Synthesis of the Spatio-temporally Coherent Line Drawing Animation from Video

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Outline

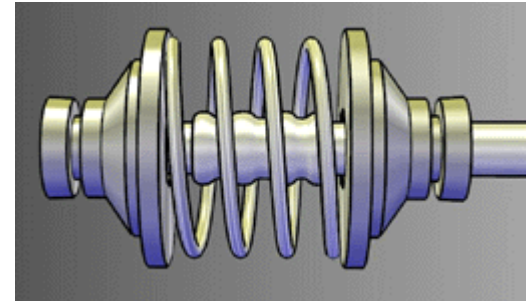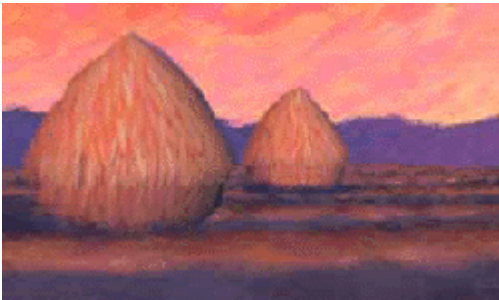- **Introduction**
- **Related work**
- **Basic idea**
- **Expected results**
- **Future work**
- **Conclusion**

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Introduction

- **Non-photorealistic rendering (NPR)**
  - **Rendering to generate artistic expression or abstraction**
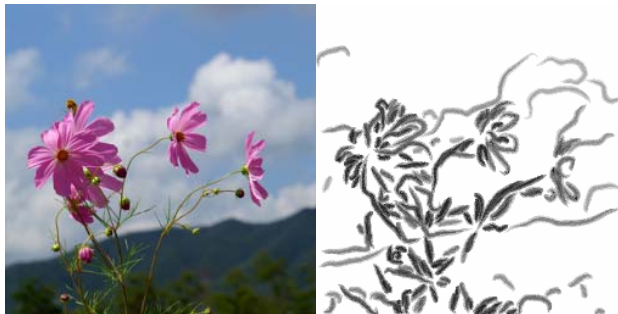
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Introduction

- **Rendering real images in non-photorealistic styles**
  - **Painterly stylization**

  - **Sketchy stylization (line drawing)**
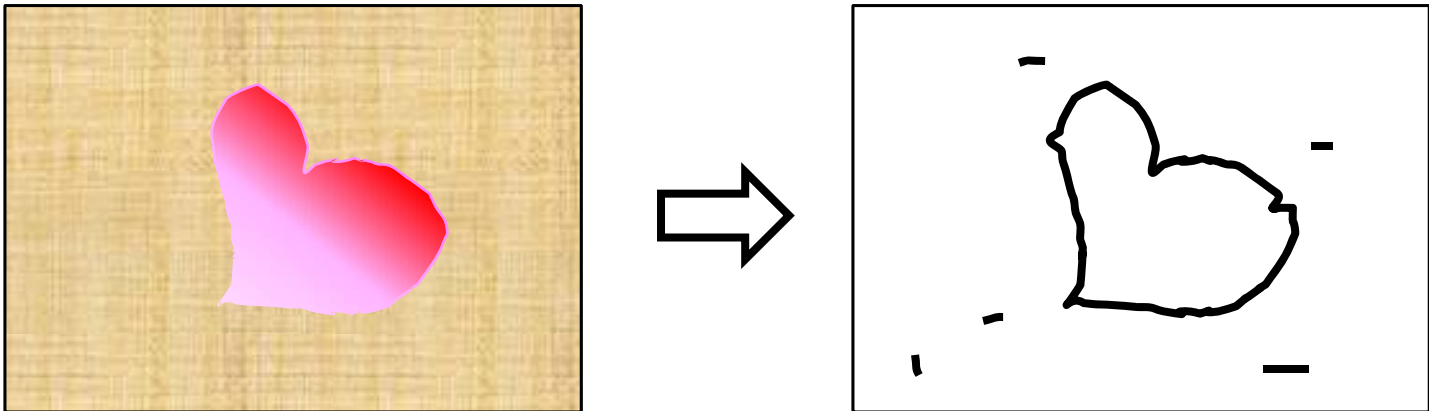
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Introduction

- **Sketchy stylization of video**
  - **Direct application of image stylization: X**
    - **Popping / flickering artifacts**

  - **Temporal coherence must be considered.**

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Introduction

- **Goal of the research**
  - **Generate a nice-looking line drawing animation from real video.**

- **Overview**

Input video ⇨ | Determine semantically meaningful regions for each frame semi-automatically. |

⇨ | Apply image stylization for the semantic regions, while considering temporal coherence | ⇨ Animation

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Related Work

- **Coherent Line Drawing**
  - **[Kang et al. 2007]**

- **Treat video as a space-time volume of image data.**
  - **[Wang et al. 2004]**

- **Translate strokes from frame to frame.**
  - **[Litwinowicz et al. 1997; Hertzmann and Perlin 2000]**

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Coherent Line Drawing [Kang et al. 2007]

- **Extracts lines that are:**
    - **Spatially coherent**
    - **Smooth**
    - **Stylistic**
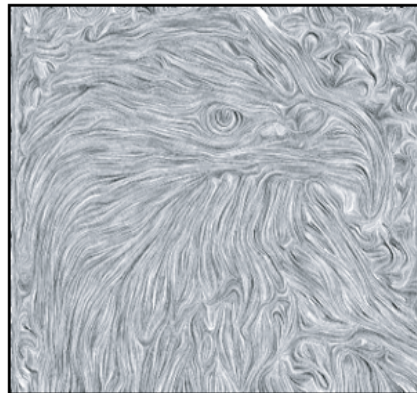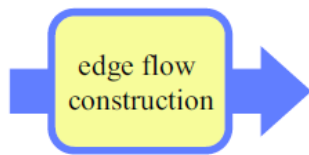- **Well captures and conveys important object shapes.**
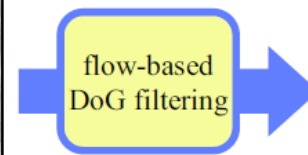
Coherent Line Drawing [Kang et al. 2007]
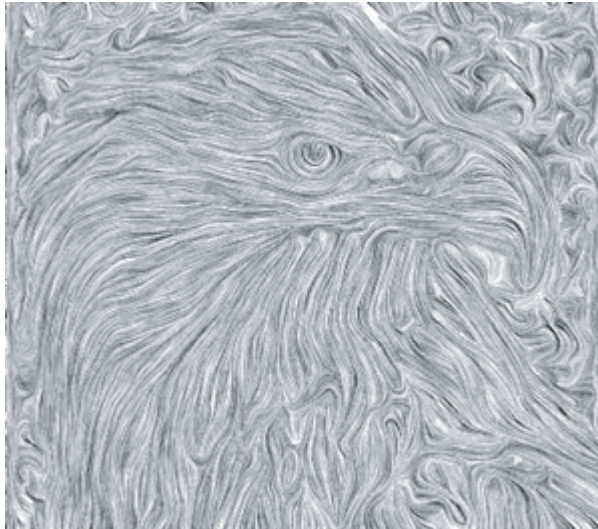
- **Process overview**

Input image   edge flow construction   Edge tangent flow   flow-based DoG filtering   Line drawing

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# Coherent Line Drawing [Kang et al. 2007]

- **Edge tangent flow (ETF)**
  - **Vector field**
  - **Perpendicular to gradient directions.**
  - **Describe salient edge directions.**
    - Around important features: strong
    - Elsewhere: smooth

Line Integral Convolution (LIC)
representation of the vector field

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Coherent Line Drawing [Kang et al. 2007]

- **Flow-based anisotropic DoG filtering**
  - **Exaggerate filter output along genuine edges.**
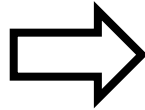 - **Attenuate the output from spurious edges.**
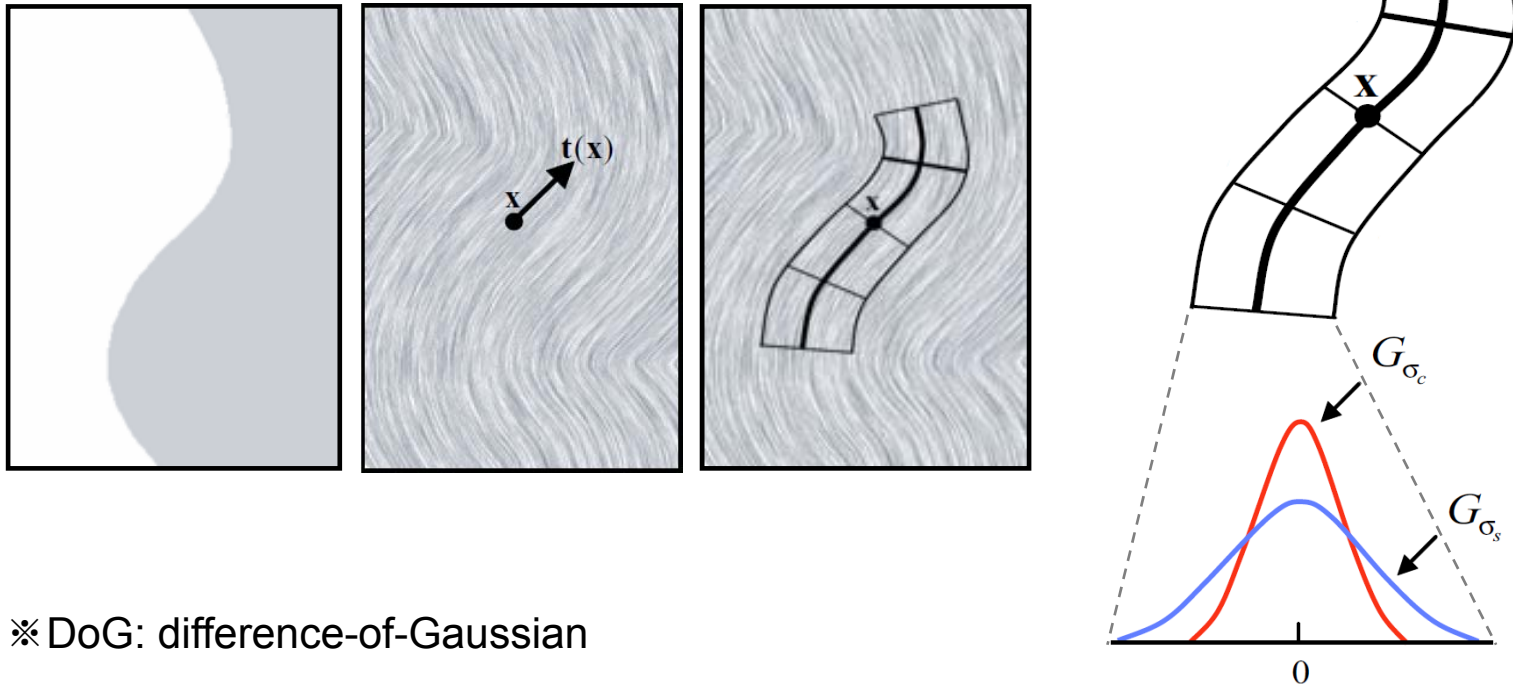
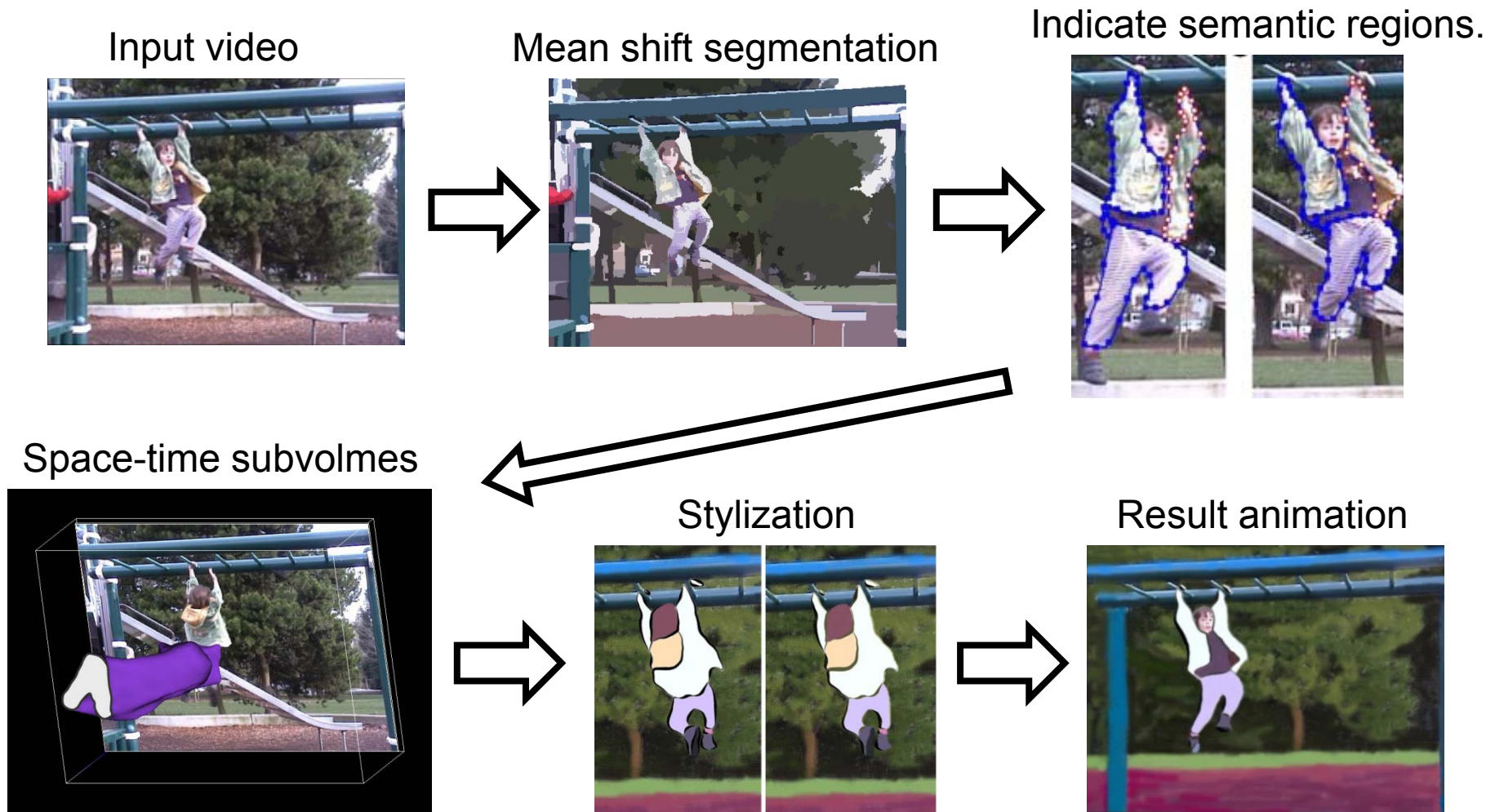※DoG: difference-of-Gaussian

Video as a Space-time Volume

[Wang et al. 2004]

- **User can semi-automatically rotoscope semantically meaningful regions.**

※Only region for the girl is meaningful though the whole video

Video as a Space-time Volume

[Wang et al. 2004]

Input video → Mean shift segmentation → Indicate semantic regions.

Space-time subvolmes → Stylization → Result animation

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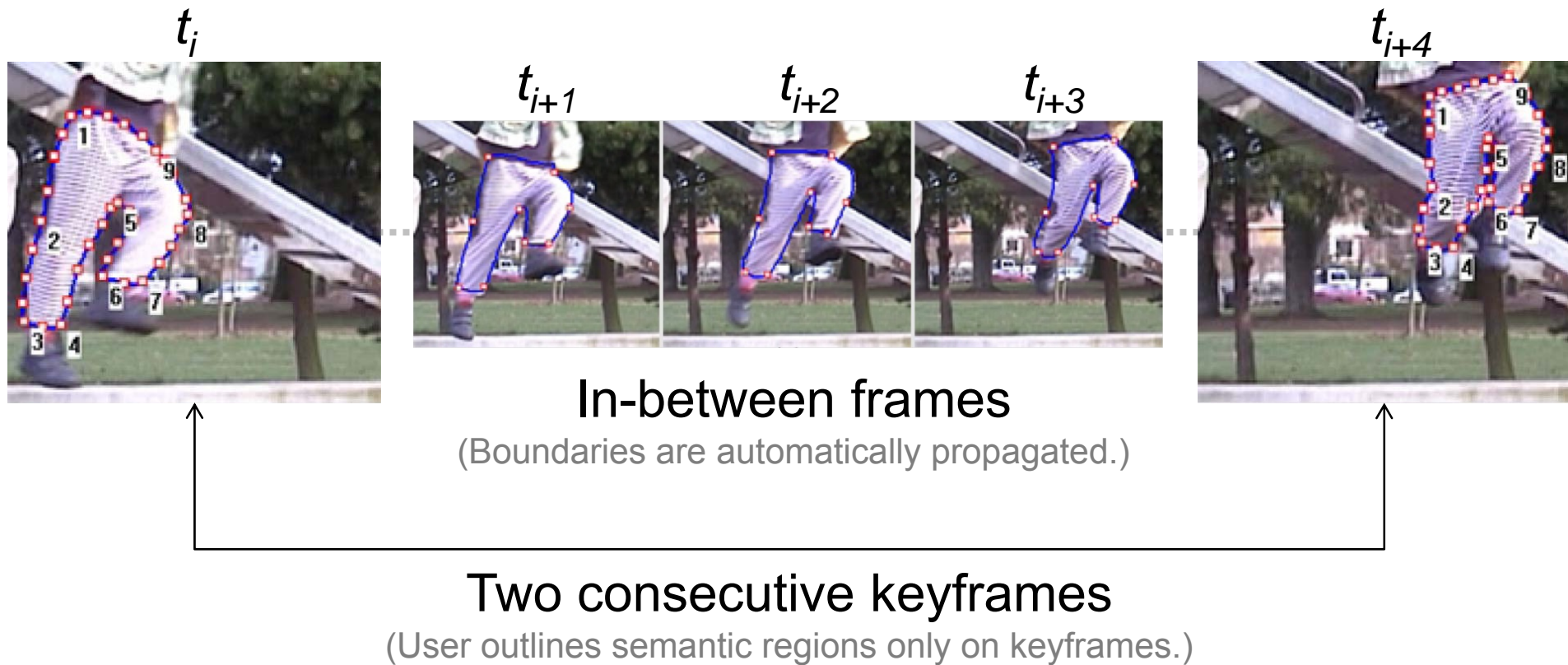
Video as a Space-time Volume
[Wang et al. 2004]

- **Generating space-time subvolmes that correspond to semantic regions**

t_i t_{i+1} t_{i+2} t_{i+3} t_{i+4}

In-between frames
(Boundaries are automatically propagated.)

Two consecutive keyframes
(User outlines semantic regions only on keyframes.)

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Video as a Space-time Volume

[Wang et al. 2004]

- ## Space-time subvolumes

  - ### Merge mean-shift-segmented small subregions, enclosed in the specified boundaries.

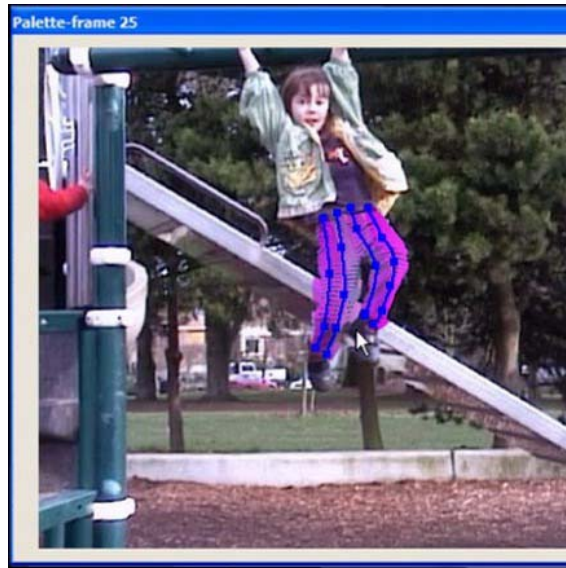A slice at time *t* = a semantic region at frame *t*
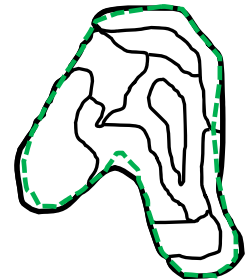
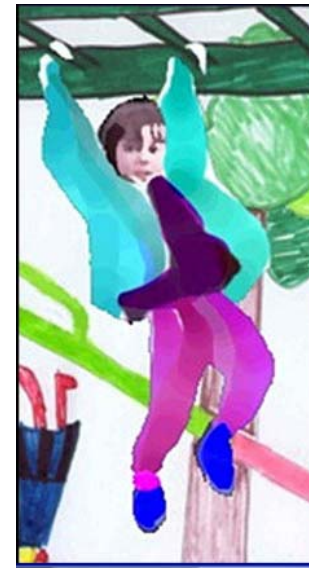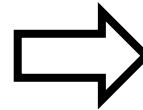The semantic space-time subvolume for the girl's legs

Video as a Space-time Volume

[Wang et al. 2004]

- **Stylization for each semantic region**
    - **Again, the user provides stylization for keyframes.**
    - **The stylization is propagated/interpolated in-between frames.**

Strokes set with control points by the user

A frame of the result

※ Vector graphics

Video as a Space-time Volume

[Wang et al. 2004]

- **Result**

Stroke Translation [Hertzmann and Perlin 2000]

- **Process**
  - **Estimate pixel movement (optical flow).**
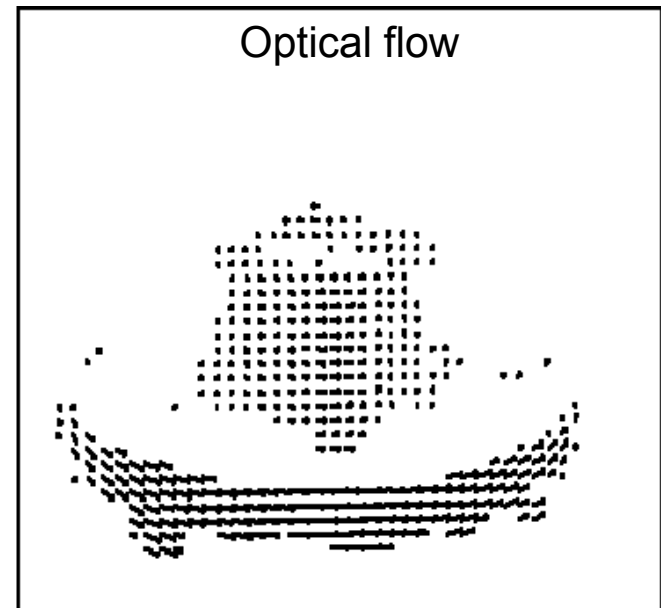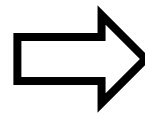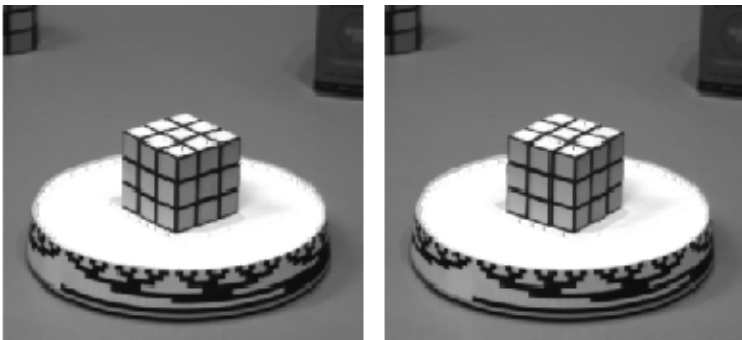 - **Warp strokes of the first frame to subsequent frames following the movement .**

Stroke Translation [Hertzmann and Perlin 2000]

- ## Optical flow
  - ### Measurement of object movement in a video sequence

Consecutive frames

Optical flow

- ## Problem
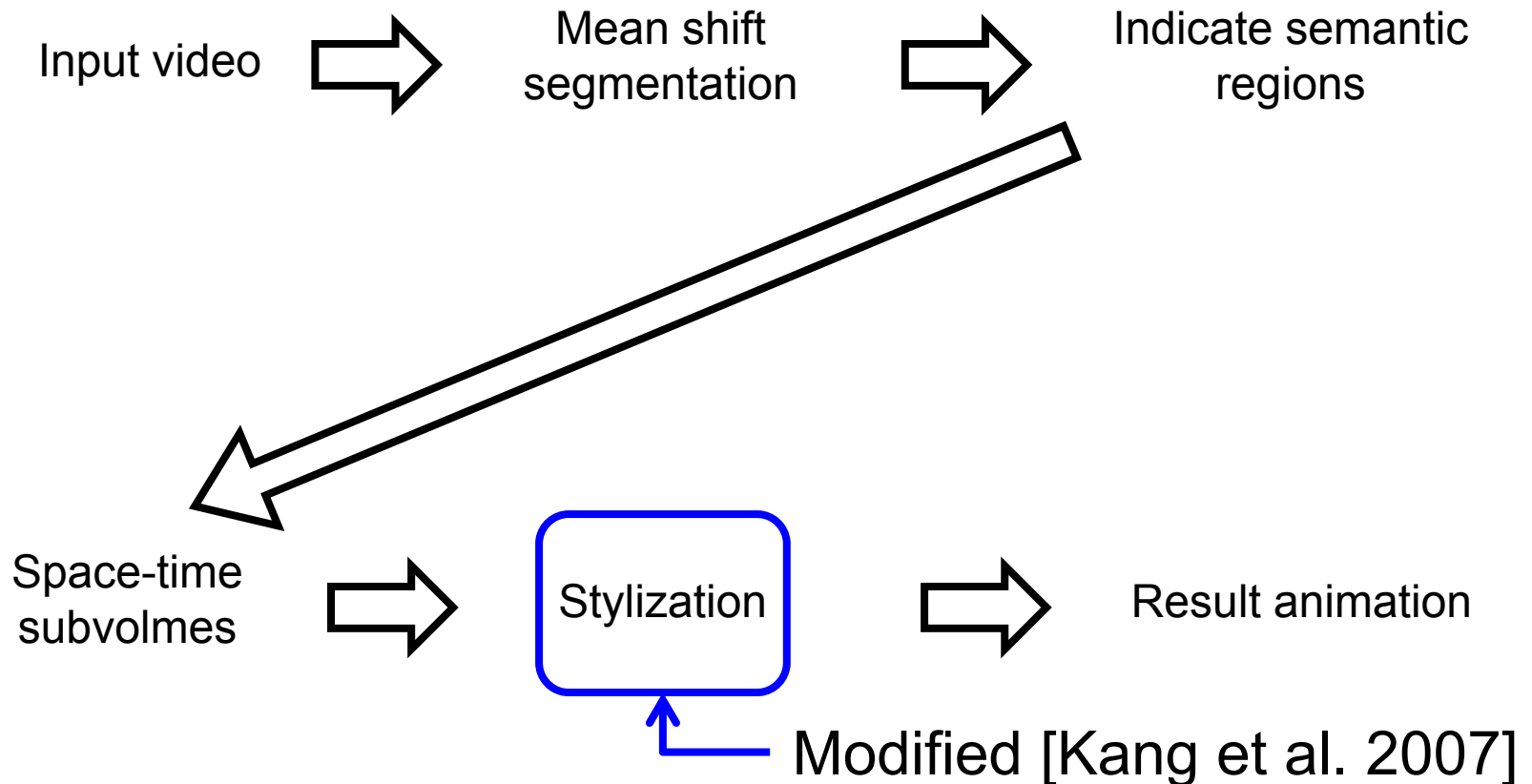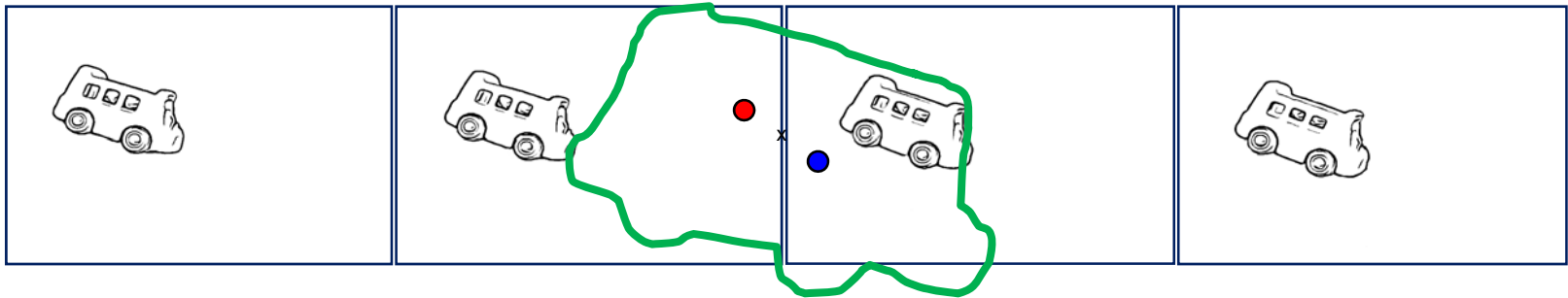 - ### Errors quickly accumulate and propagate to subsequent frames
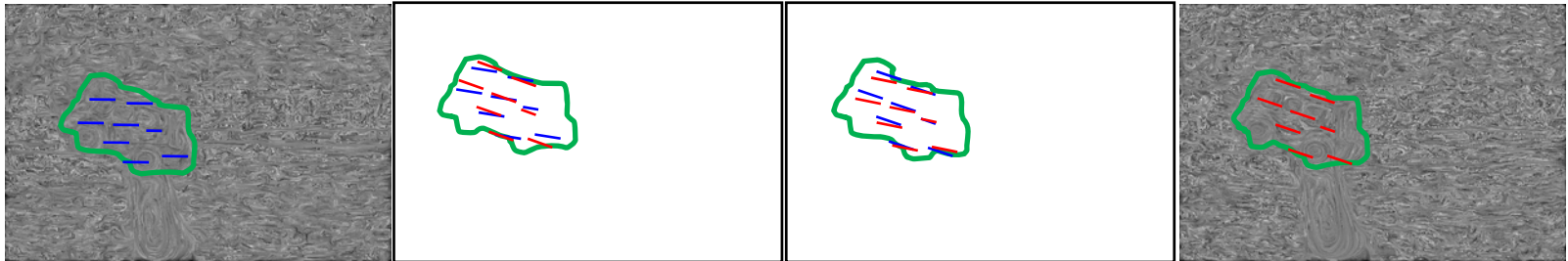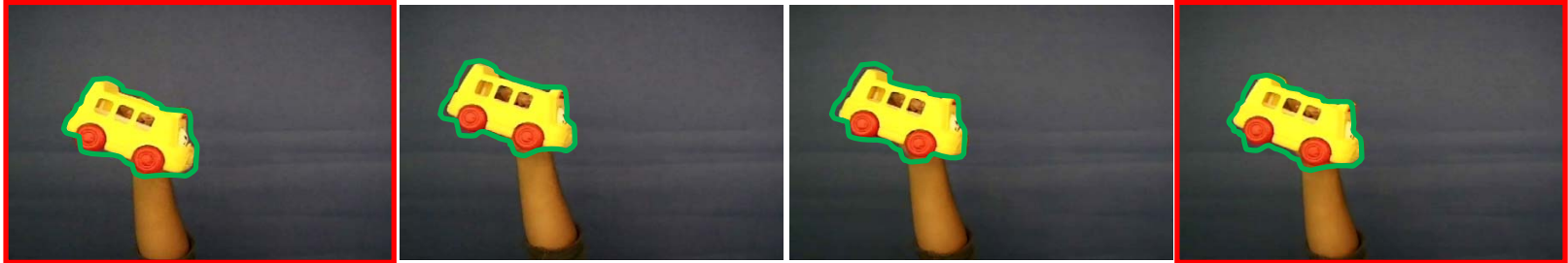
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Basic Idea

- **Employ the framework of [Wang et al. 2004].**
- **Modify [Kang et al. 2007] and apply it into the framework.**

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Basic Idea

- **In the framework of Wang et al.,**

Input video ⟹ Mean shift segmentation ⟹ Indicate semantic regions

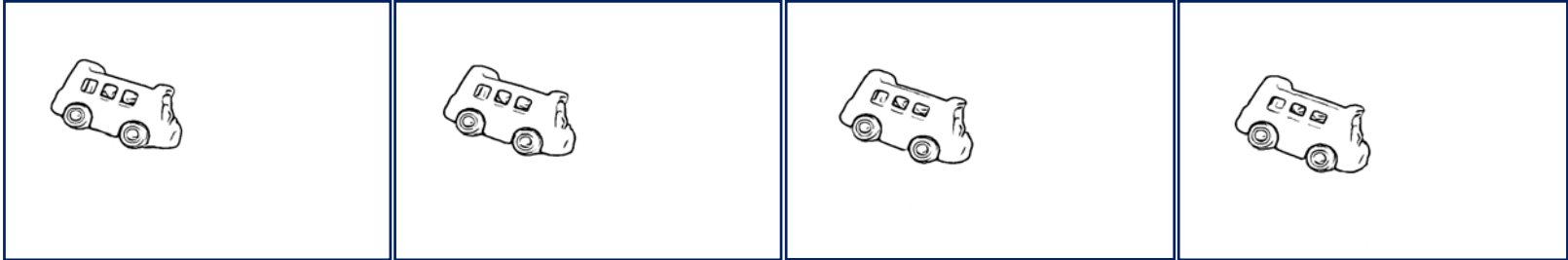Space-time subvolmes ⟹ Stylization ⟹ Result animation
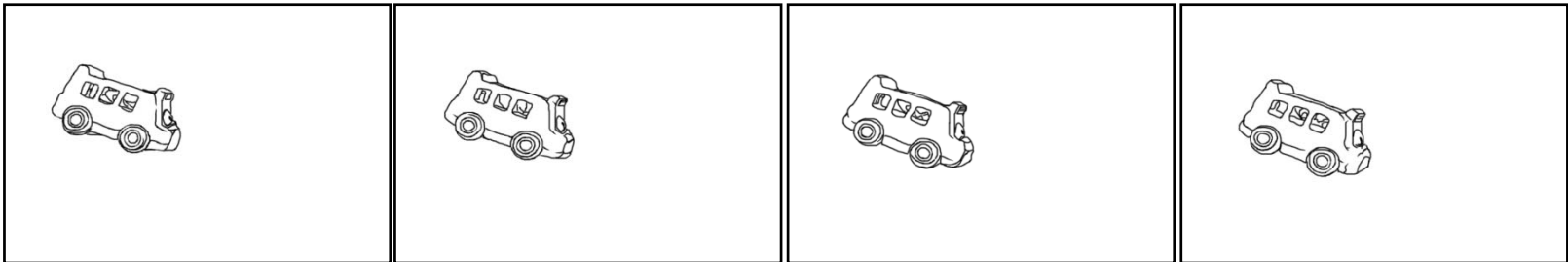
Modified [Kang et al. 2007]
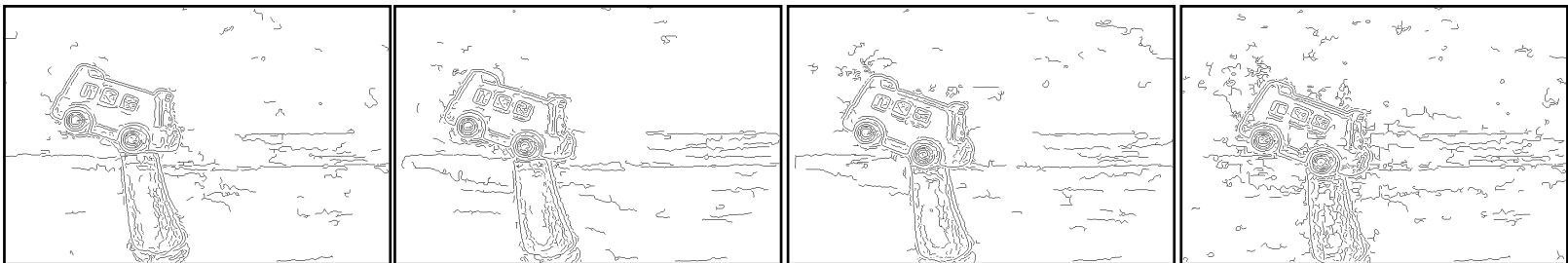
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Modified *Coherent Line Drawing*

Expected Results

Expected results

Manual rotoscope

Canny edge detection

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Future Work

- **Reduce still remaining flickering.**
  - Measure difference between image regions.

- **Unsatisfactory lines may be produced around boundaries of the semantic regions.**
  - Further refinement is needed.

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Conclusion

- **Proposed a method to semi-automatically synthesize a line drawing animation from real video.**

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