

4Deform: Neural Surface Deformation for Robust Shape Interpolation



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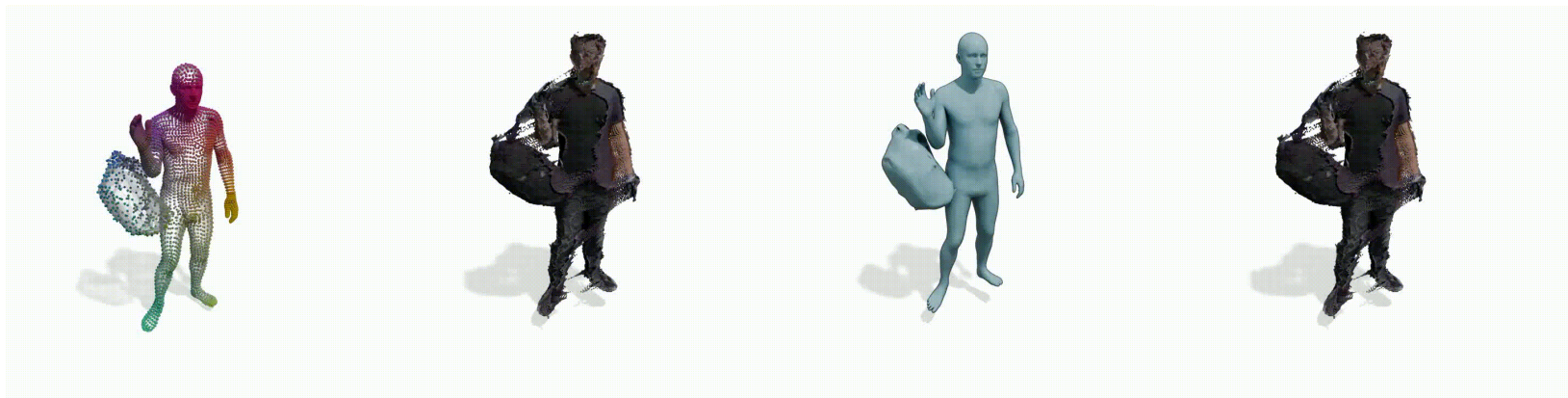


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³Bonn University

Our Goal

Take a **sparse** temporal sequence of **point clouds** as input and generate
Generalize the interpolation results to **real-world data**.
realistic intermediate shapes.



keyframe point clouds

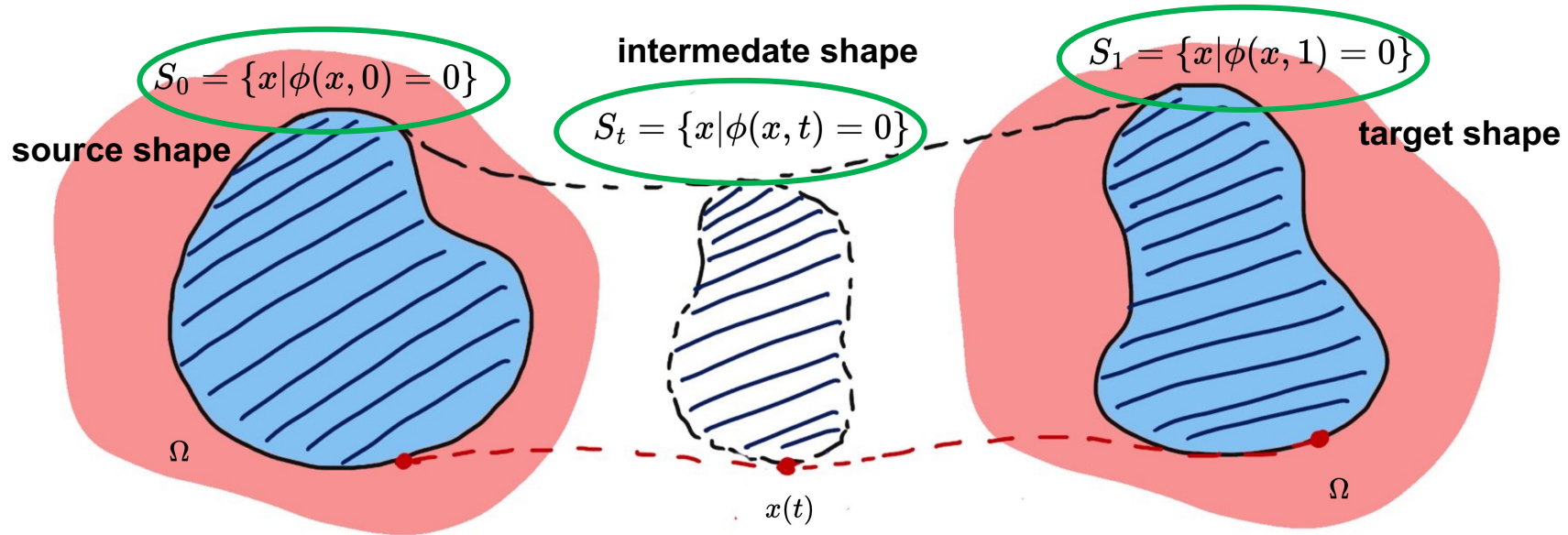
keyframe kinect data

Intermediate shapes

generalized real-world data

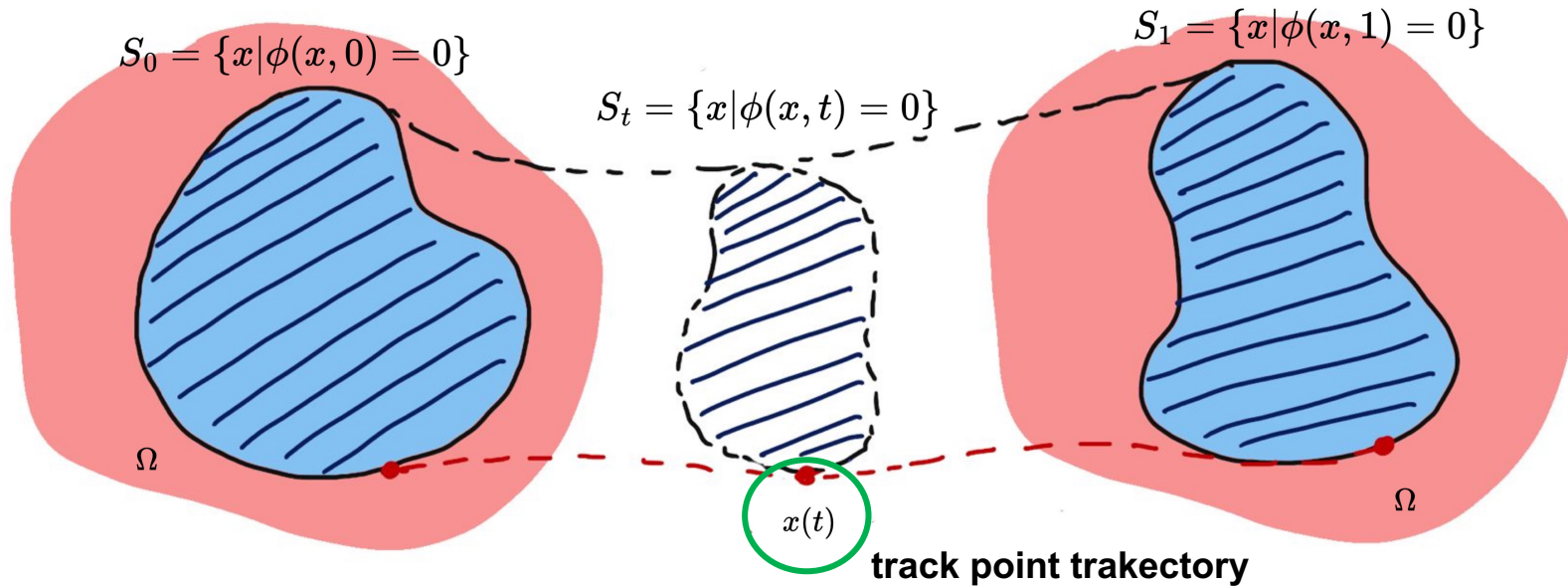
Our Approach

- Geometry Representation



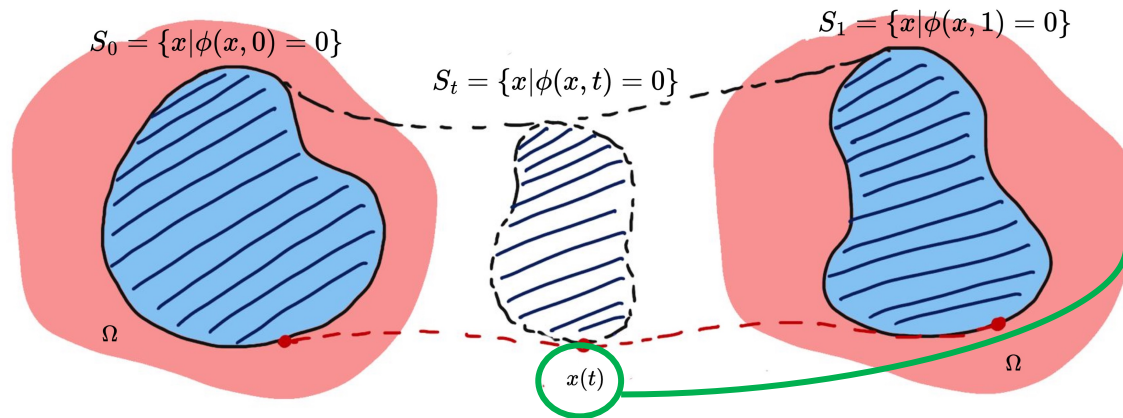
Our Approach

- Deformation Representation



Our Approach

- Deformation Representation



$$\phi(x(t), t) = 0$$

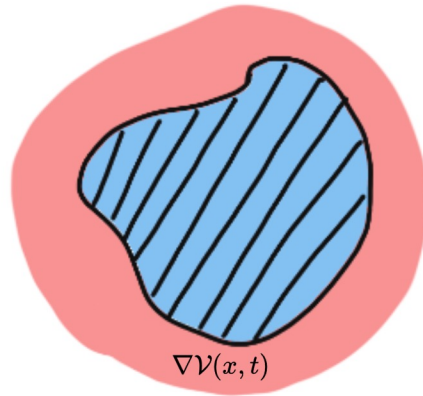
level-set equation

$$\frac{d}{dt} \phi(x, t) = \boxed{\partial_t \phi} + \boxed{V^\top} \boxed{\nabla \phi} = 0$$

$\frac{d}{dt} \phi(x, t)$

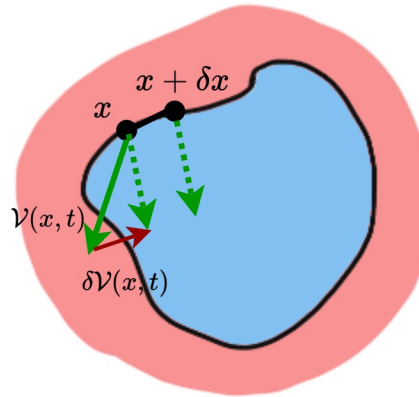
Our Approach

- Physically Plausible Deformation



volume preserving

$$||\nabla V(x, t)|| = 0$$

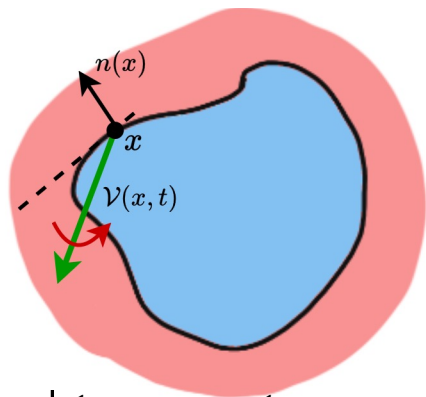


spatial smoothness

$$||(-\alpha\Delta + \gamma L)V(x, t)|| = 0$$

Our Approach

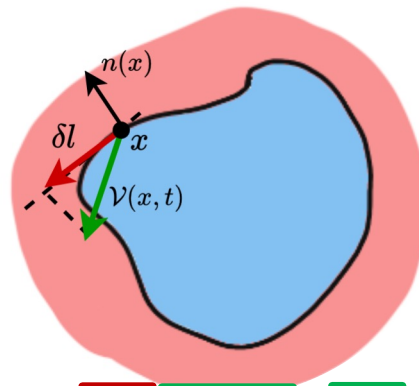
- Physically Plausible Deformation



distortion free

$$\left\| \frac{1}{6} Tr(D)^2 - \frac{1}{2} Tr(D \cdot D) \right\|_F = 0$$

$$D = \frac{1}{2} (\nabla V + (\nabla V)^T)$$



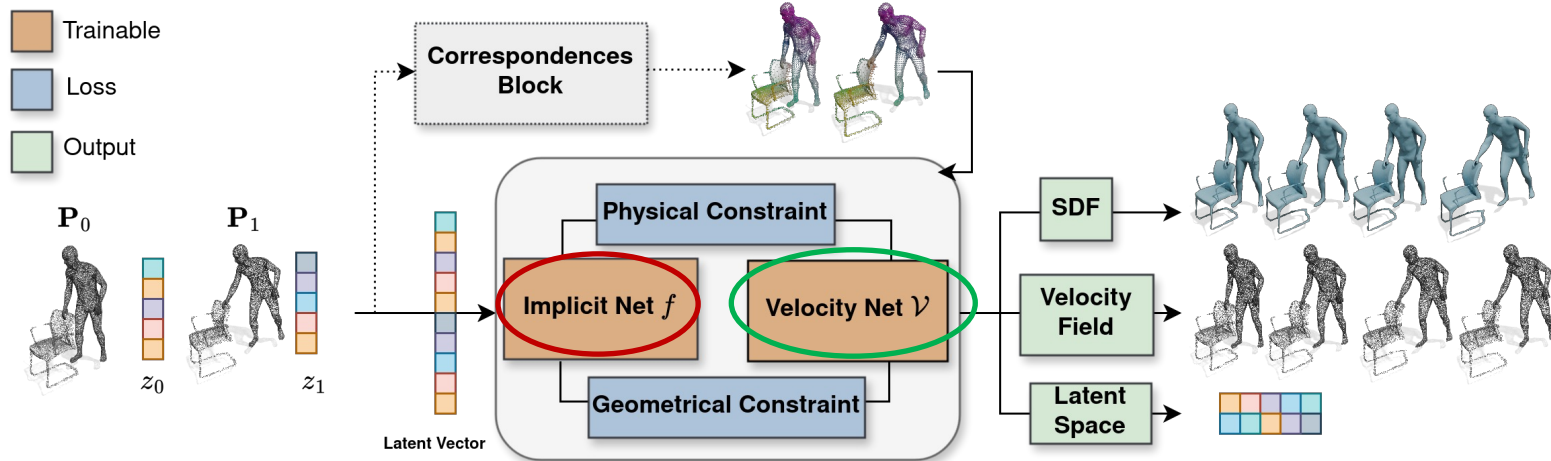
stretching constraint

$$\| P^T \nabla V^T \nabla V + \nabla V + \nabla V^T P \|_F = 0$$

$$P = I - \nabla \phi \nabla \phi^T$$

implicit field
velocity field

Our Pipeline



Physical Constraints

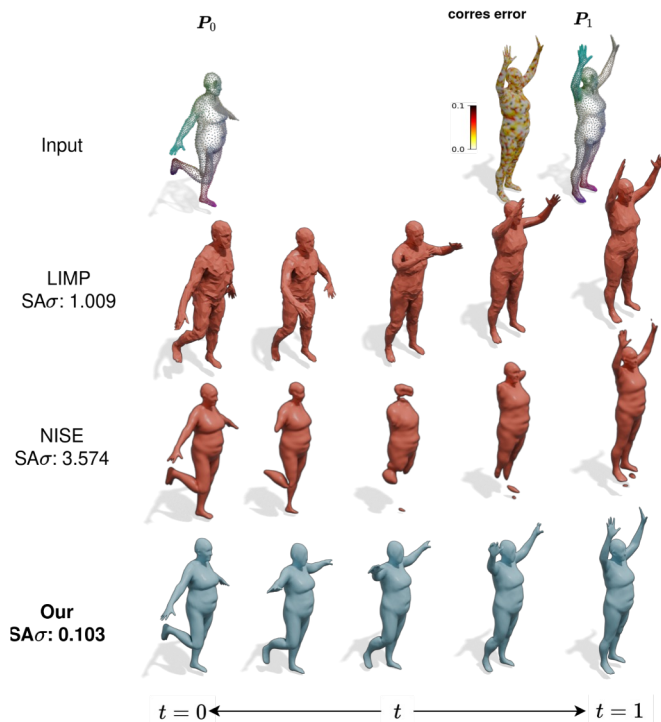
- Spatial smoothness velocity
- Volume preserving deformation
- Stretching constraint
- Distortion constraint

Geometrical Constraints

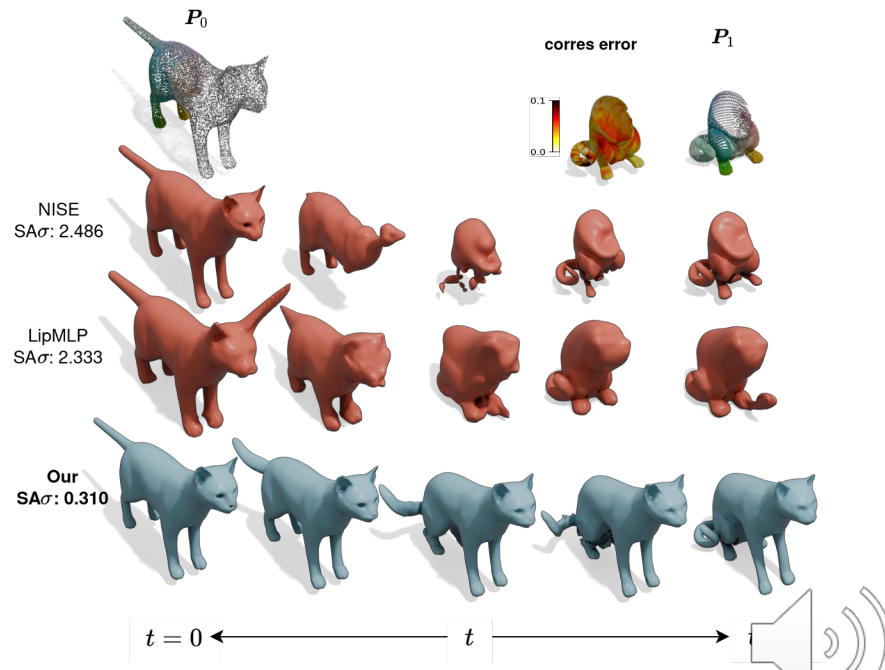
- Normal deformation constraint
- Level set equation constraint
- Matching loss

Our Results

Large deformation



Partial shape deformation



Our Results

- Real-World Application

Training Input
Approximated Registration



Inferring Input
Kinect Point Cloud



Our Output
Interpolated Mesh



Our Output
Interpolated Kinect PC

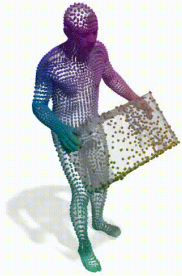


Real-world data upsampling

Our Results

- Real-World Application

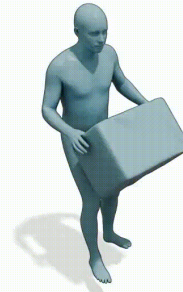
Training Input
Approximated Registration



Inferring Input
Kinect Point Cloud



Our Output
Interpolated Mesh



Our Output
Interpolated Kinect PC

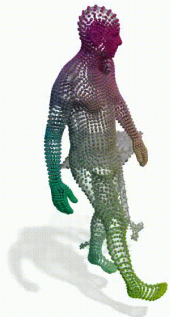


Real-world data upsampling

Our Results

- Real-World Application

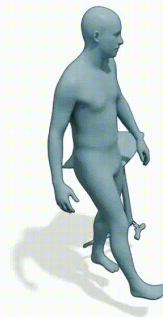
Training Input
Approximated Registration



Inferring Input
Kinect Point Cloud



Our Output
Interpolated Mesh



Our Output
Interpolated Kinect PC



Real-world data upsampling

Our Results

- Real-World Application

Training Input

Approximated Registration

Our output

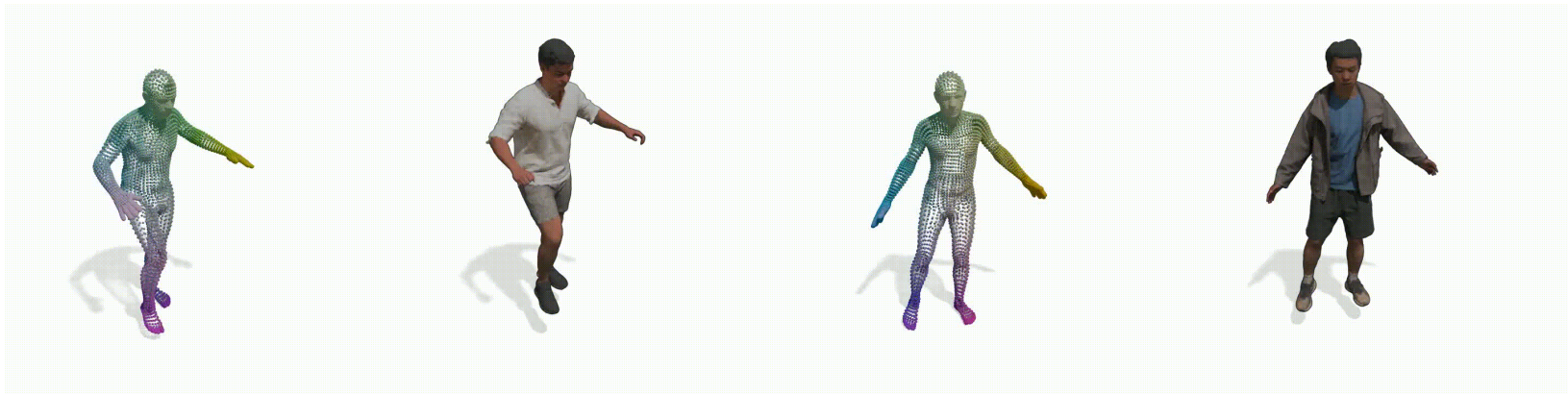
Deformed Mesh

Training Input

Approximated Registration

Our output

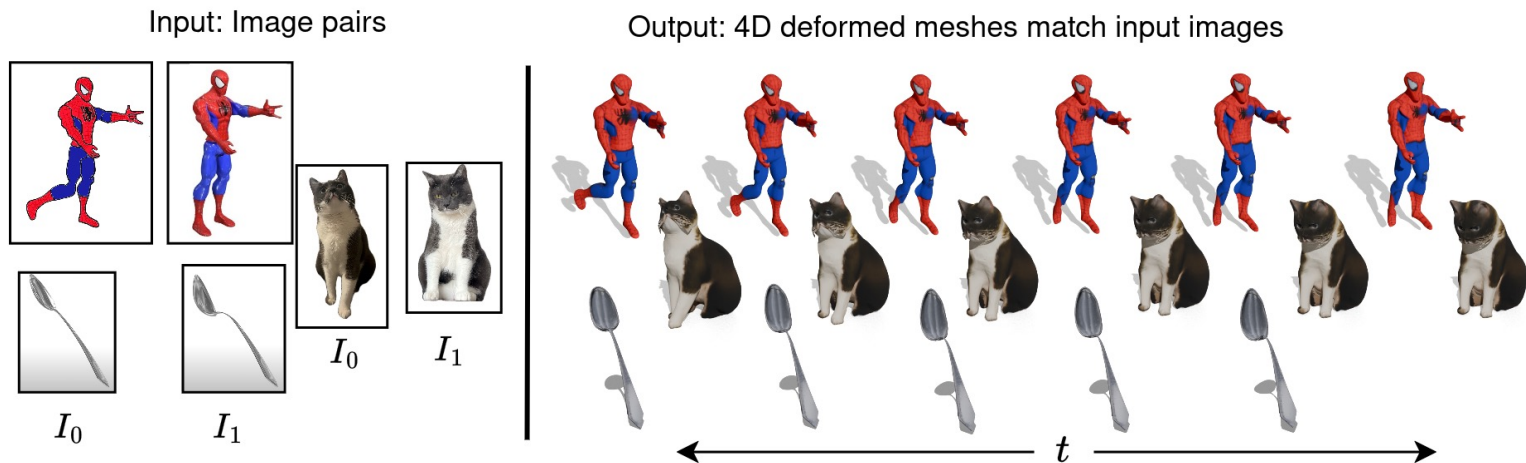
Deformed Mesh



high-resolution real-world data deformation

Follow Up

- TwoSquared: 4D Reconstruction from 2D Image Pairs



Follow Up

- TwoSquared: 4D Reconstruction from 2D Image Pairs

Input images



4D motion
left



4D motion
front



4D motion
right



4D motion
back



3D shape
 $t=0.0$



3D shape
 $t=0.3$



3D shape
 $t=0.6$



3D shape
 $t=1.0$



More details please check our
project page

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