Video based Animation Synthesis with the Essential Graph

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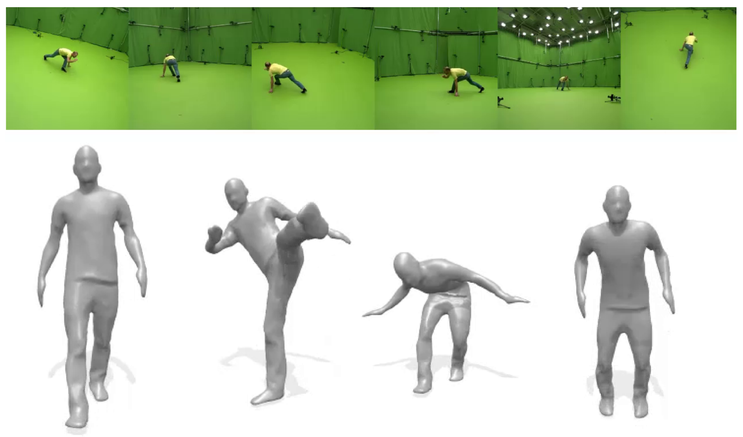
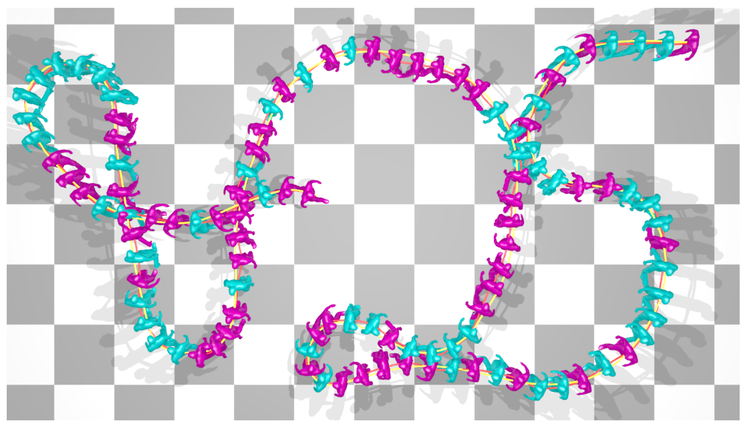
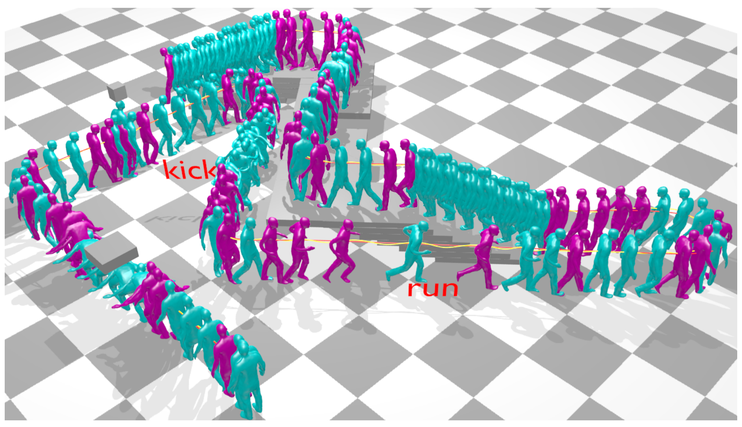
Problem

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



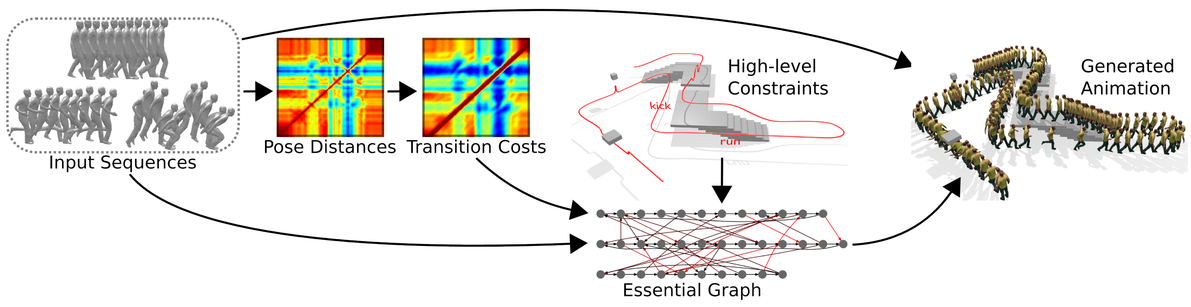
Input: Video based temporally consistent mesh sequences of cyclic or acyclic elementary motions.



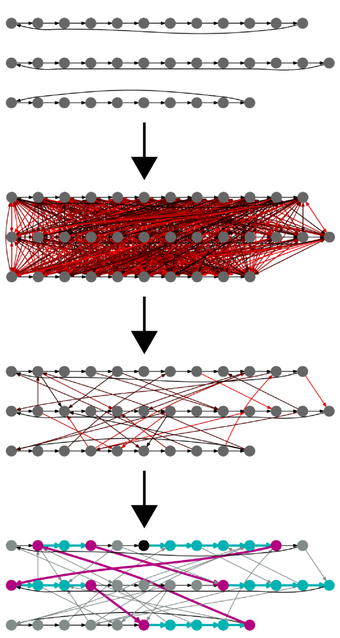


Output: Novel, user-guided realistic surface animation.

Approach

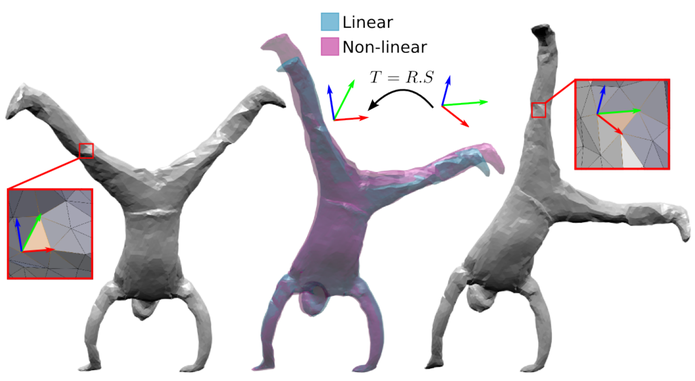


Data organizing structure



- Initial graph instance: Node = frame, edge = transition.
- Complete directed graph: All nodes connected with a realism cost.
- Essential sub-graph: Extraction of the union of shortest path trees rooted at every node.
- Minimum cost graph walk: Graph search for a walk satisfying user high-level constraint.

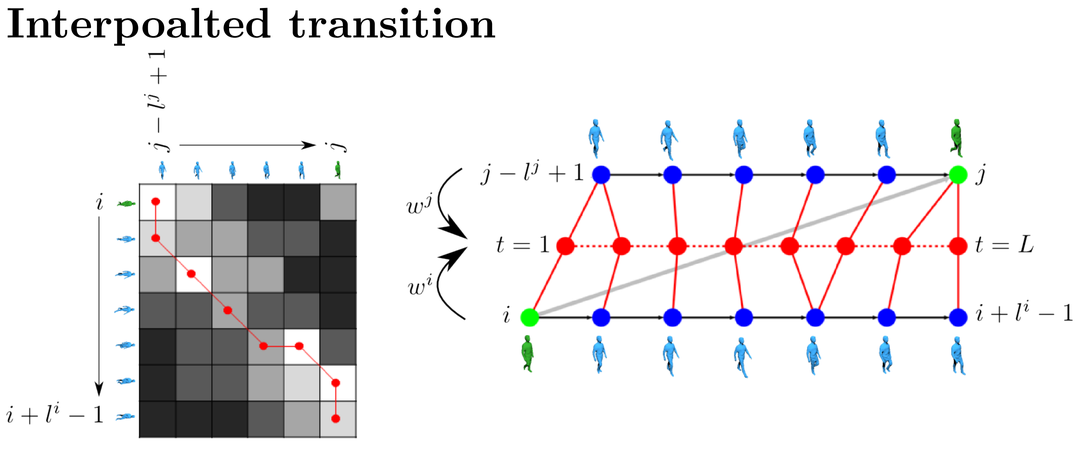
Pose parametrization



Pose distance based on local deformation gradients.

Pose interpolation using Poisson reconstruction of mesh deformed with geodesically interpolated deformation gradients.

Interpoalted transition



Generation of a transition from frame i to frame j through gradual frame blending with optimal segment lengths l_i and l_j, and temporal warps w_i and w_j w.r.t surface deformation cost.

Contributions

- **The essential graph**, an optimal structure for motion data organization and reuse.
- **Dynamic Time Warping & Variable Length Blended Segments**, for more realistic interpolated motion transitions.

Qualitative comparison

Interpolated transition

Combining **dynamic time warping** and **variable length blended segments** (a), compared to a standard interpolated transition (b).

Organizing data structure

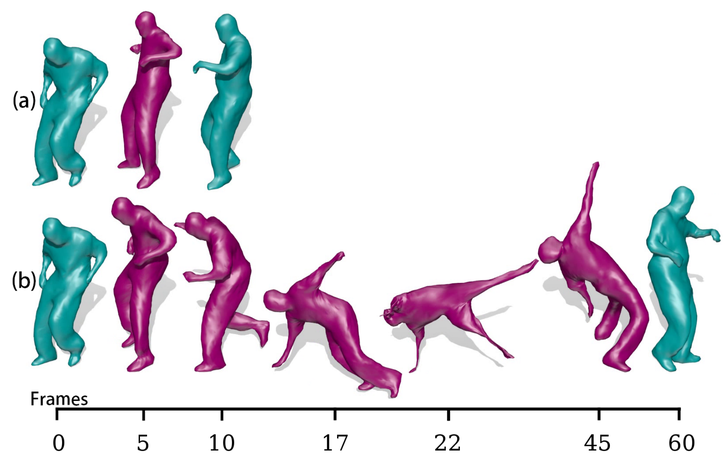
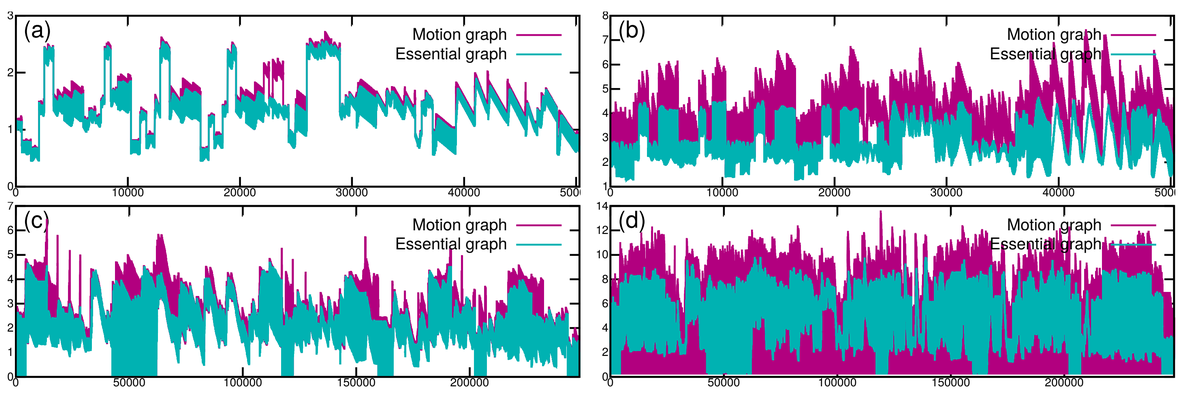


Illustration of a **motion graph**'s (b) failure to find a graph walk as short and costless as the **essential graph** (a).

Quantitative comparison

Organizing data structure



Costs of all optimal paths joining all pairs of frames in the dataset for a motion graph and an essential graph. *Dan* dataset: (a)$\alpha = 0.01$, (b)$\alpha = 0.1$. *JP* dataset: (c)$\alpha = 0.01$, (d)$\alpha = 0.1$.