

## Holes

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### Why do we get holes?

- expansion
  - pixels spread apart (zoom, looming)
- exposure
  - occluded surface in reference image is exposed

### Solutions

- expansion: interpolation techniques
- exposure: much harder (have to guess)

## Filling Holes

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Fixed background

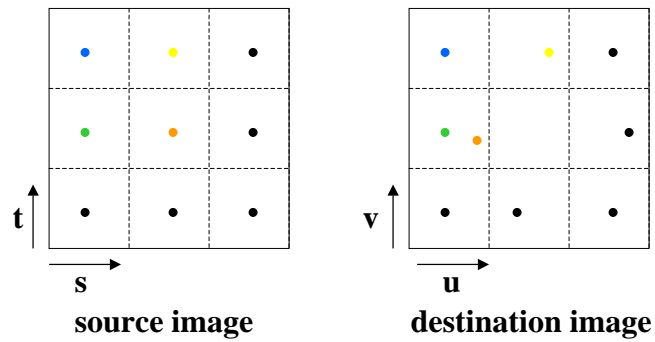
Color interpolation

Displacement interpolation

Texture Synthesis

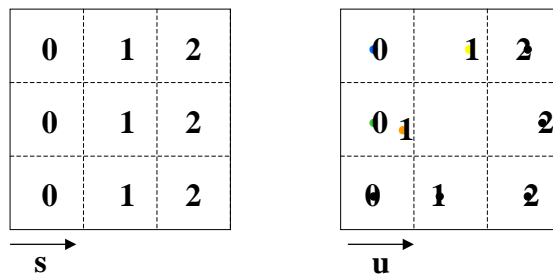
## Color Interpolation

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## Displacement Interpolation

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Destination  $(u,v)$  image contains  $(s,t)$  coords

- map each  $(s,t)$  value to  $(u,v)$  image
- bilinear interpolation in  $(u,v)$  image
- for each pixel in  $(u,v)$  image, inverse map and use bilinear interpolation to compute color from  $(s,t)$  image

## Exposures

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### Interpolation stretches the image

- not always what you want
- what if you want to keep the same frequencies?
- texture synthesis
  - Efros and Leung
    - » [http://www.cs.berkeley.edu/~leung/Research/ICCV99c\\_abstract.html](http://www.cs.berkeley.edu/~leung/Research/ICCV99c_abstract.html)
  - Debonet
    - » <http://www.ai.mit.edu/~jsd/Research/TextureSynthesis/>

## Layered Representations

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### 2.5-D image representations

- more than one value per pixel
- roots in cel animation
- video games: “sprites”
- computer vision: “layers”

### Today: layer extraction and rendering

- Wang and Adelson “Layered Video”
- Shade et al. “Layered Depth Images”
- Horry et al. “Tour into the Picture”

### Related work

- Talisman (Torborg, Kajiya, Snyder, Lengyel), SIGGRAPH 96, 97, 98

## Wang and Adelson

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For each pair of two consecutive images

- compute optical flow (Lucas & Kanade)
- find candidate affine regions (K-means clustering)
  - minimize  $\|\text{optical flow} - \text{affine flow}\|$  for each pixel
  - pixels with large residual are outliers
- for each outlier, assign a region based on color
  - warp pixel based on each affine region
  - choose affine region which gives least color error

Now we have regions for each image pair

Aggregate into a single set of layers for the sequence

- warp all regions into a common reference image
- use median to solve for opacity, color