

### Problem

Given a set of recorded elementary 4D models, generate "realistic" new animations that satisfy user specified constraints.



**Input:** Video-based temporally consistent mesh sequences of cyclic or acyclic elementary motions.







# Contributions

- The essential graph, an optimal structure for motion data organization and reuse.
- **Dynamic Time Warping & Variable Length Blended Segments**, for more realistic motion transitions
- 3D behavioral path synthesis, a novel high-level constraint formulation.

### Challenges

- Limited data: Make exhaustive use of it
- User perceptual acuity: Reliable numerical realism criterion Optimal results in terms of said criterion
- Sensitive data: Robust mesh processing technique
- Complex dynamics:
  - Robust transition generation technique

# Video based Animation Synthesis with the Essential Graph Adnane Boukhayma, Edmond Boyer MORPHEO - INRIA Grenoble Rônes-Alpes

### **Organizing data structure**



- Complete di-graph
- Essential sub-graph



warps w<sup>i</sup>, w<sup>j</sup> w.r.t surface deformation cost:

$$D(i,j) = \min_{l^i, l^j \in [l_{\min}, l_{\max}]} \min_{w^i, w^j} \sum_{t \in [0,L]} d(w^{\overline{i}^1}(t), w^{\overline{j}^1}(t))$$
  
Dynalic Time Warping

where d(.,.) is a static pose distance.

# Static Pose distance and interpolation

Pose parameterization through local surface deformations:

- Polar decomposition of Deformation Gradients [2] for all mesh triangles yields product Riemannian manifold:  $(SO(3) \times S_3^{+*})^{m_{triangles}}$
- Pose metric  $d(.,.) = \sum_{m_{triangles}} \frac{1}{\sqrt{2}} \left( \left\| \log(R) \right\|_F + \left\| \log(S) \right\|_F \right)$  Pose interpolation
- Geodesic transformation interpolation  $\tilde{T} = e^{\lambda \log(R)} . e^{\lambda \log(S)}$
- Gradient deformation with interpolated transformation
- 3D Poisson Shape reconstruction [3]







### **References:**

[1] L. Kovar, M. Gleicher, and F. Pighin. Motion graphs. ACM Trans. Graph., 2002. [2] R. W. Sumner and J. Popovic. Deformation transfer for tri- angle meshes. ACM Trans. Graph., 2004.

[3] D. Xu, H. Zhang, Q. Wang, and H. Bao. Poisson shape Video: interpolation. ACM Symposium on Solid and Physical Modeling,

[4] J. Starck and A. Hilton. Surface capture for performancebased animation. IEEE Comput. Graph. Appl., 2007. [5] C. Budd, P. Huang, M. Klaudiny, and A. Hilton. Global nonrigid alignment of surface sequences. Int. J. Comput. Vision, 2013.

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