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

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

[Starck et al. CVIU’08]
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

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

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

Real-Time Motion Parameterisation

Original Walk

Original Run

Node #1
4D Animation

4D parametric motions

[Casas et al. ACM-i3D 2012, IEEE-TVCG 2013]
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]
there are errors in surface reconstruction or camera calibration. In this paper we address the problem of optimal representation of appearance for dynamic objects, such as people, from multi-view video acquisition. Figure 1 presents an overview of our approach mapping the captured multi-view video to a multi-layer texture map. Our primary contributions are:

- Multi-layer texture map representation of view-dependent appearance to maintain FVR quality in the presence of errors in geometry and calibration.
- Alignment of multi-view appearance to refine spatial coherence for resampling.
- Optimal sampling from multi-view video to maximise spatio-temporal coherence.
- Quantitative evaluation of rendering and storage for multi-layer texture map representation verses FVR from the captured images.

Optimal resampling and multi-layer texture map representation of multi-view video is evaluated on reconstructions from dynamic sequences of cloth, faces and people wearing a variety of clothing. Results demonstrate that the approach achieves a comparable visual quality to direct FVR from the captured multi-view video with >90% reduction in storage/transmission costs and improvements in rendering efficiency.

2 Related Work

Image and video-based modelling uses multi-view reconstruction to capture detailed object geometry and render novel views by resampling from the captured images. Extraction of a single surface texture map per frame combining the observed appearance from multi-view images has been widely used to provide a compact representation.

The simplest approach is to blend overlapping image regions weighted according to surface visibility for each camera [18]. This approach assumes accurate geometric reconstruction and camera calibration. In practice these errors commonly result in degradation of the visual quality producing blurring and ghosting artefacts due to misalignment between camera views projected onto the reconstructed surface. Correction of misalignment between multi-view images, due to errors in geometry and camera calibration, is addressed for image-based rendering in Floating Textures [10]. The approach performs online optical flow alignment in the rendered image for a specific viewpoint to reduce visual artefacts. Recent work has extended this approach to interactive video-based character animation using video-textures.
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 $f : z_f \in \mathbb{C}$

$$\arg \min (z_f) \Rightarrow \sum_f \left( \epsilon_V(z_f) + \sum_{g \in N_f} \epsilon_S(z_f, z_g) + \epsilon_T(z_f(t), z_f(t-1)) \right)$$

visibility spatial coherence temporal coherence
Parametric Surface Motion Graph

- Walk/Run
- Stand-to-Walk
- Walk-to-Stand
- Stand
- Vertical Jump Low-to-High
- Horizontal Jump Short-to-Long

Motion Node
Parametric Motion Node
Transitional Motion Node
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
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
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http://cvssp.org/projects/4d/web3D/

http://react-project.eu/