Metamorphosis
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Metamorphosis is the gradual evolution of a source object, through intermediate objects to a target object

Object = image, polygon, curve volume, polyhedron, surface
You must do things right!
Cross dissolves

Problem - misaligned regions
Issues in morphing

- Correspondence:
  - Feature specification
  - Warp generation
- Transition control
Some image metamorphosis methods

- Mesh Warping  (Wolberg)
- Field Morphing  (Beier & Neely)
- Radial Basis Functions  (Arad et al, Edge&Maddock)
- Energy minimization  (Lee et al)
- Compatible triangulation  (Aronov et al, Tal&Elber, Surazhsky et al)
Mesh-based morphing (Wolberg)
Correspondence in mesh warping

A combination of warping two images so they have the same “shape” and then cross-dissolving the resulting images

- **Image warping**: Specify a warp that distorts the first image into the second

- **Cross-dissolve** between image elements: The color of each pixel is interpolated over time from the first image to the corresponding second image value
Intermediate frame in the morph sequence

For each frame $f$

- Linearly interpolate mesh $M$ between $Ms$ and $Mt$
- Warp $Is$ to $I_1$ using meshes $Ms$ and $M$
- Warp $It$ to $I_2$ using meshes $Mt$ and $M$
- Linearly interpolate image $I_f$ between $I_1$ and $I_2$
Warping algorithm

Given a source image and two 2D arrays of coordinates S and D, fit splines to produce a continuous mapping.

Apply a two-pass algorithm:

- Map \((u,v)\) to \((x,v)\)
- Map \((x,v)\) to \((x,y)\)
Triangulation-based morphing

Polygon triangulation = A decomposition of a polygon into triangles by a maximal set of non-intersecting diagonals
The problem (Aronov et al)

- P1 and P2 are two simple polygons
- Generally cannot be triangulated compatibly without extra points
But

If we are allowed to add (Steiner) points, it can be done
Compatible triangulation
Compatible triangulation

Given two polygons $P_1$ and $P_2$ each with $n$ vertices, their compatible triangulation is a joint labeling of their vertices and some of their internal points, such that a triangulation of one polygon admits a triangulation in the other polygon and it is labeled compatibly.
Use in morphing (Tal&Elber)

1. Outline extraction
2. Establishment of correspondence between the boundaries
3. Compatible triangulation
4. Texture mapping
Compatible triangulation algorithm

**Intuition:** “convexize” the polygons

1. Find a triangulation $T_1$ ($T_2$) for $P_1$ ($P_2$)
2. Map $T_1$ into $T_1'$ ($T_2'$) of a convex polygon $P$
3. Overlaying $T_1'$ and $T_2'$ on $P$ yields a convex subdivision, that can be triangulated into $T$
4. Map $T$ back into $T_1$ and $T_2$ to obtain a compatible triangulation of $P_1$ and $P_2$
Polygons with holes
Results
Results
Results
Composing objects like clip-arts