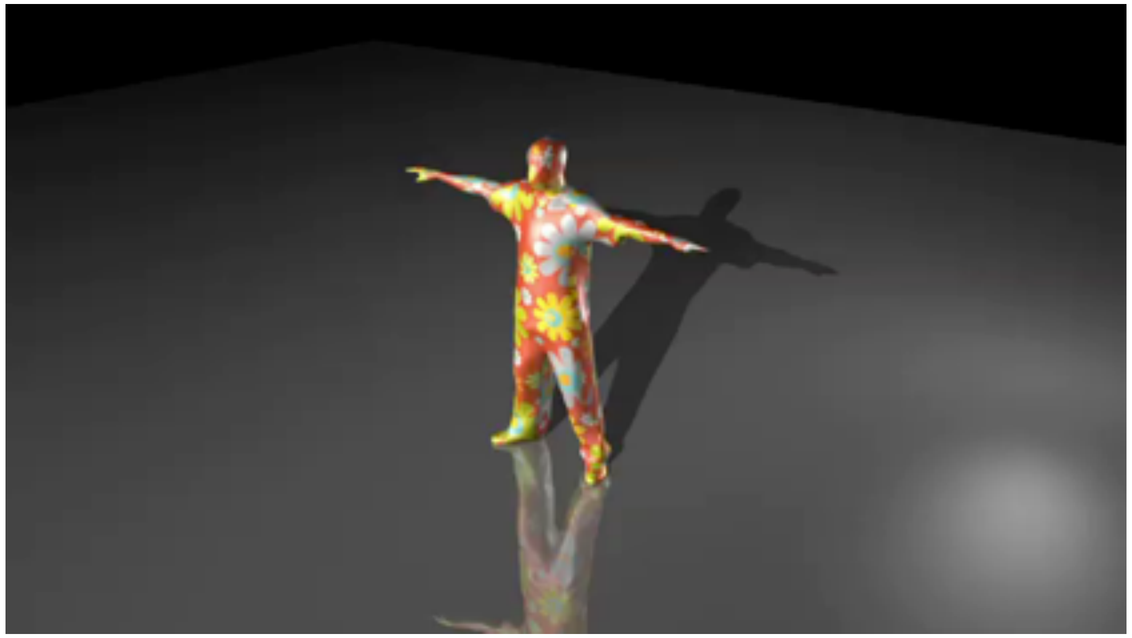
Spatio-temporally coherent models from video



2D



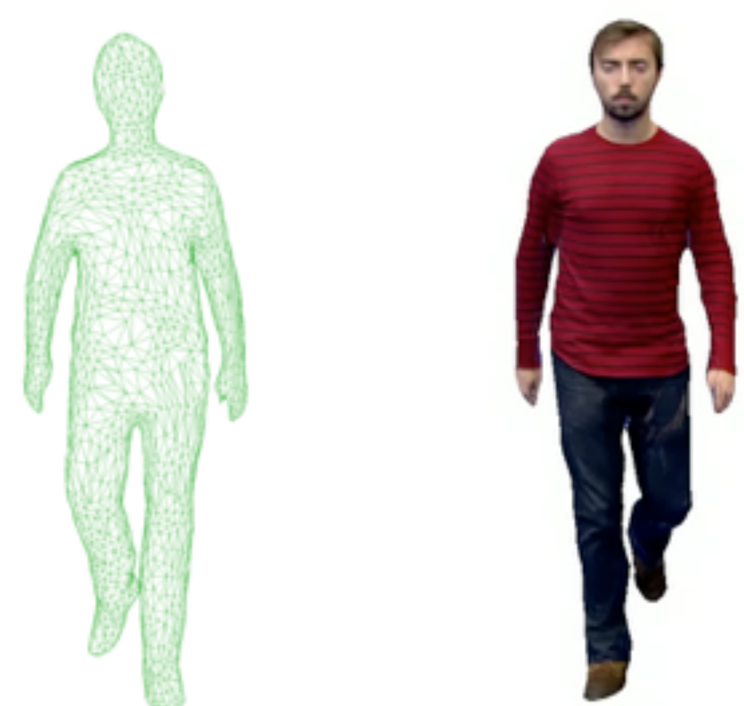
3D



4D

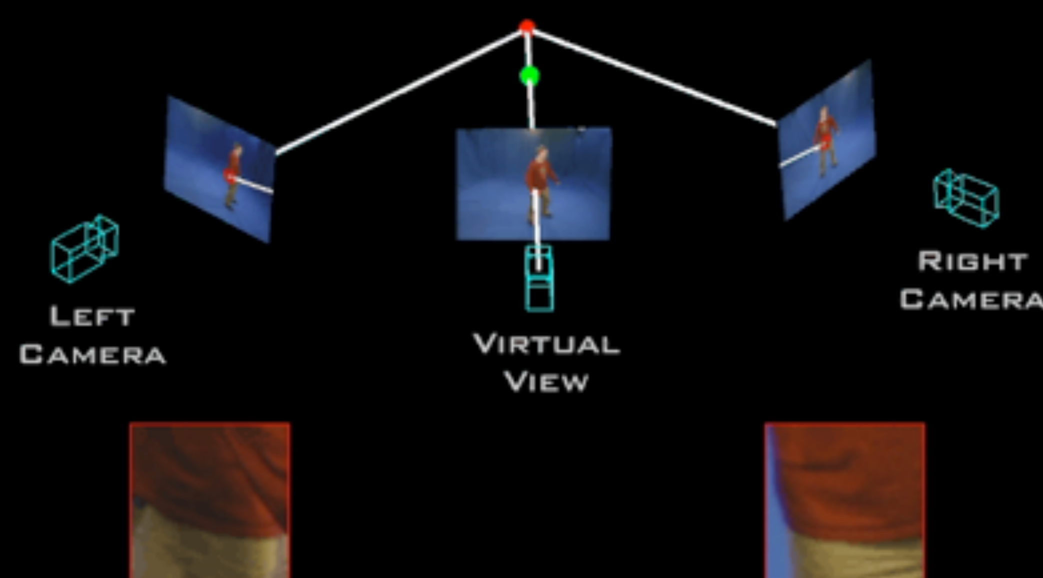
4D Performance Capture

- Acquisition of dynamic shape and appearance
- Represented as a deforming 3D mesh sequences
- Video-realistic 3D content production



Multiple View Reconstruction

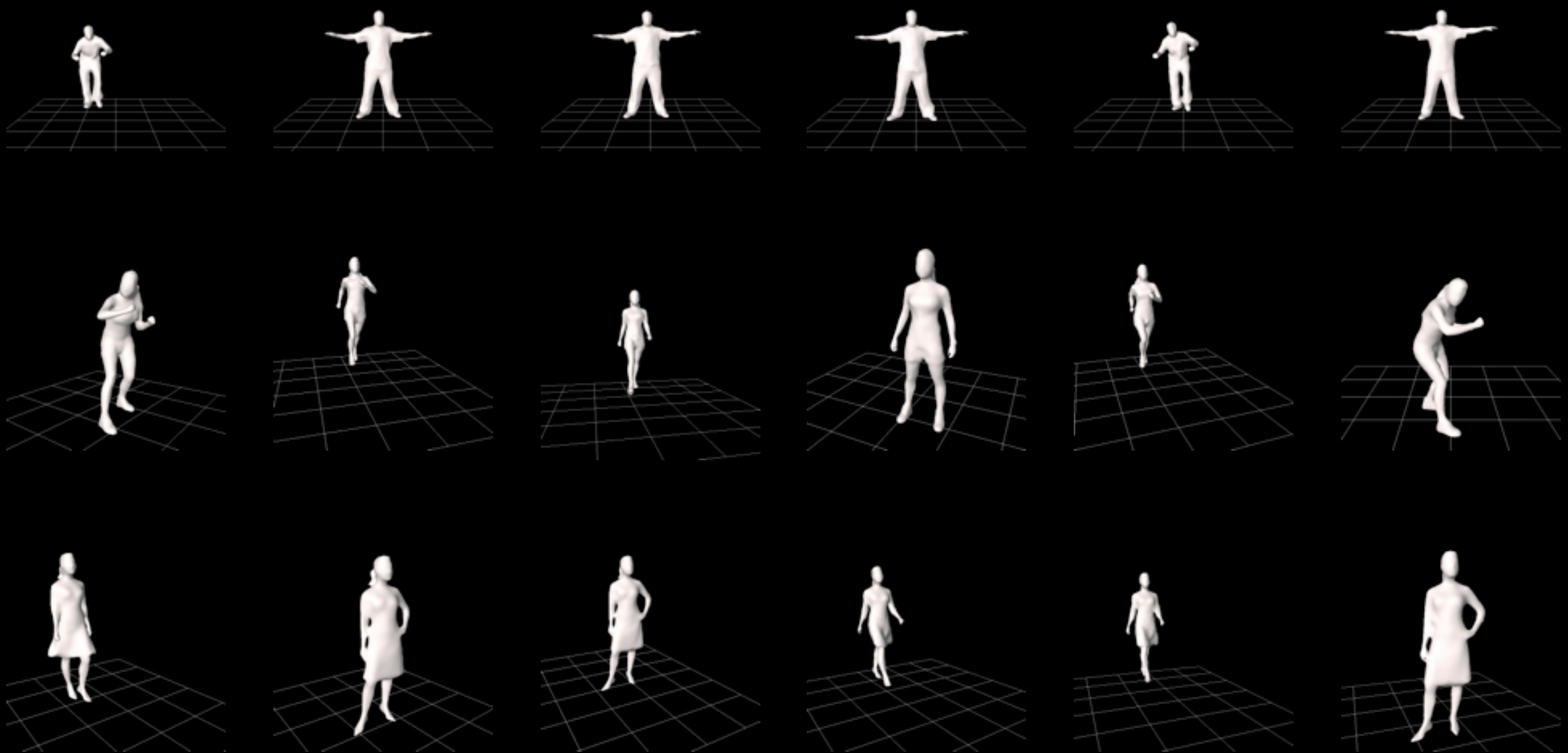
Visual Hull



Stereo Refinement

[Starck et al. CVIU'08]

3D Video



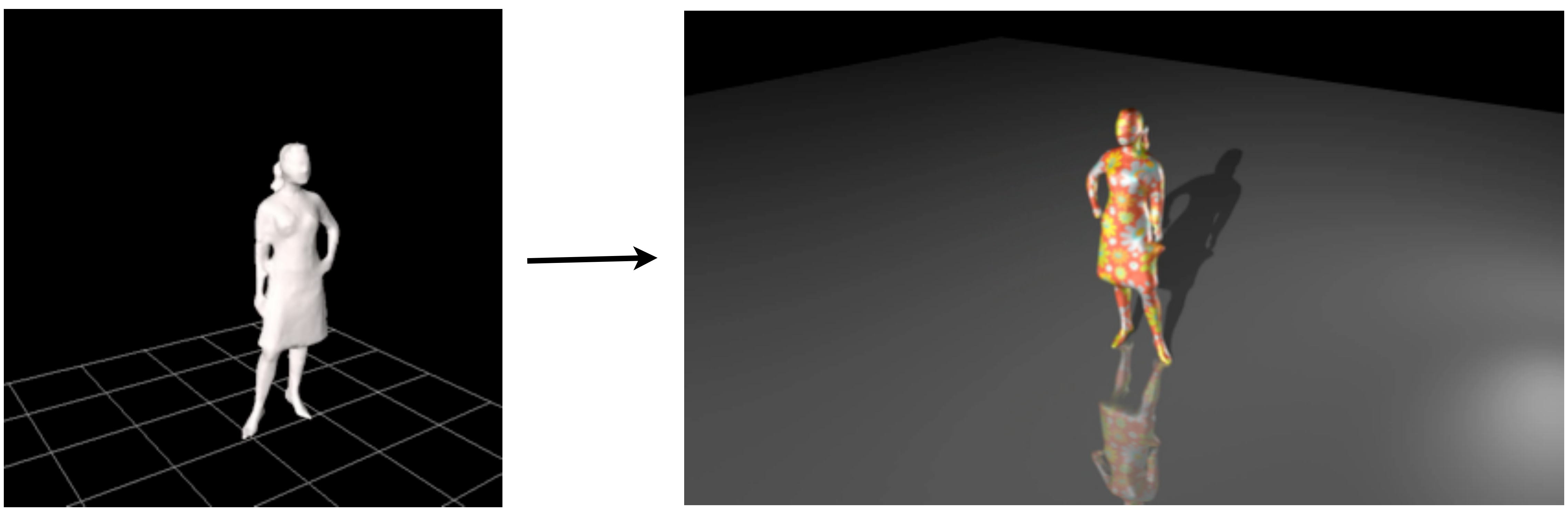
SurfCap 3D Video Database *[Starck et al. CGA'07]*

4D Representation

3D video capture:

- unstructured mesh sequences
- no temporal correspondence

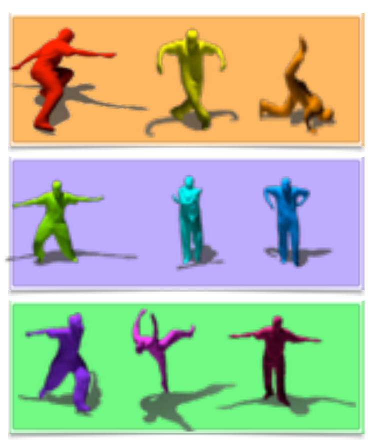
4D: coherent structure with temporal correspondence



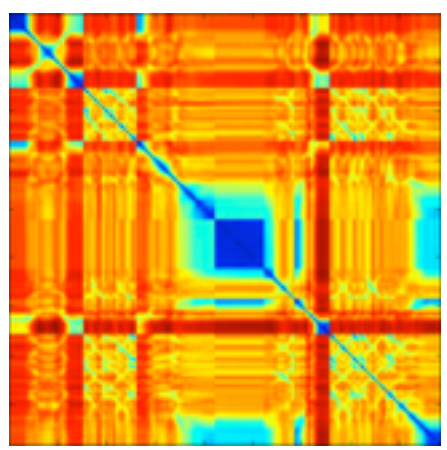
Global Non-rigid Alignment

Shape similarity tree construction:

- 3D shape similarity
- fully connected graph construction
- graph optimisation for shortest non-rigid alignment path



3D video sequences



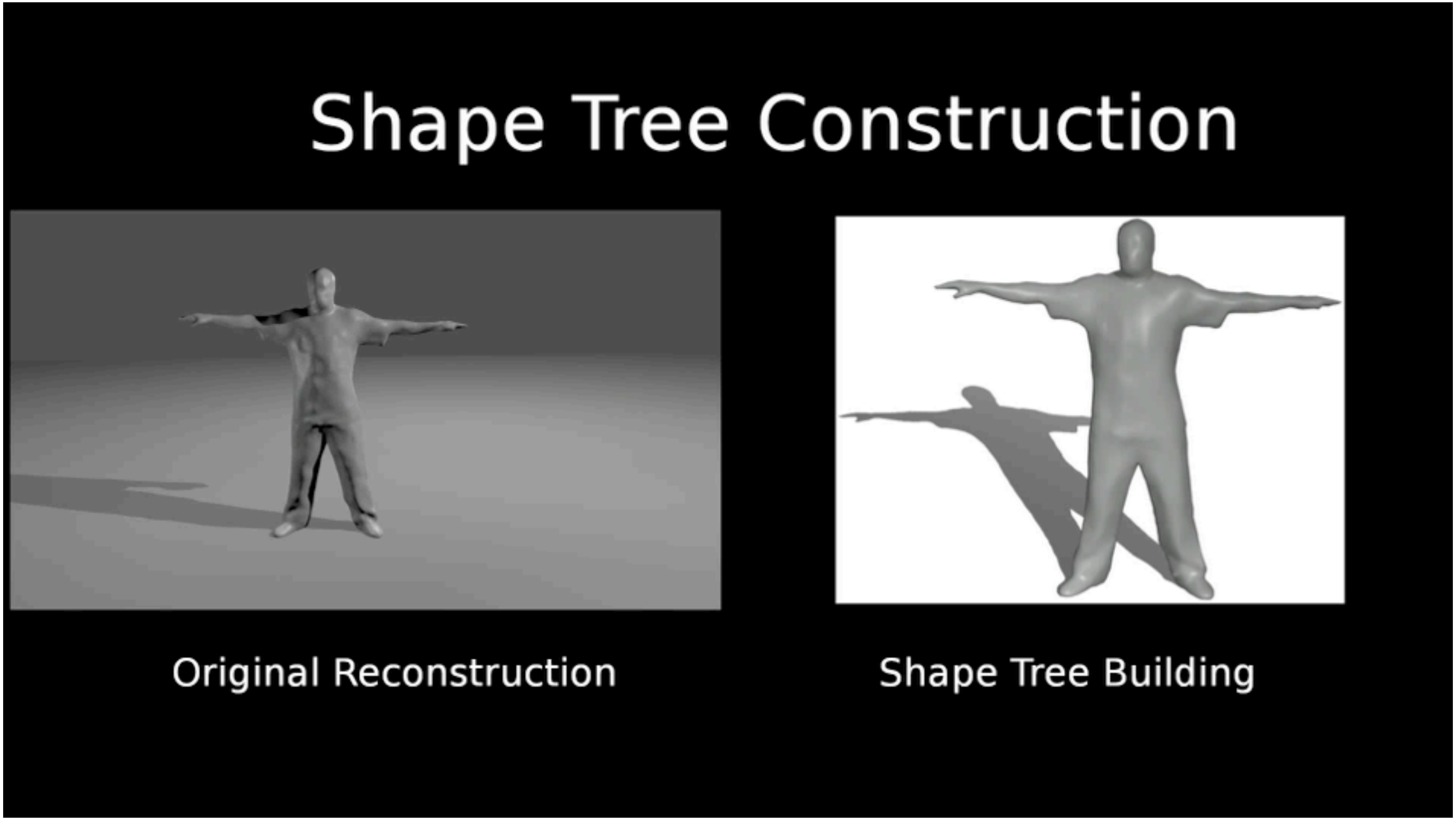
shape similarity matrix

fully connected graph

Shape similarity tree

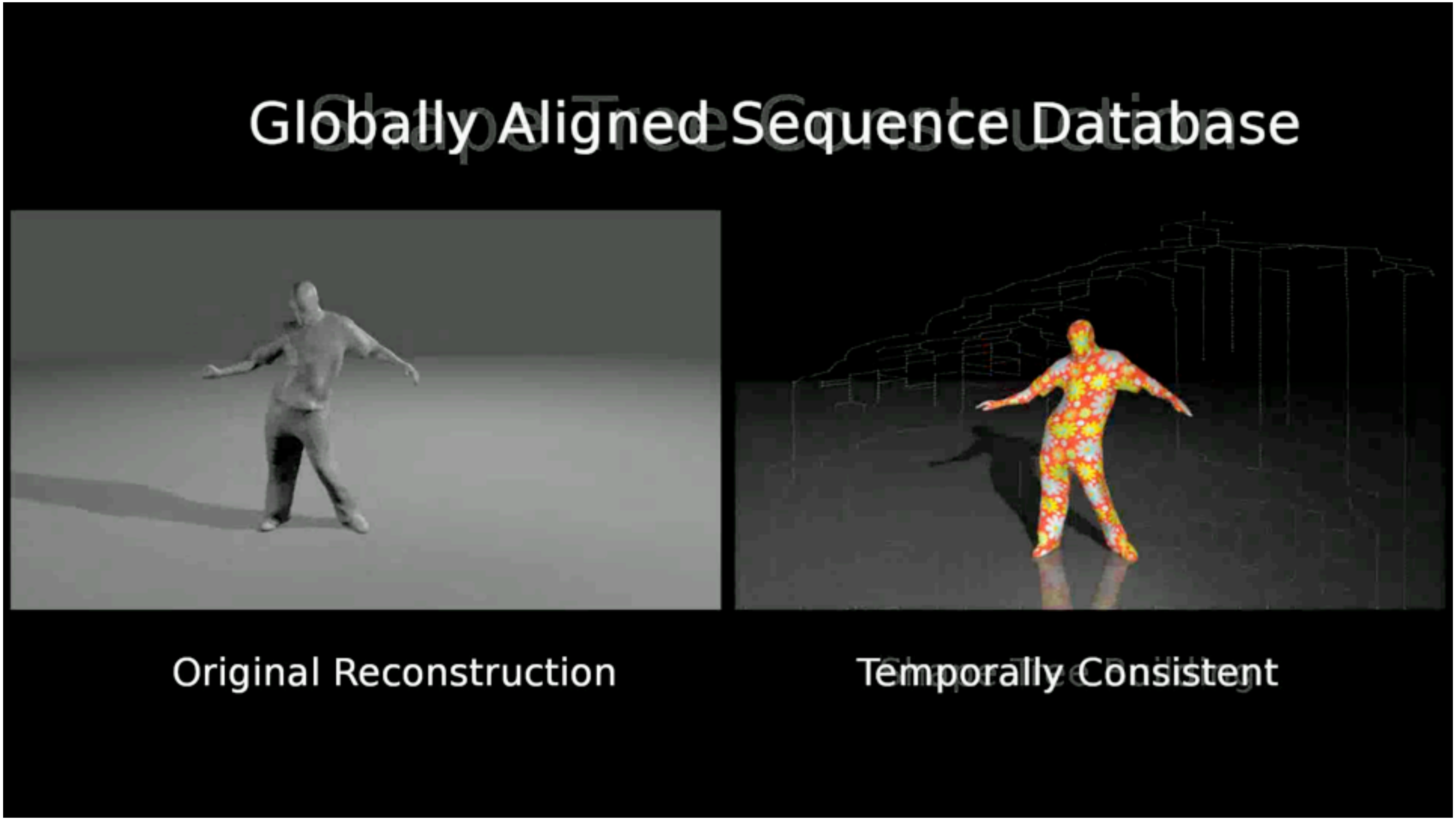
[Budd et al. IJCV'12]

Global Non-rigid Alignment



[Budd et al. IJCV'12]

Global Non-rigid Alignment



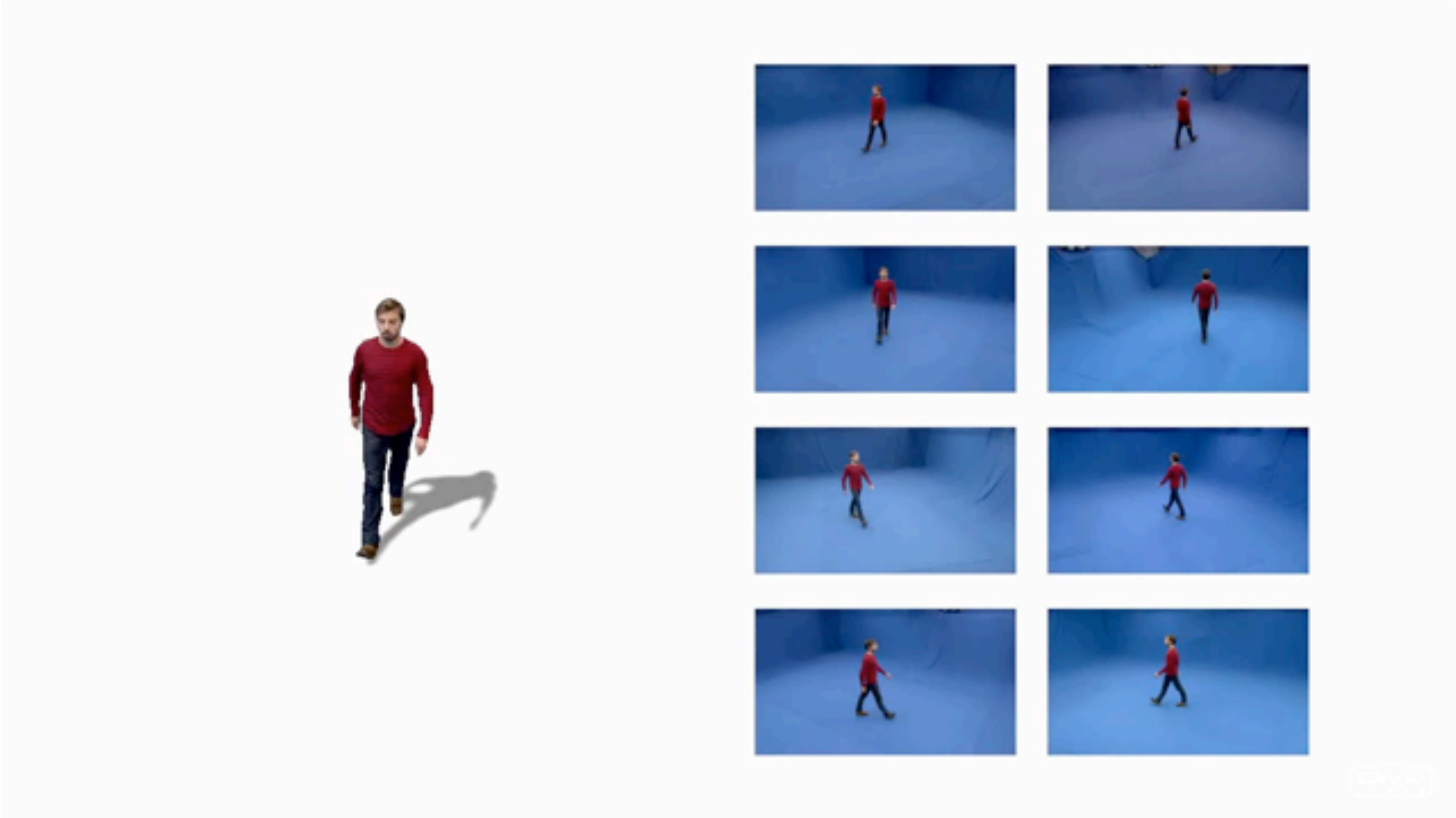
[Budd et al. IJCV'12]

4D Animation

Goal: Interactive character from actor performance capture

- realism of actor performance
- real-time interactive motion control

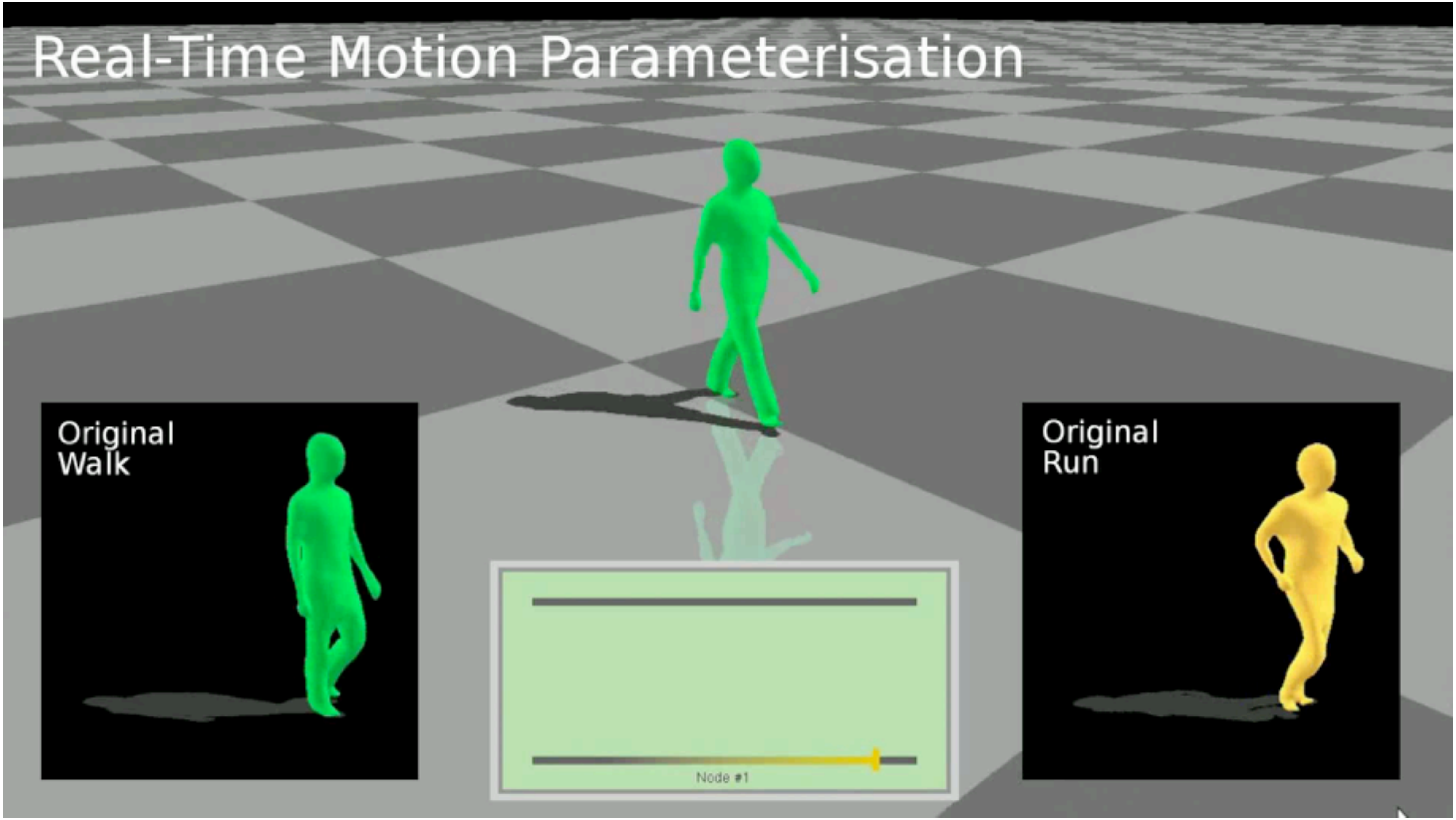
4D parametric motion control



[Casas et al. ACM-i3D 2012, IEEE-TVCG 2013]

4D Animation

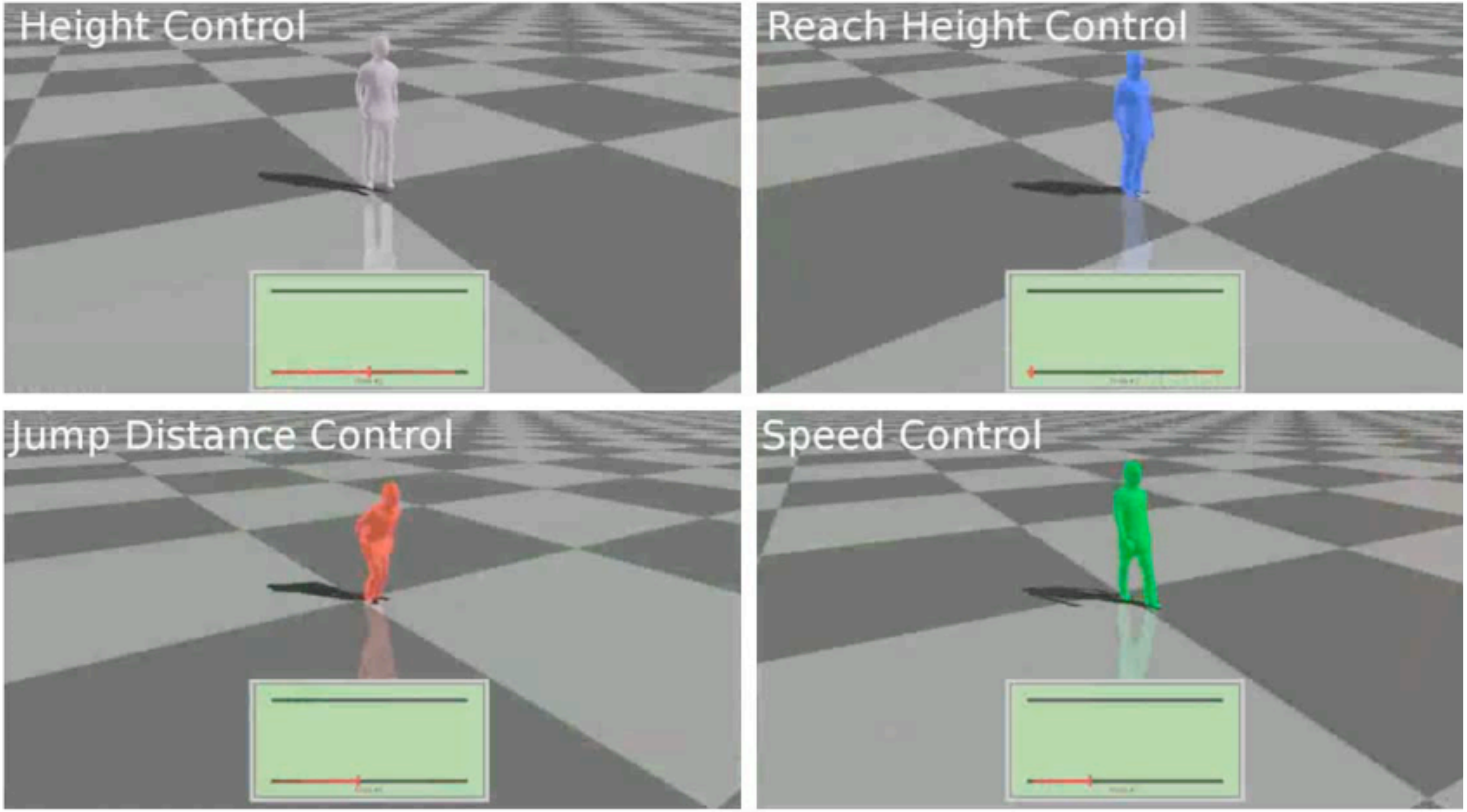
Parametric motion control



UNIVERSITY OF SURREY

4D Animation

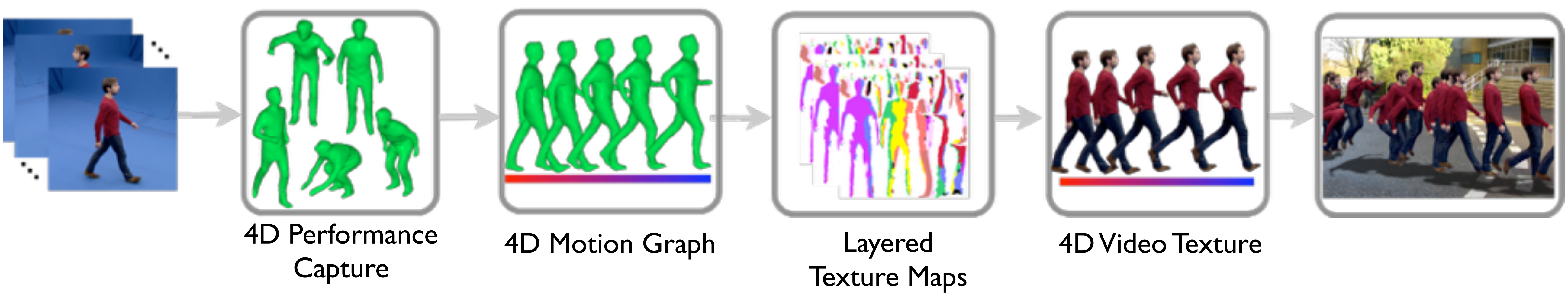
4D parametric motions



[Casas et al. ACM-i3D 2012, IEEE-TVCG 2013]

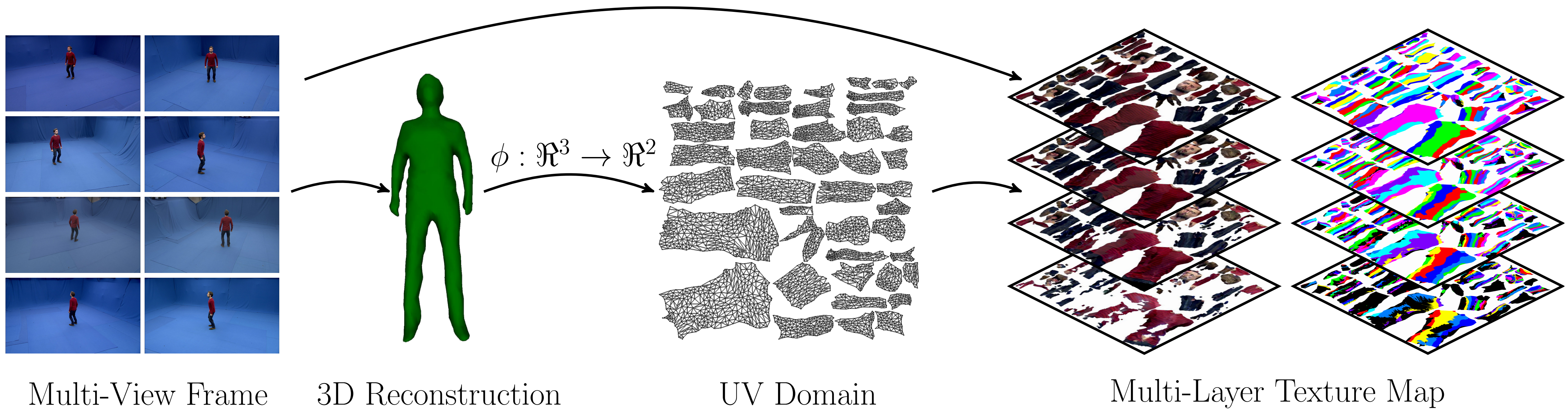
4D Video Textures

4D Video Textures
- Optimal representation of multi-view video
- Animation of dynamic appearance for new motions
- Video-realistic rendering



[Casas EG'14, Volino BMVC'14]

4D Video Textures



[Casas EG'14, Volino BMVC'14]

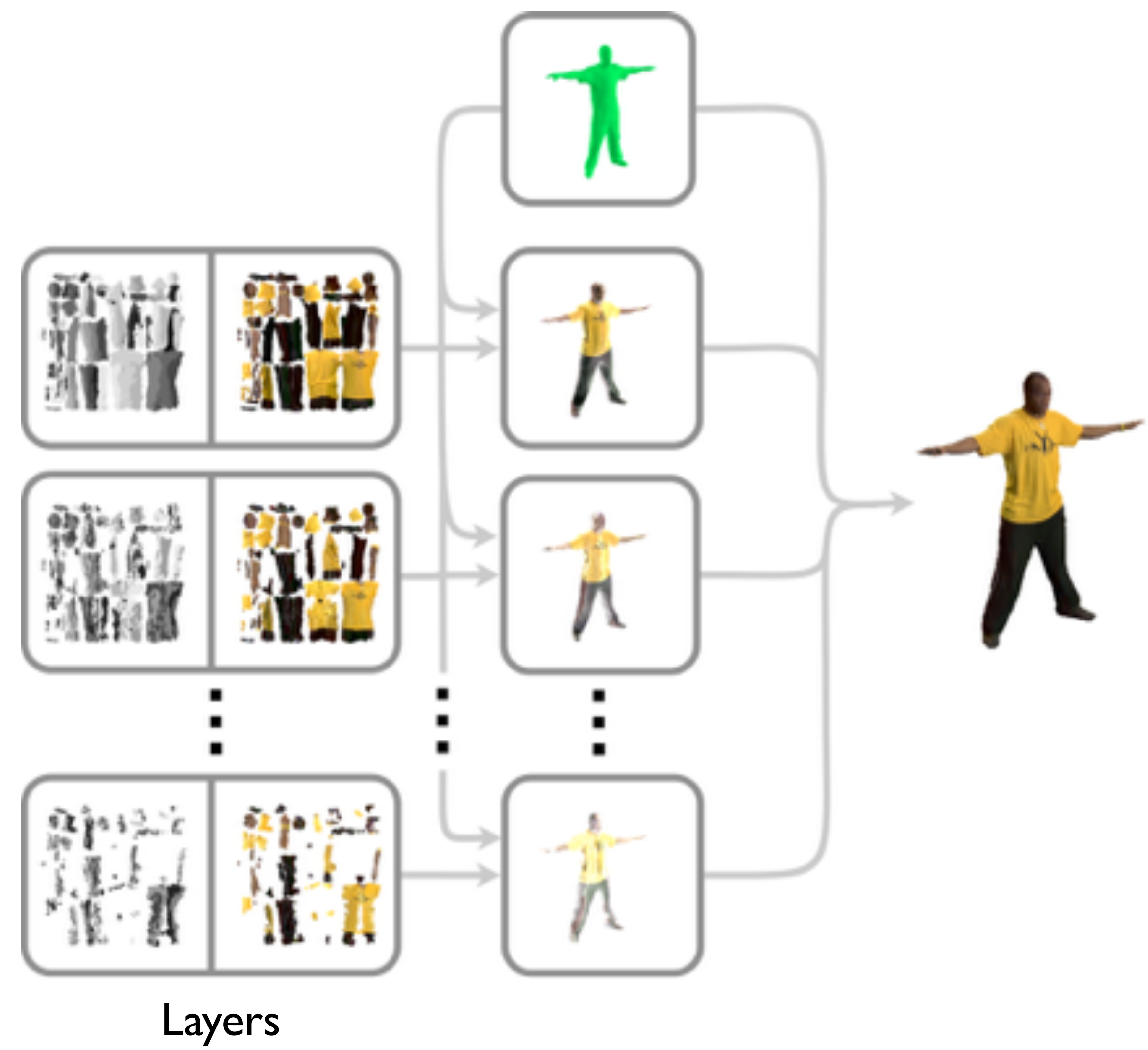
Optimal Representation of Multi-view Video

Layered texture maps
- layers ordered by visibility/sampling resolution
- optimisation of sampling for spatial & temporal coherence

Problem: Optimise the camera label assignment for each mesh element

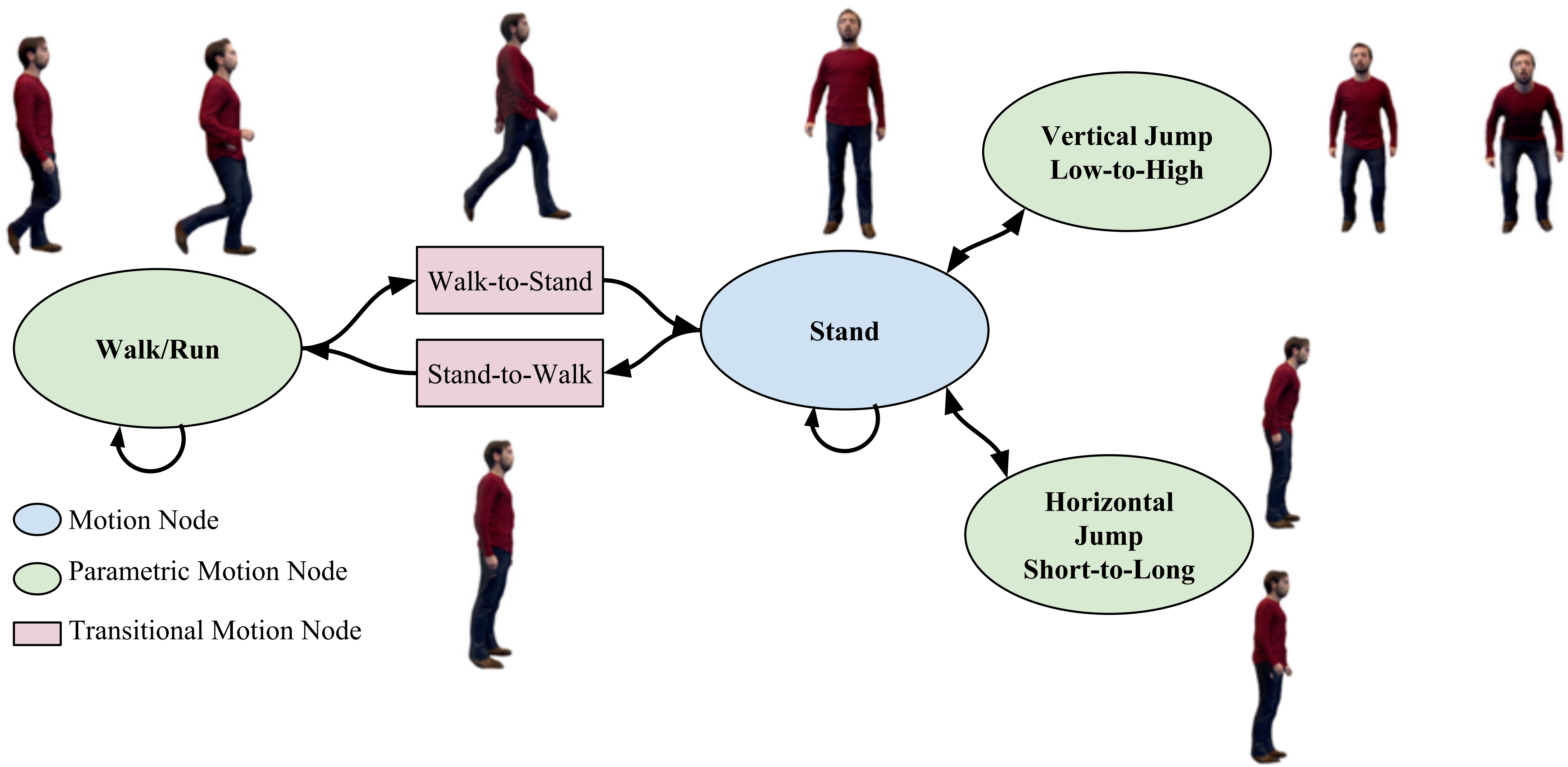
camera label for mesh face f : $z_f \in \mathbb{C}$

$$\arg\min \ (z_f) \Rightarrow \sum_f \left(\underbrace{\varepsilon_V(z_f)}_{\text{visibility}} + \sum_{g \in \mathbb{N}_S(f)} \underbrace{\varepsilon_S(z_f, z_g)}_{\text{spatial coherence}} + \underbrace{\varepsilon_T(z_f(t), z_f(t-1))}_{\text{temporal coherence}} \right)$$



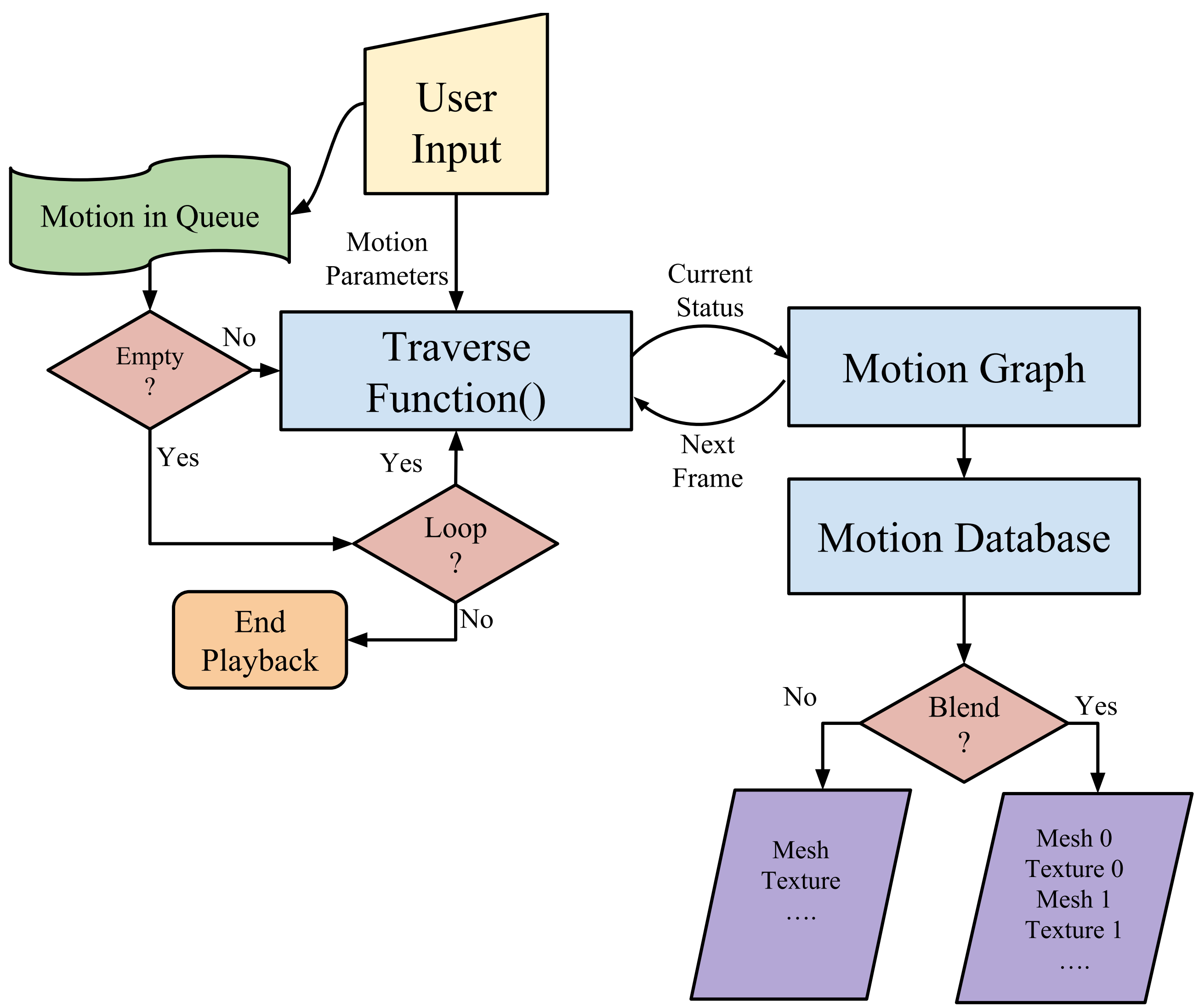
[Volino BMVC'14]

Parametric Surface Motion Graph



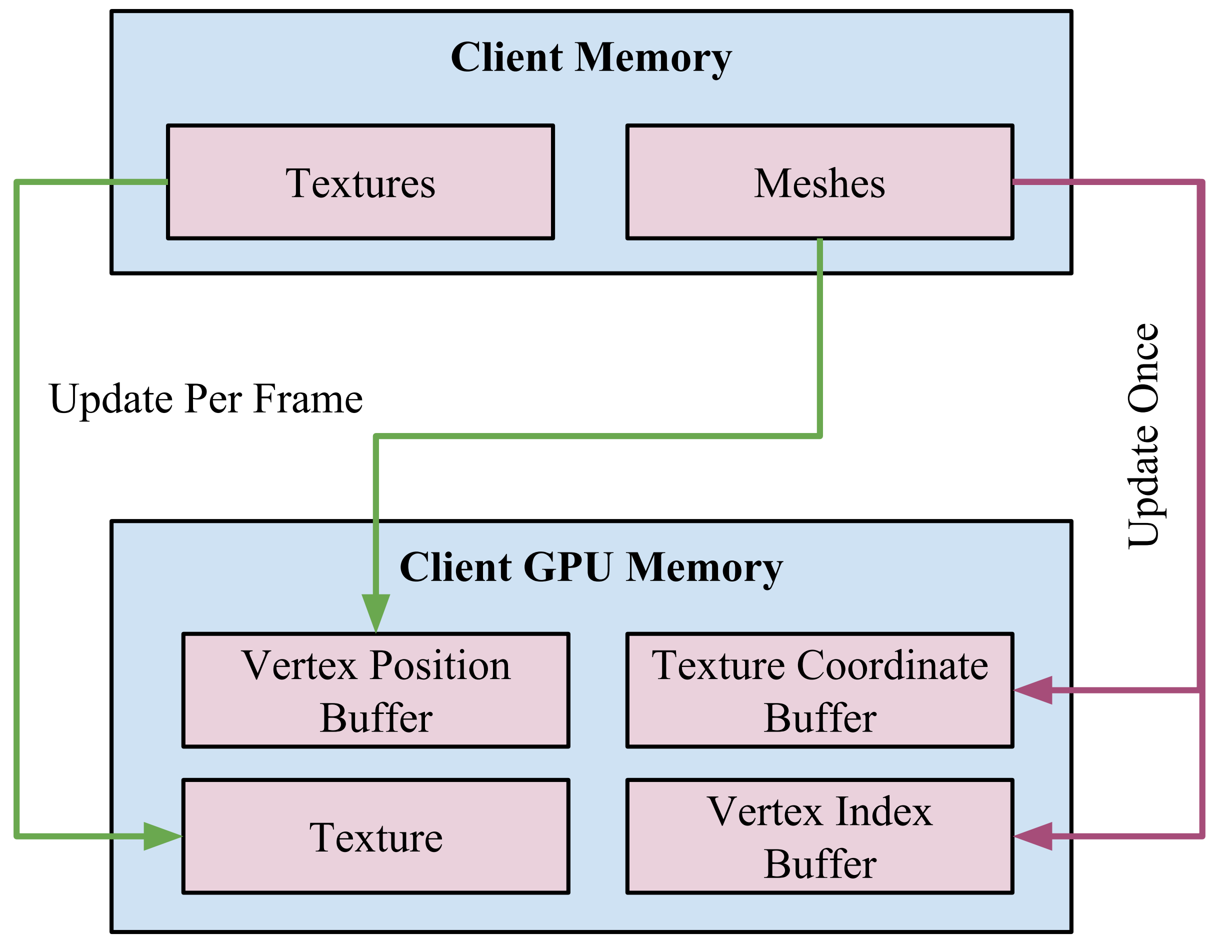
WebGL Character Animation Engine

- Motion graph and database are loaded in client memory
- User input updates the state for interactive control
- Traverse function identifies transitions & plays back sequence

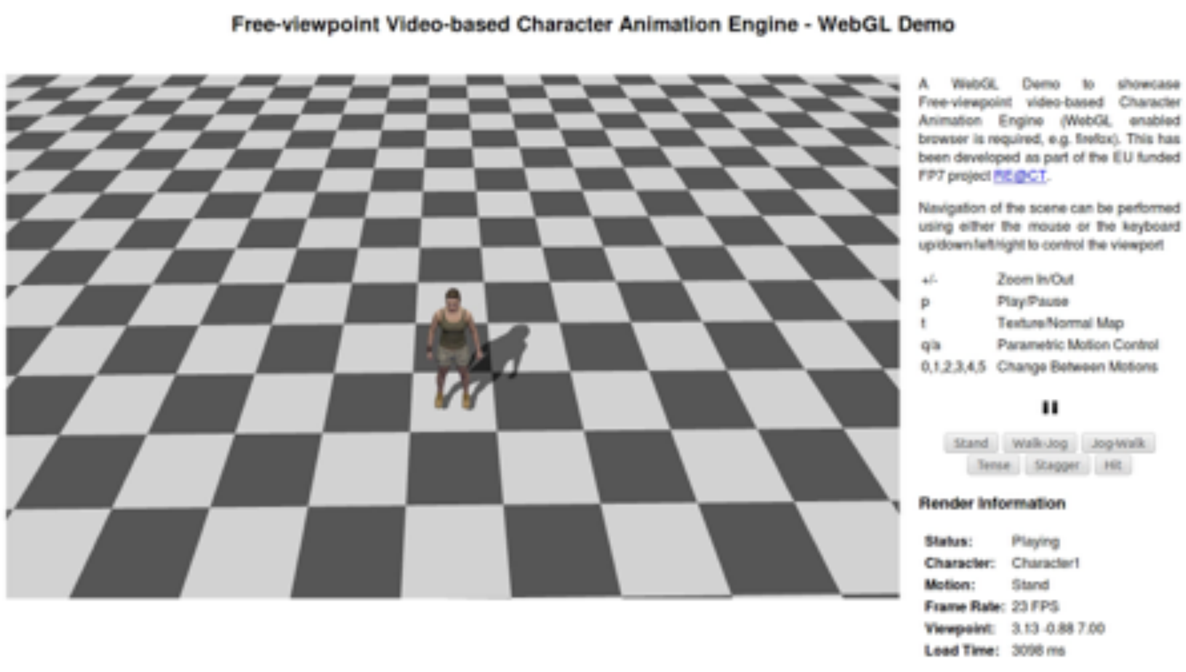


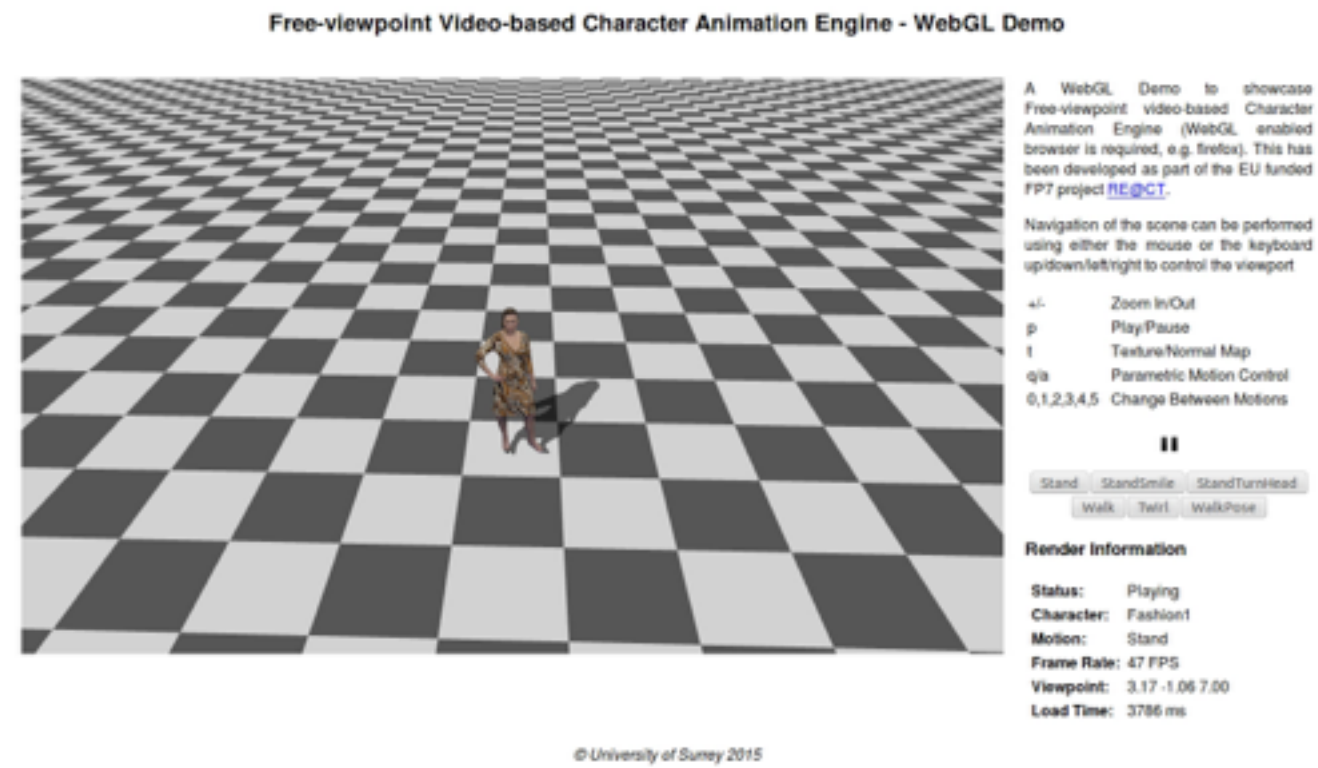
WebGL Renderer

- Resources are allocated to render a single frame of animation
- Updated per frame:
  - 2 x Vertex Position Buffer (to enable parametric motion)
  - 1 x Texture Buffer
  - 1 x Shadow Texture
- Updated Once:
  - 1 x Texture Coordinate buffer
  - 1 x Mesh Connectivity Buffer



Results


Free-viewpoint Video-based Character Animation Engine - WebGL Demo
A WebGL Demo to showcase Free-viewpoint video-based Character Animation Engine (WebGL enabled browser is required, e.g. firefox). This has been developed as part of the EU funded FP7 project RE@CT.
Navigation of the scene can be performed using either the mouse or the keyboard up/down/left/right to control the viewport
+/- Zoom In/Out
p Play/Pause
t Texture/Normal Map
q/a Parametric Motion Control
0,1,2,3,4,5 Change Between Motions
Stand Walk-Jog Jog-Walk
Tense Stagger Hit
Render Information
Status: Playing
Character: Character1
Motion: Stand
Frame Rate: 23 FPS
Viewpoint: 3.13 -0.88 7.00
Load Time: 3098 ms


Free-viewpoint Video-based Character Animation Engine - WebGL Demo
A WebGL Demo to showcase Free-viewpoint video-based Character Animation Engine (WebGL enabled browser is required, e.g. firefox). This has been developed as part of the EU funded FP7 project RE@CT.
Navigation of the scene can be performed using either the mouse or the keyboard up/down/left/right to control the viewport
+/- Zoom In/Out
p Play/Pause
t Texture/Normal Map
q/a Parametric Motion Control
0,1,2,3,4,5 Change Between Motions
Stand StandSmile StandTurnHead
Walk Twirl WalkPose
Render Information
Status: Playing
Character: Fashion1
Motion: Stand
Frame Rate: 47 FPS
Viewpoint: 3.17 -1.06 7.00
Load Time: 3786 ms
© University of Surrey 2015


Status: Playing Character: Ballet Motion: Move7 Frame Rate: 28 FPS Viewpoint: 1.56 -1.27 5.10 Load Time: 48104 ms
nodeIDs_input: 0,1,2,3,4,5,6 Submit
Current NodeID: 6 NodeIDs in Queue:
A WebGL Demo showcases Free-viewpoint video-based Character Animation Engine (WebGL enabled browser is required, e.g. firefox). This has been developed as part of the EU funded FP7 project RE@CT.
Navigation of the scene can be performed using either the mouse or the keyboard up/down/left/right to control the viewport and +/- for zoom. 'p' - Play/Pause, 't' - Texture Map Mode/Normal Colouring Mode.
© University of Surrey 2015

Conclusions

- First WebGL 4D Character Animation Engine
- Video-realistic 4D characters on the web
- Interactive control of character movement using a parametric motion graph

Demo and Data Available:
http://cvssp.org/projects/4d/web3D/

Future Work

- **Data Quality**
  shape & texture super-resolution
- **Data Size**
  current compression 98% vs. captured data
  compressed representation of texture sequence
- **Data Transfer**
  streaming 4D shape and texture

Online Interactive 4D Character Animation

Marco Volino, Peng Huang, Adrian Hilton

Demo and Data Available:
http://cvssp.org/projects/4d/web3D/

http://react-project.eu/