Image Morphing

Outline
• Image transition
• Cross-dissolving
• Image morphing
• Mesh-based morphing
• Feature-based morphing

What is Image Morphing
• Objective:
  - Generate fluid transition between 2 images
• Application:
  - Special effects

Image Transition
• A sequence of images are needed to show the transition between the two images
• Parameter t controls position of the transition
  - \( t = 0 \): source image
  - \( t = 1 \): target image
  - \( 0 < t < 1 \): intermediate images to be generated

Cross-Dissolving
• Blend two images using alpha compositing:
  - Set alpha for bottom (source) image to 1
  - Alpha for top (target) image varies from 0 to 1
• Software implementation:
  - \( \text{result}(u,v) = (1-t) \times \text{source}(u,v) + t \times \text{target}(u,v) \)

Cross-Dissolving Results
**Image Morphing**
- Combine image warping & cross-dissolving
- Use warping to change the shape
- Use image composition to change color
- Problems involved:
  - How to generate intermediate images through warping?

**Mesh-based Morphing**
- Proposed by G. Wolberg in 1990
- Basic idea:
  - Break the images into a grid of quadrilaterals
  - Deform the quadrilaterals to match the source & the target
- Steps:
  - User specify a set of corresponding points
  - The algorithm generate a grid mesh
  - Each pixel is warped using the 3 closest grid points

**Corresponding Grid Points**

**Algorithm Evaluation**
**Pros:**
- Fast and intuitive
- Efficient algorithms exist for computing the mapping of each pixel from the control grid

**Cons:**
- Need to specify the number control points to use in advance
- Points left unmodified are still used by the warping algorithm
- Moving mesh points around may not always provide the desired effect

**Feature-Based Morphing**
- Proposed by Beier & Neeley in Siggraph 1992
- Use in Jackson’s MTV “Black & White”
- Basic steps:
  - Use line segments to define features in both source & target images
  - Interpolate line segments for the intermediate frames
  - Warp both source & target images to the intermediate frame
  - Blend between the warped results

**Define Control Lines**
- Draw control line segments along the key features of the source & target images
- Corresponding features should be show using corresponding control lines
Interpolate Control Lines

- For a given intermediate frame $t$:
  - Calculate the position of control line segments in frame $t$
  - Can be done by linearly interpolating between the positions of corresponding line segments in source & target images

Warp from Source

- Warp source image to intermediate frame:
  - Apply backward warping
  - Use control lines defined in both intermediate frame & the source image
  - The result distorts the source image to the shape defined by the control lines in the intermediate frame

Warp from Target

- Warp target image to intermediate frame:
  - Use the same technique
  - The result distort the target image to the shape defined by the control lines in the intermediate frame
  - Key features line up with the warping results obtained from the source image

Blend between the Two

- Blend the two warped images using the over operator
  - i.e., apply cross-dissolving on the warped images
  - The alpha value used depends on the parameter $t$

Morphing Results

$\Delta t = 0.25$
$\Delta t = 0.5$
$\Delta t = 0.75$

Pseudocode for Morphing

```plaintext
for ( each intermediate frame $t$ )
  for ( each pair of control line segment $i$ )
    $L_{inter}[i] = (1-t)*L_{src}[i] + t*L_{tgt}[i]$;
  for ( each pixel $P$ in intermediate image $t$ )
    $P_{src} = \text{warping}(L_{inter}, L_{src}, P)$;
    $P_{tgt} = \text{warping}(L_{inter}, L_{tgt}, P)$;
    $\text{inter}_\text{img}[t](P) = (1-t)*\text{src}_\text{img}[P_{src}] + t*\text{tgt}_\text{img}[P_{tgt}]$;
```