Pose-to-Pose Skinning of Animated Meshes

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1. Abstract

In computer animation, key-frame compression is essential for efficient storage, processing and reproduction of animation sequences. Previous work has presented efficient techniques for compression using affine or rigid transformations to derive the skin from the initial pose using a relatively small number of control joints. We present a novel pose-to-pose approach to skinning animated meshes by observing that only small deformation variations will normally occur between sequential poses. This scheme results in reducing approximation error and further enabling a novel forward-propagated editing of arbitrary frames.

2. Skinning Animated Meshes

Benefits:

- GPU-accelerated
- High compression
- Collision Detection
- Rest-pose Editing

Skinning Components to be stored:

- v_i : *Rest-pose* (may be corrected using EigenSkin [2])
- $w_{b,i}$: *Vertex Weights per bone b* - (positive, convex)
- M_b^p : *Transformation Matrices* [1,4] or *Dual Quaternions* [3] *from rest-pose to pose p.*

Fitting Formula:

$$\forall p : min\left\{\left\|\sum_{i=1}^{n}\left(\mathbf{v}_i^p - v_i^p\right)\right\|^2\right\}$$

Rest-Pose skinning:

$$v_i^p = T_i^p v_i \quad \text{, where} \quad T_i^p = \sum_{b=1}^{B} w_{b,i} M_b^p$$

3. Pose-to-Pose Approach

Advantages:

- Low entropy
- Temporal coherence

Supported Features:

- Rest-Pose reproduction scheme: full spectrum of previously supported applications
- Uncorrected rest-pose editing
- Arbitrary pose editing

Pose-to-Pose Skinning:

$$v_i^p = \sum_{b=1}^{B} w_{b,i} Q_b^p v_i^{p-1}$$

Rest-Pose Skinning Reproduction:

$$T_i^p = \left(\sum_{b=1}^{B} w_{b,i} Q_b^p\right) T_i^{p-1}$$

4. Arbitrary Pose Editing

Design Goals:

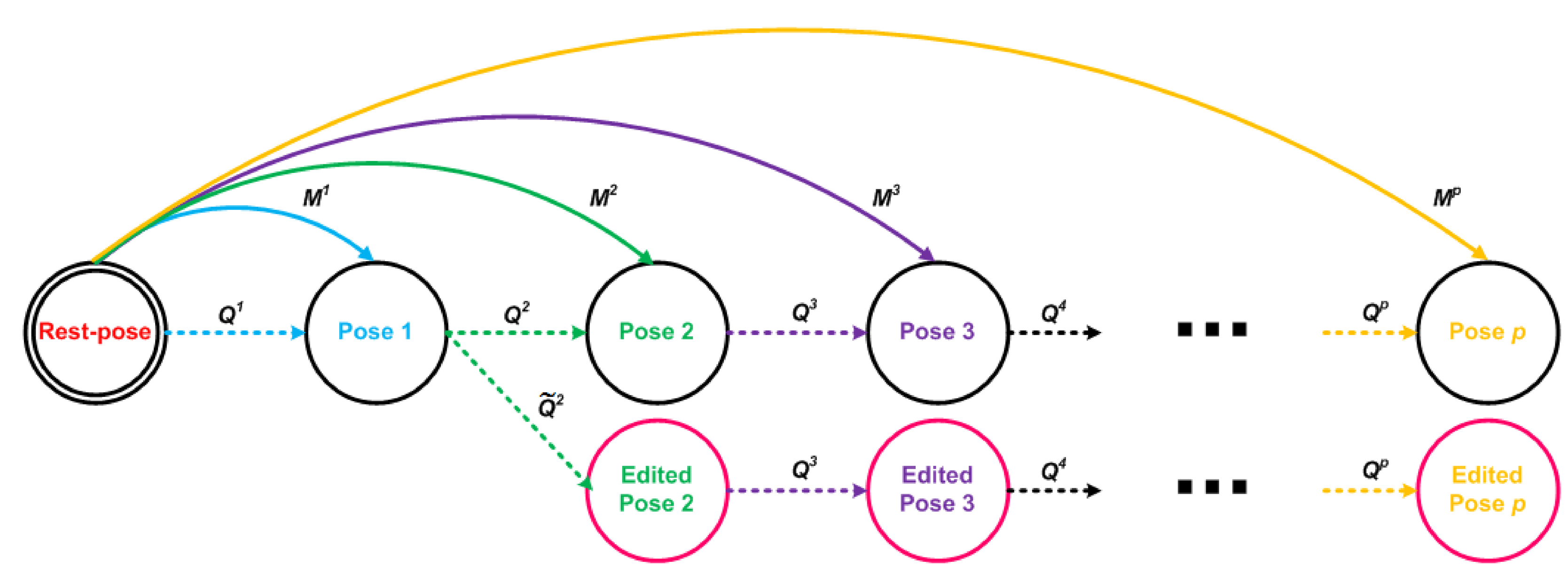
- Forward propagated editing operations
- Not altering skinning representation
- Only recompute the transformation moving to the newly edited pose from the previous one.

Rest-Pose Skinning Reproduction:

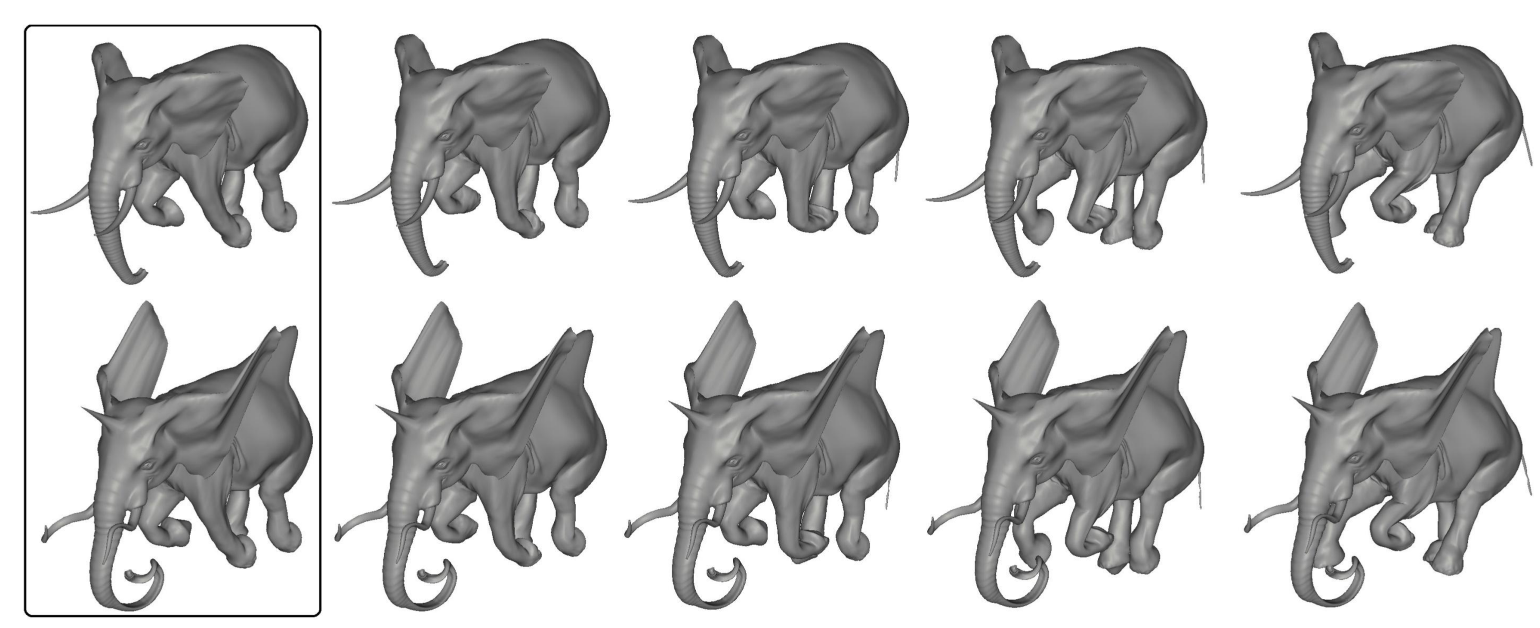
$$T_i^p = T_i^{p,p_e-1}\left(\sum_{b=1}^{B} w_{b,i} Q_b^{p_e}\right) T_i^{p_e-1,1} \quad \text{, where}$$

$$T_i^{t_0,t_1} = \prod_{t=t_0}^{t_1} \sum_{b=1}^{B} w_{b,i} Q_b^t$$

5. Figures

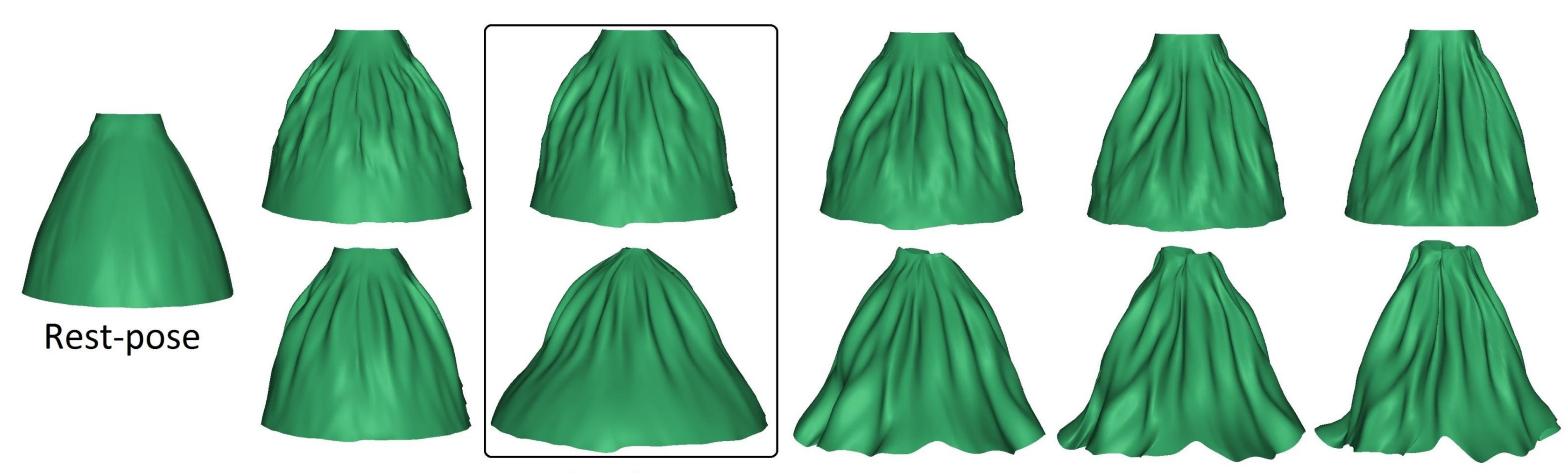


1. Rest-pose vs pose-to-pose skinning. The bottom row shows how the propagated edit works in the pose-to-pose skinning.



Editing Rest-pose

2. (top row) The original animation sequence. (bottom row) The result of editing the rest-pose and subsequently applying the pre-computed pose-to-pose transformations.



Rest-pose

Edited Pose

3. (top row) The original animation sequence. (bottom row) The result of editing the 2nd pose and subsequently applying the pre-computed pose-to-pose transformations.

6. Limitations

- Non-parallel
- Non-iterative
- Artifact propagation
- Editing flaws

7. References

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