

# Online Interactive 4D Character Animation

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# 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**

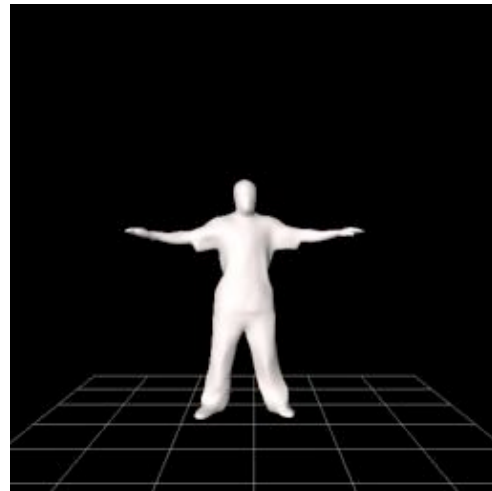
# 4D Performance Capture

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Spatio-temporally coherent models from video



2D



3D



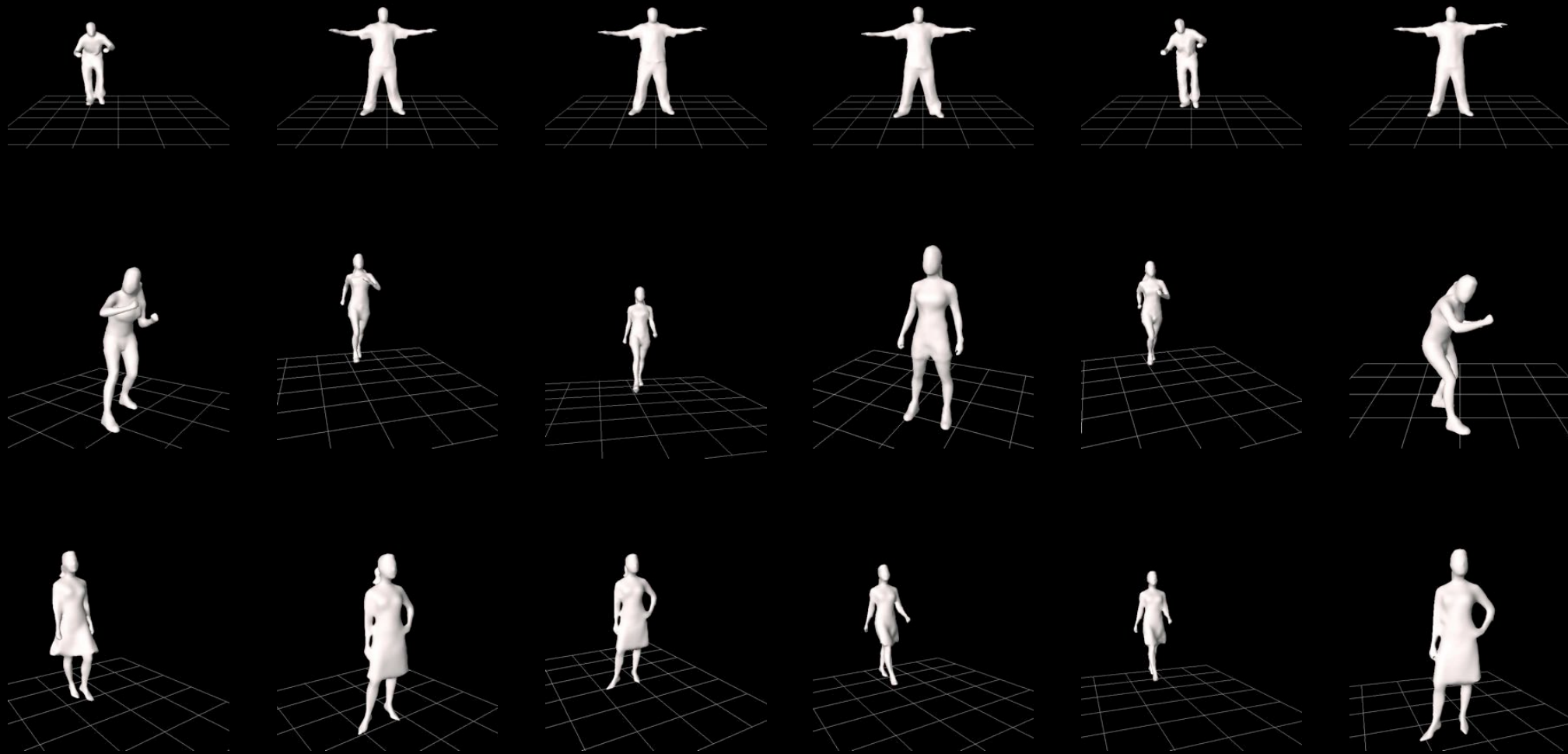
4D

# 4D Performance Capture

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



# 3D Video



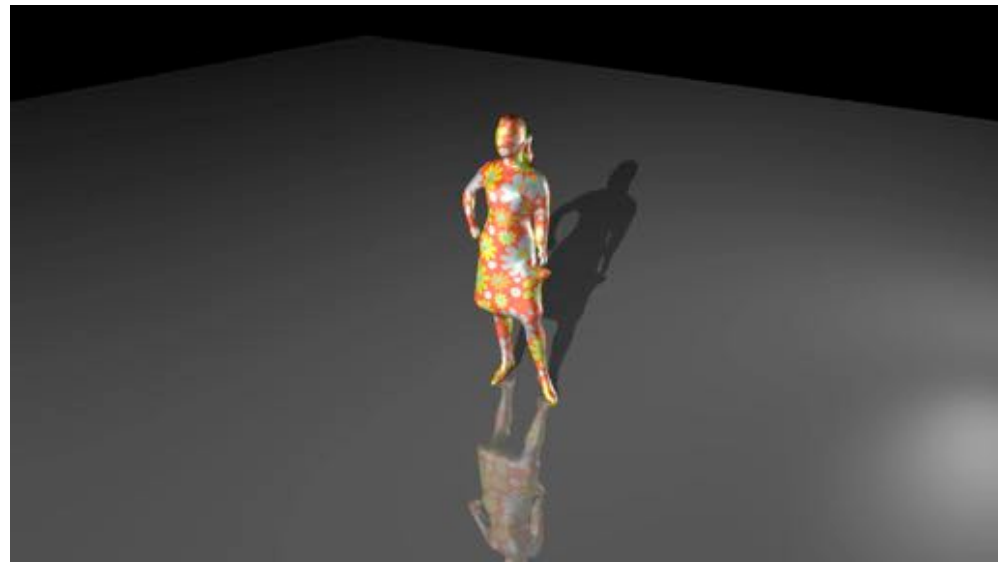
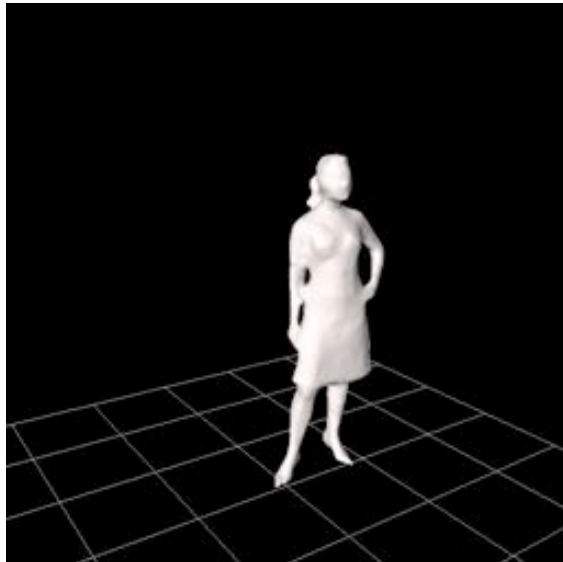
# 4D Representation

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3D video capture:

- unstructured mesh sequences
- no temporal correspondence

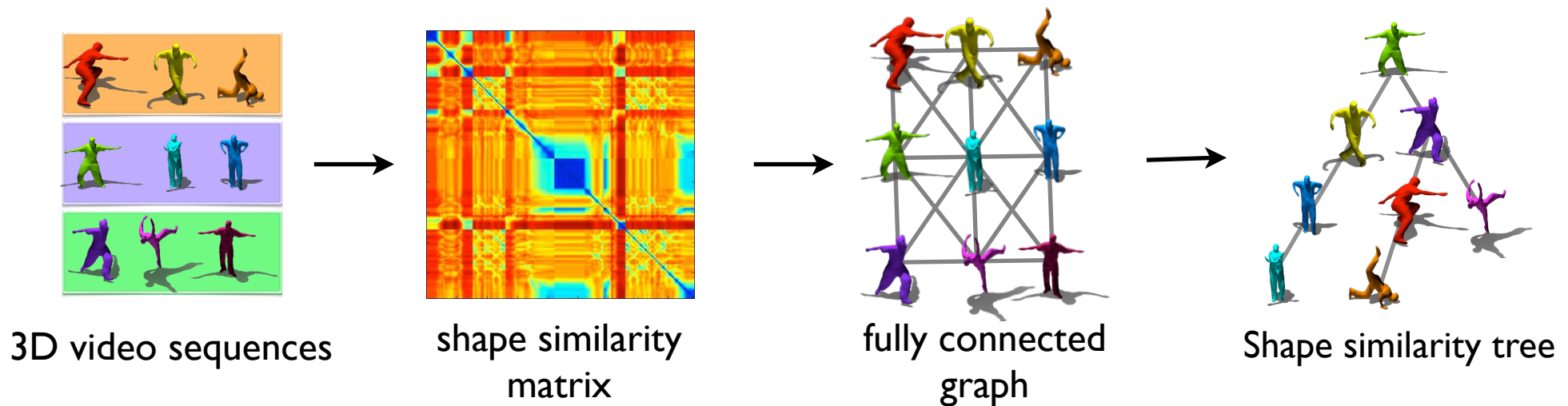
4D: coherent structure with temporal correspondence



# Global Non-rigid Alignment

Shape similarity tree construction:

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



[Budd et al. IJCV'12]

# Global Non-rigid Alignment

## Shape Tree Construction



Original Reconstruction



Shape Tree Building

[Budd et al. IJCV'12]

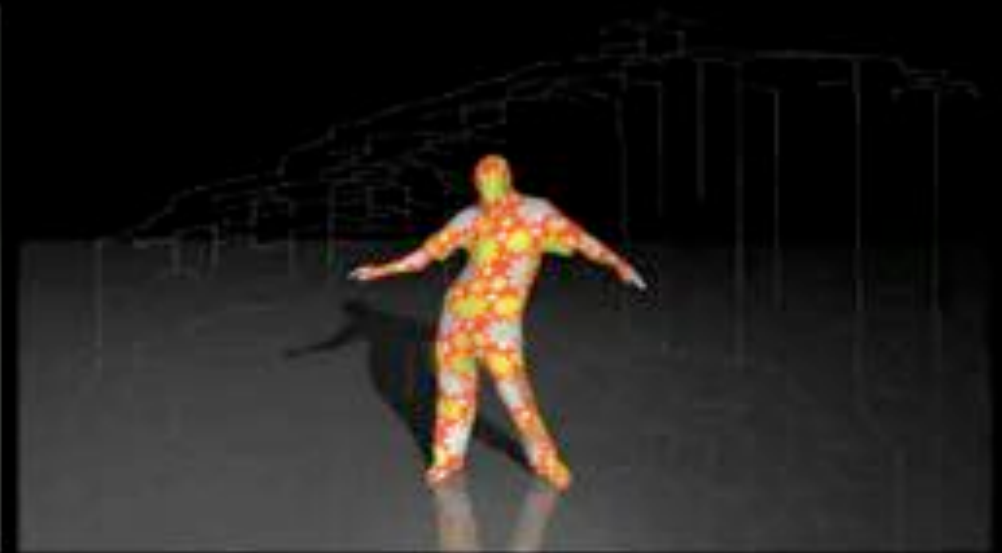


# Global Non-rigid Alignment

## Globally Aligned Sequence Database



Original Reconstruction



Temporally Consistent

[Budd et al. IJCV'12]

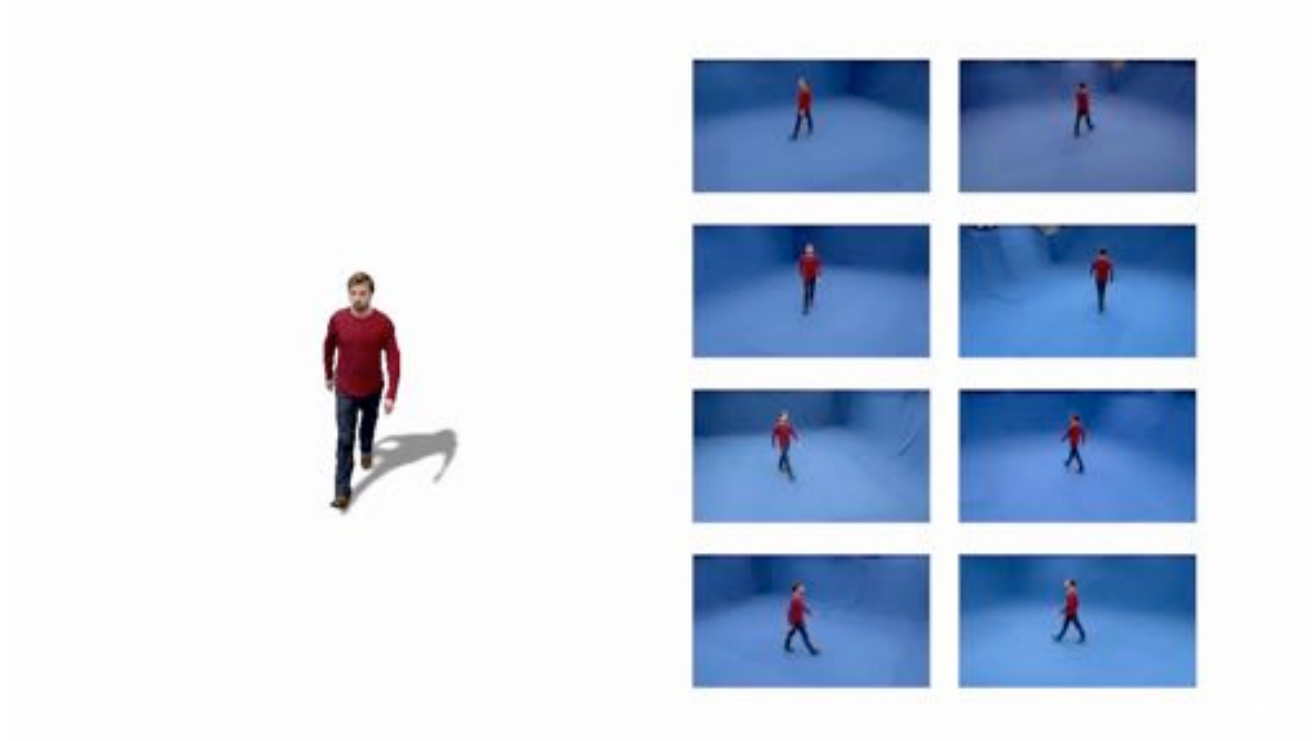
# 4D Animation

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Goal: Interactive character from actor performance capture

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

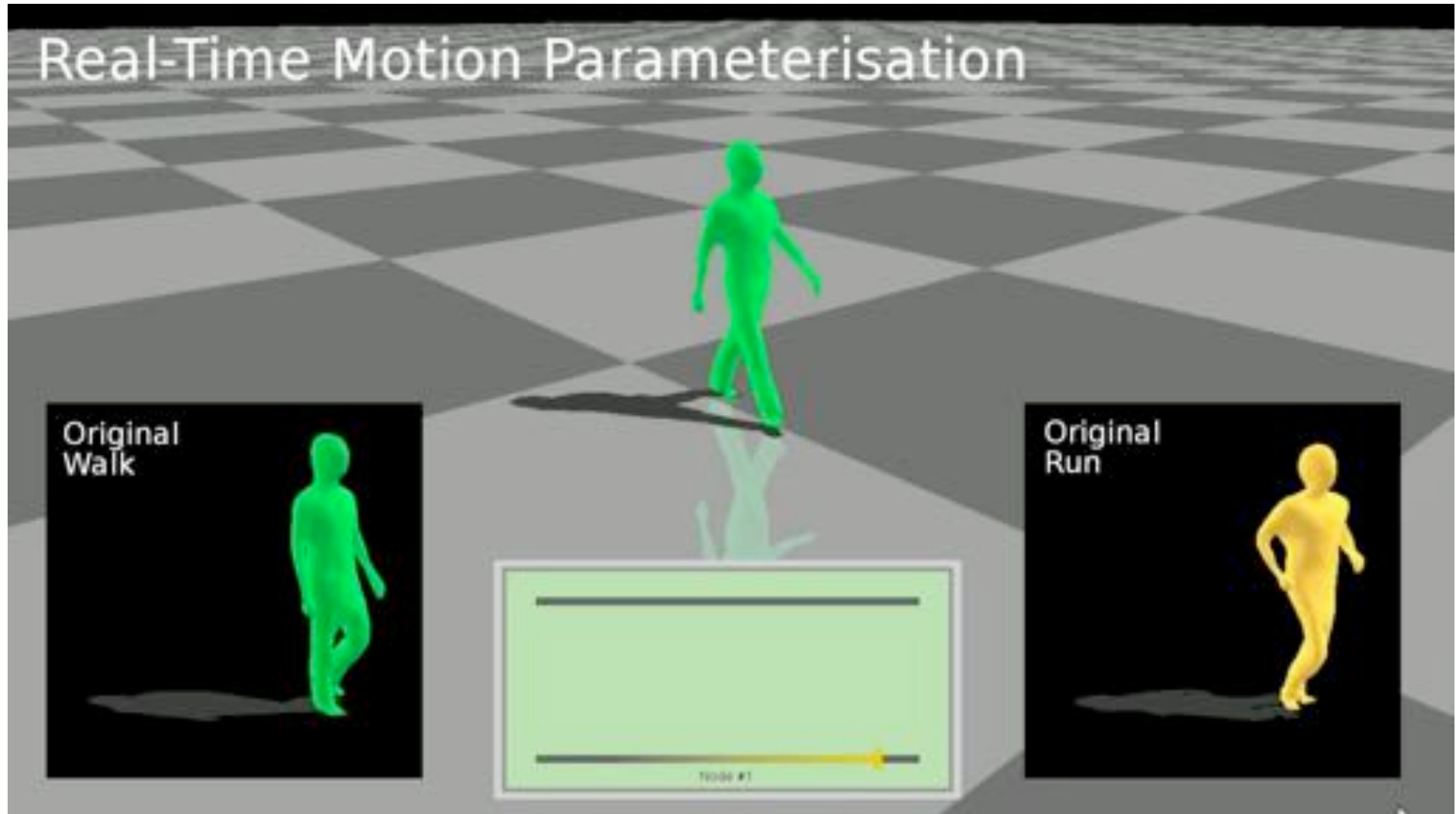
4D parametric motion control



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

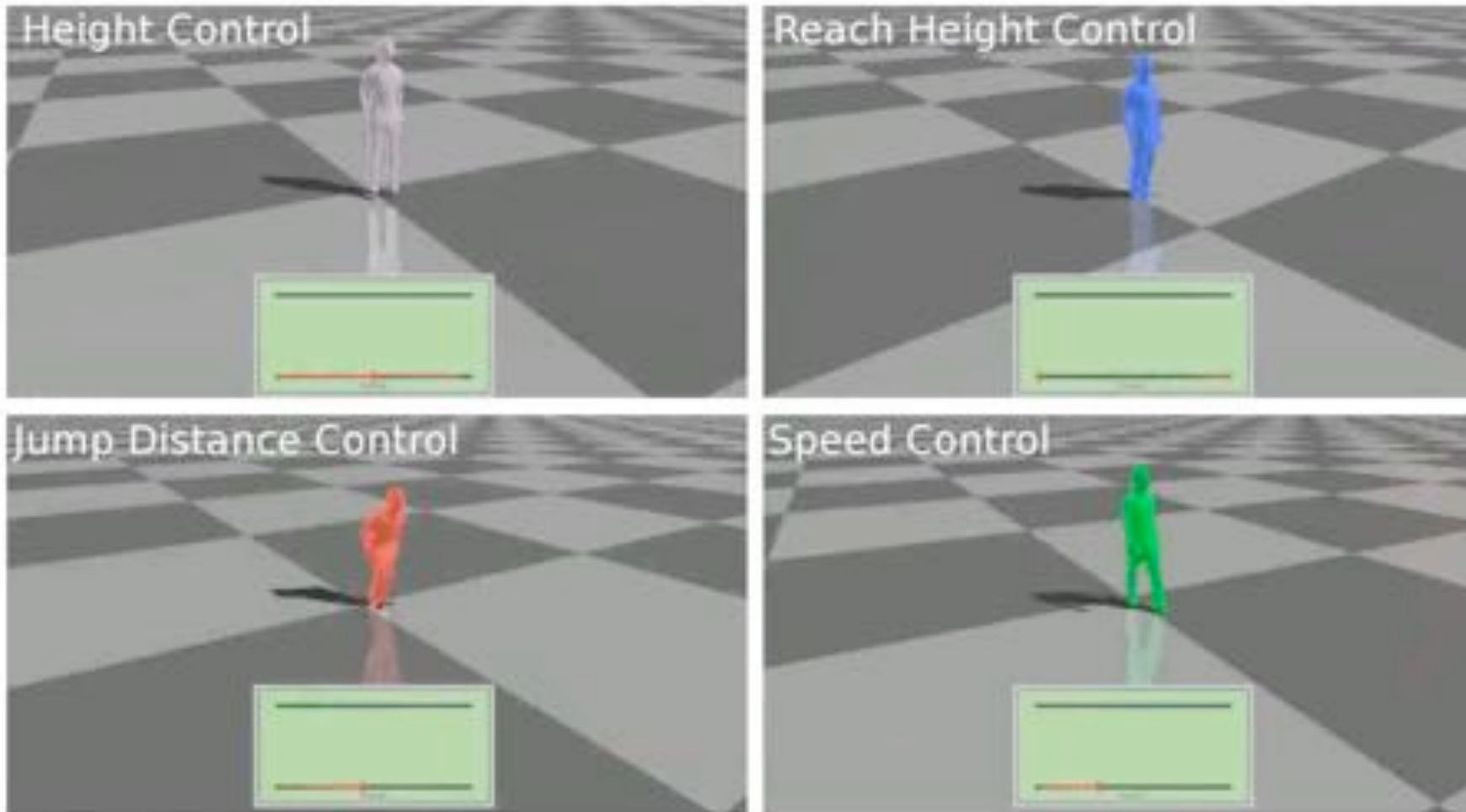
# 4D Animation

## Parametric motion control



# 4D Animation

## 4D parametric motions

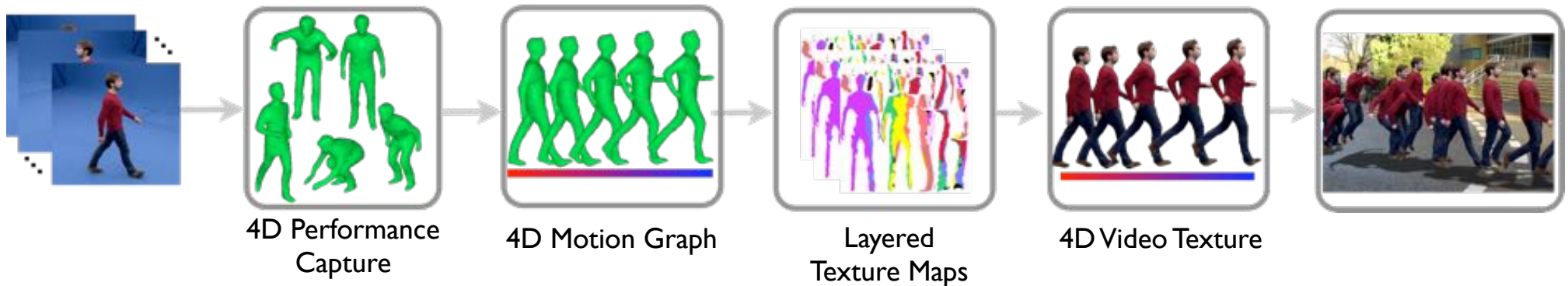


[Casas et al. ACM-i3D 2012, IEEE-TVCG 2013]

# 4D Video Textures

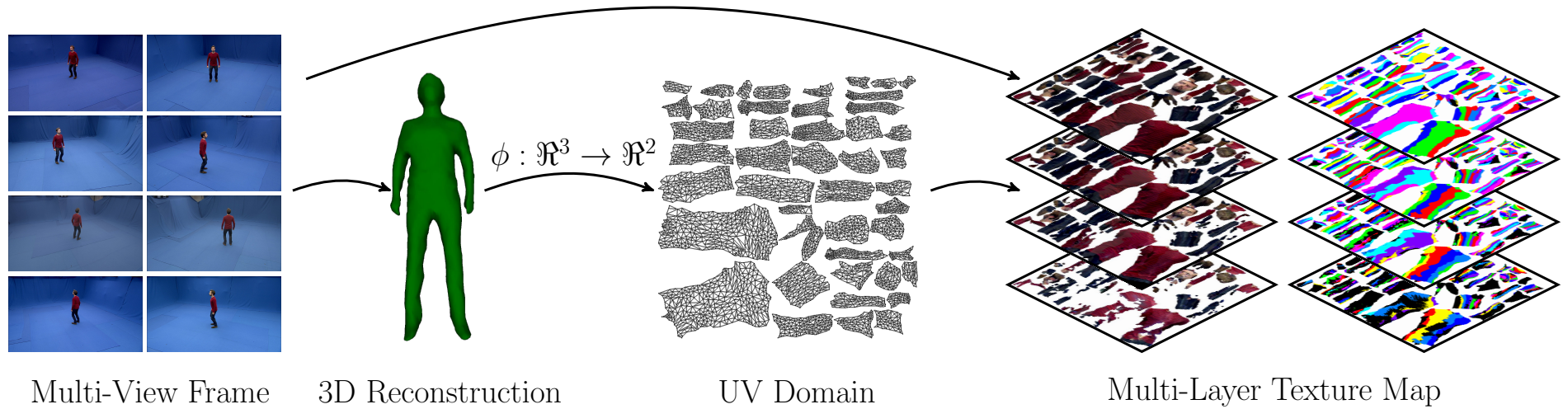
## 4D Video Textures

- 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

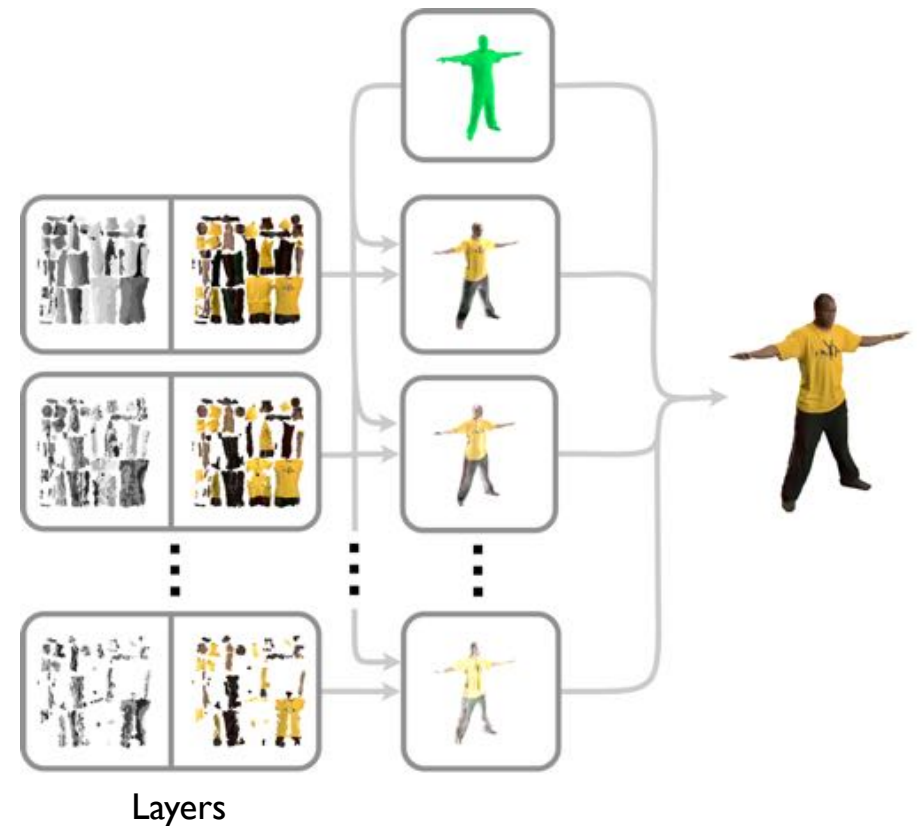
## Layered texture maps

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

Problem: Optimise the camera label assignment for each mesh element

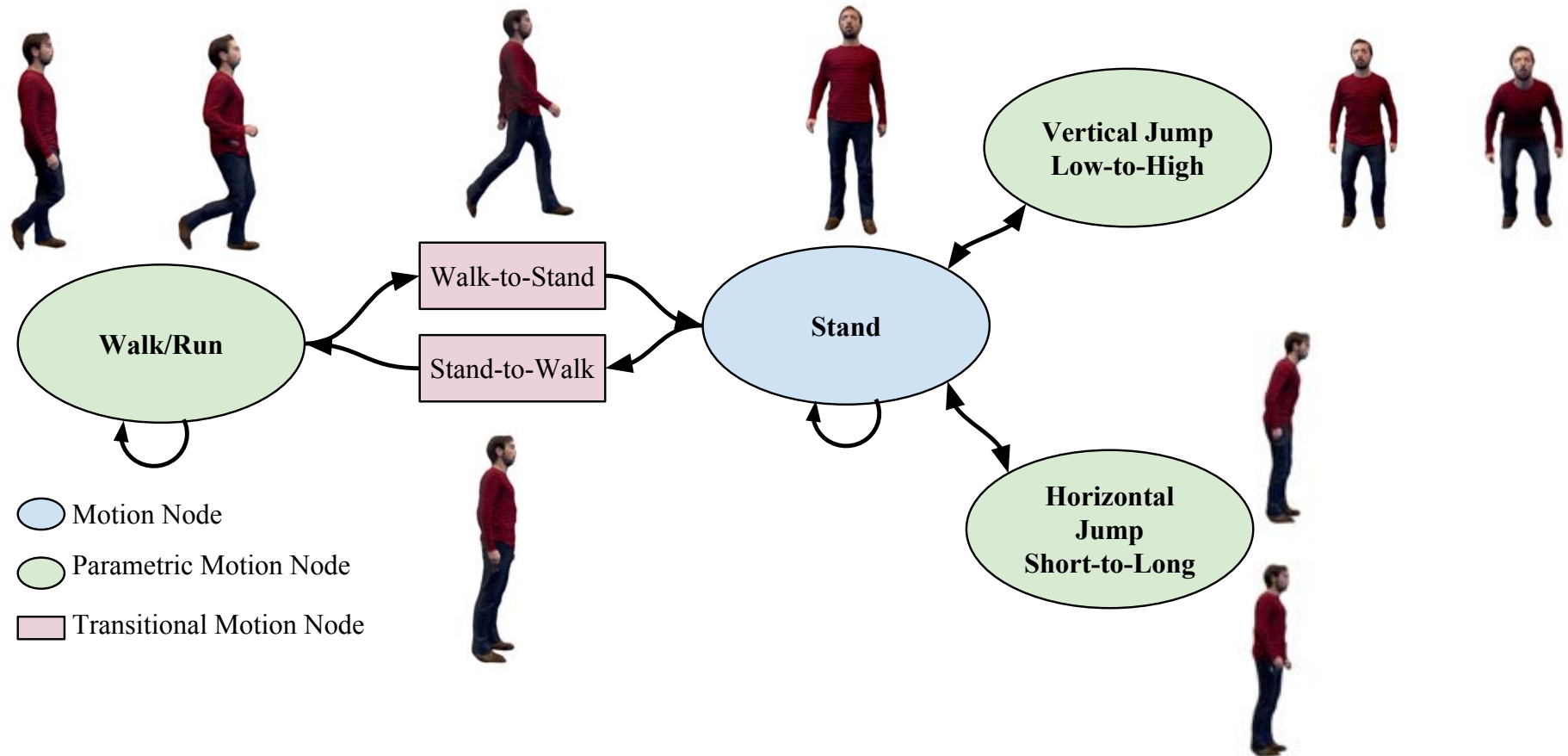
camera label for mesh face  $f$  :  $z_f \in \mathbb{C}$

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



[Volino BMVC'14]

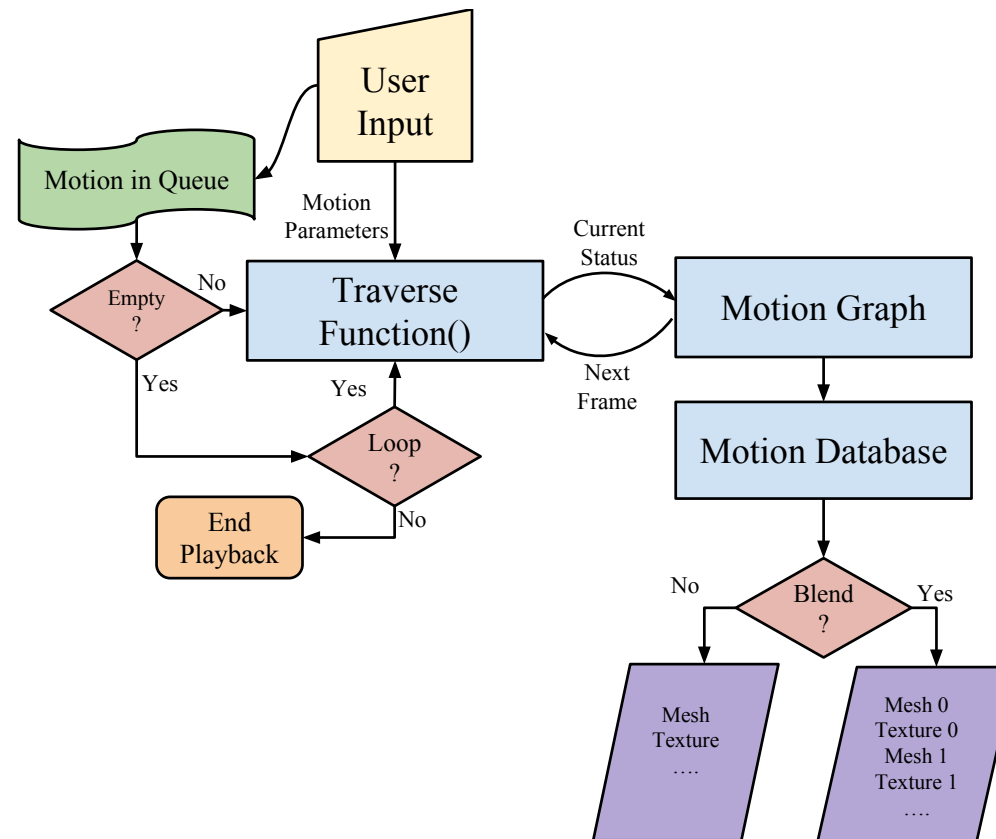
# Parametric Surface Motion Graph





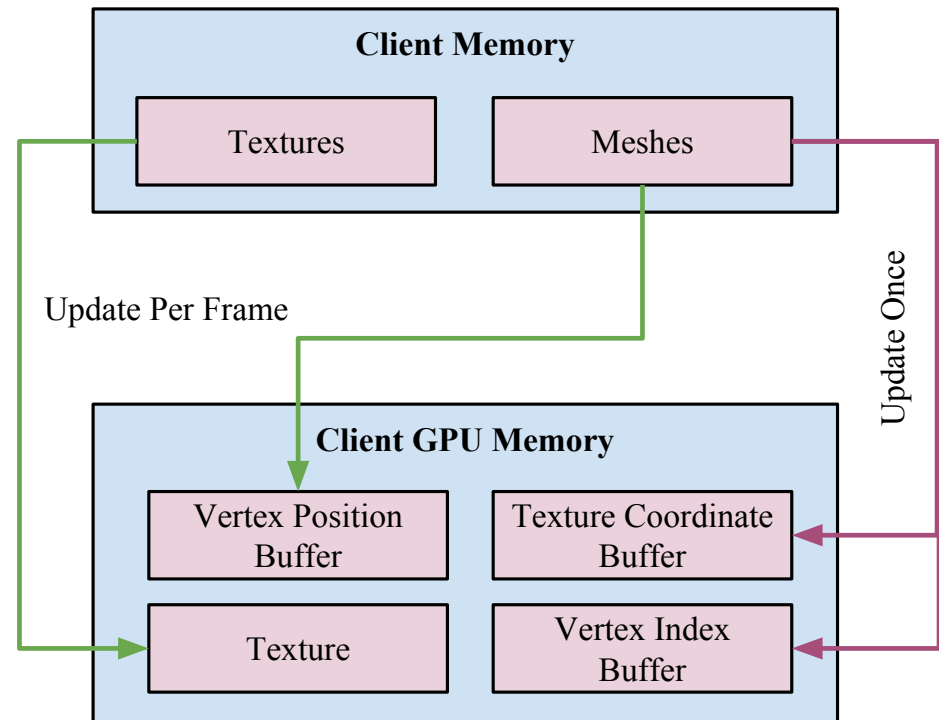
# WebGL Character Animation Engine

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



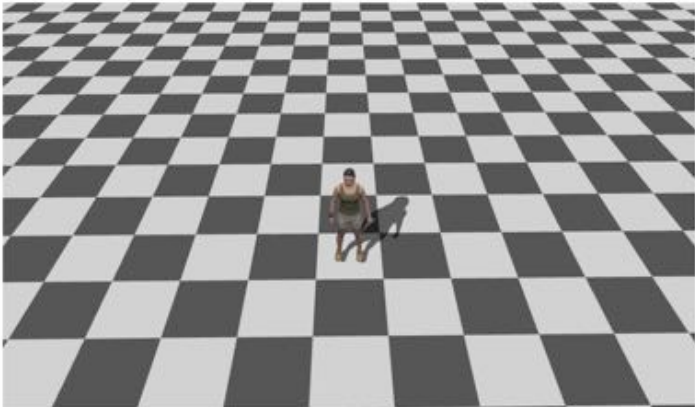
# WebGL Renderer

- 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

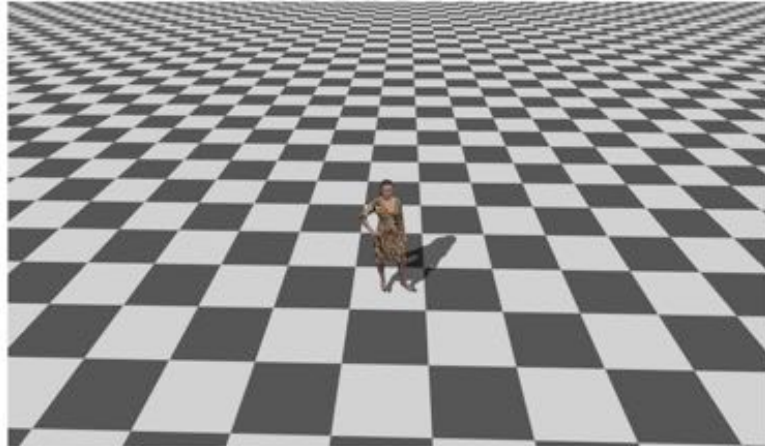
||

Stand Walk-Jog Jog-Walk  
Idle Stagger LHT

**Render Information**

Status: Playing  
Character: Character1  
Motion: Stand  
Frame Rate: 23 FPS  
Viewpoint: 3.13 -0.68 7.00  
Load Time: 3098 ms

Free-viewpoint Video-based Character Animation Engine - WebGL Demo



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+/- 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 StandIdle StandTurnHead  
Walk Turn WalkPose

**Render Information**

Status: Playing  
Character: Fashion1  
Motion: Stand  
Frame Rate: 47 FPS  
Viewpoint: 3.17 -1.06 7.00  
Load Time: 3786 ms

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Status: Playing Character: Ballie Motion: Move? Frame Rate: 28 FPS Viewpoint: 1.56 -1.27 5.10 Load Time: 48104 ms  
nodeIDs\_input: 0,1,2,3,4,5,6  ||

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.

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# Conclusions

- WebGL 4D Character Animation Engine
- Video-based 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/>

BBC 3D Dance Taster:

<http://www.bbc.co.uk/taster/projects/dancer>

# 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

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## Demo and Data Available:

<http://cvssp.org/projects/4d/web3D/>

<http://www.bbc.co.uk/taster/projects/dancer>



RE@CT



<http://react-project.eu/>