Lecture 14-Image Blending

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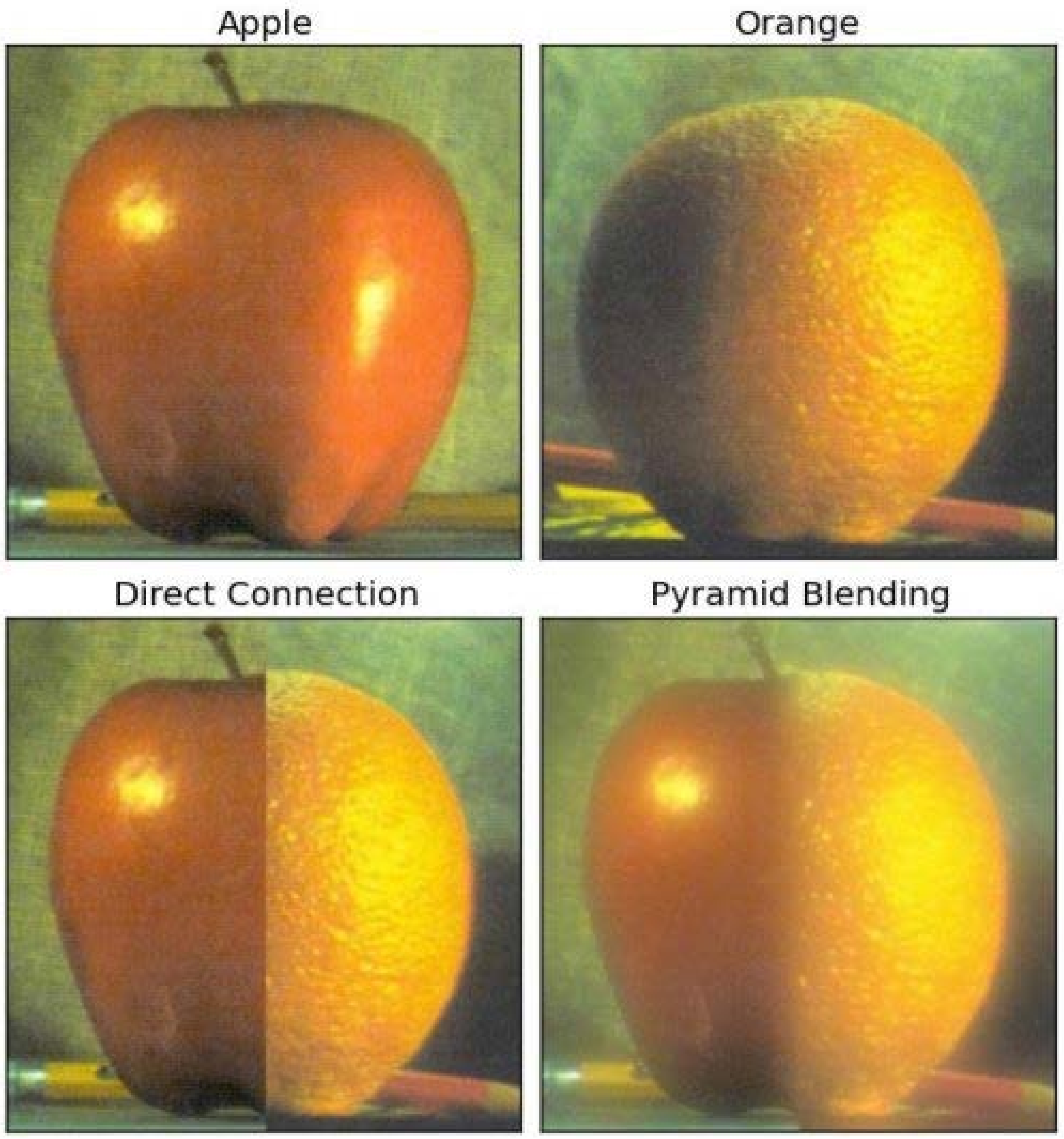
SIST Building 2 302-F

Long history of fake images

Long history of fake images

Long history of fake images

Hard edge composition vs Pyramid Blending



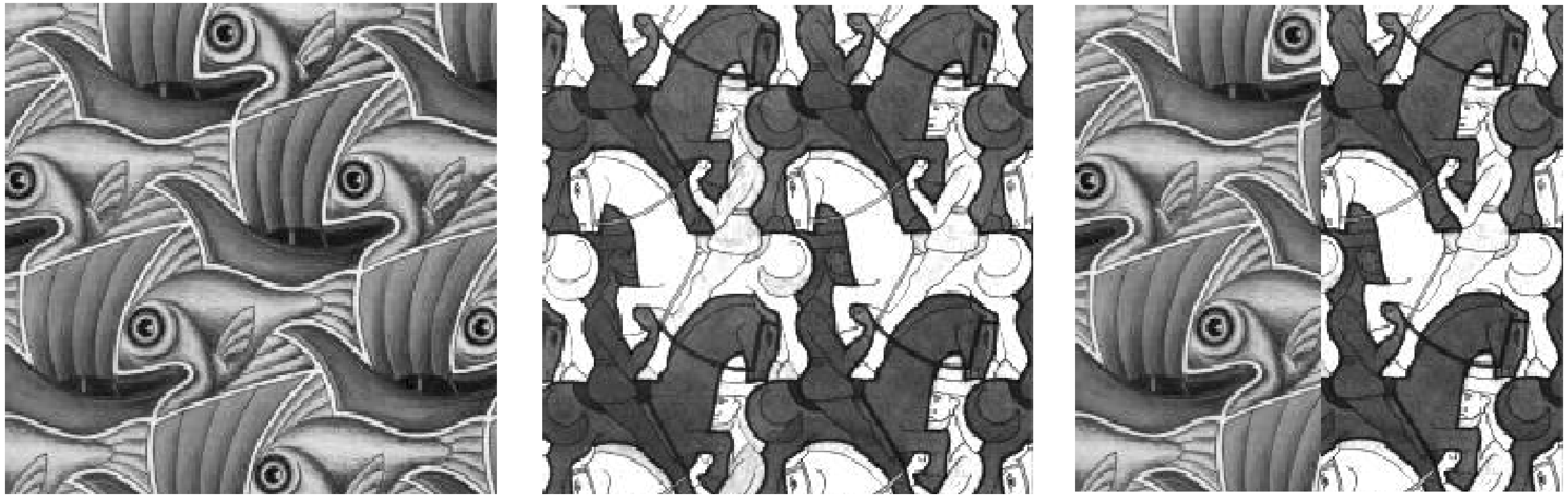
Hard compositing

- **Hard compositing:**

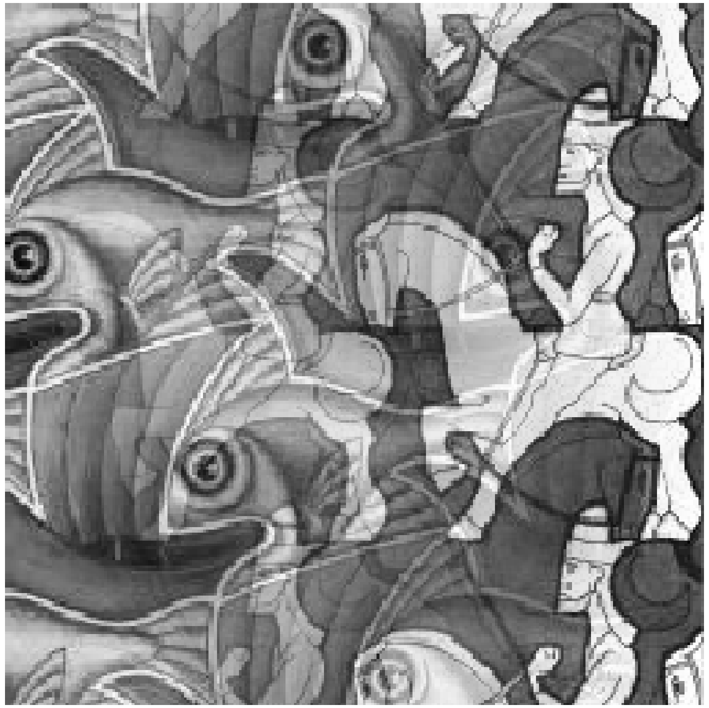
$$I(x,y) = M(x,y)S(x,y) + \big(1 - M(x,y)\big)T(x,y)$$

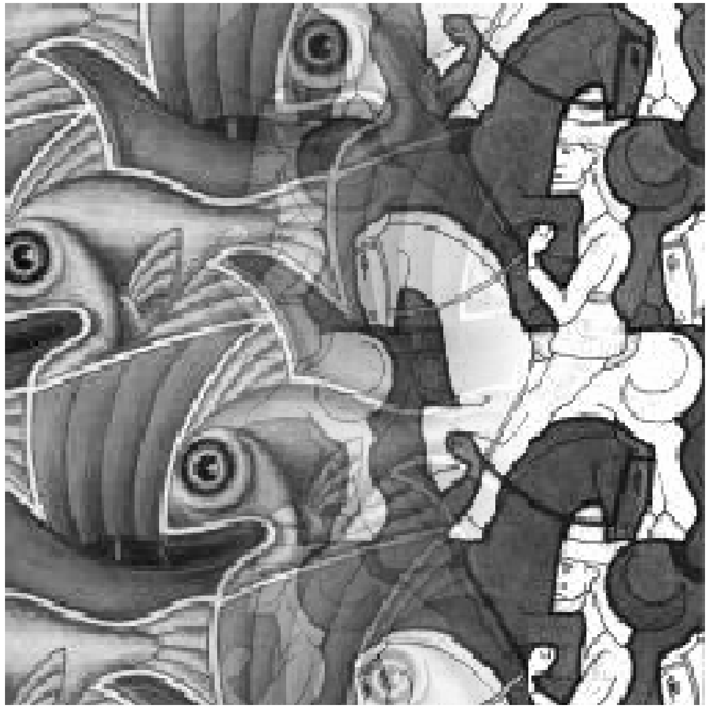
$$= \begin{cases} S(x,y) & M(x,y) = 1 \\ T(x,y) & M(x,y) = 0 \end{cases}$$

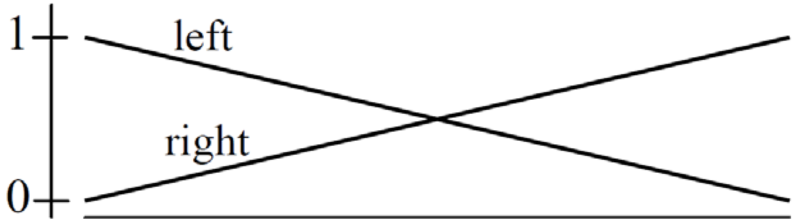
- **Generally bad: seam/matte line is visible**

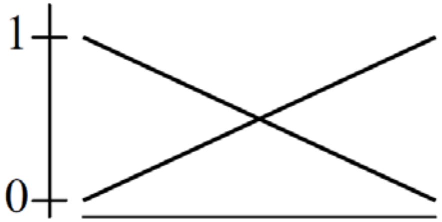


Weighted transition region:

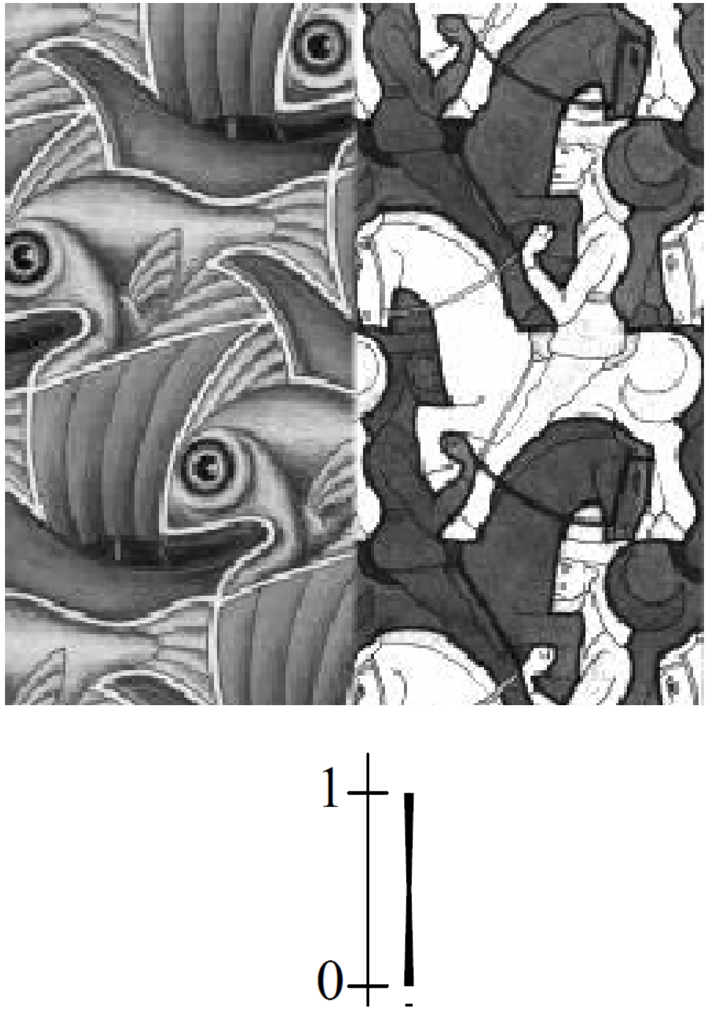




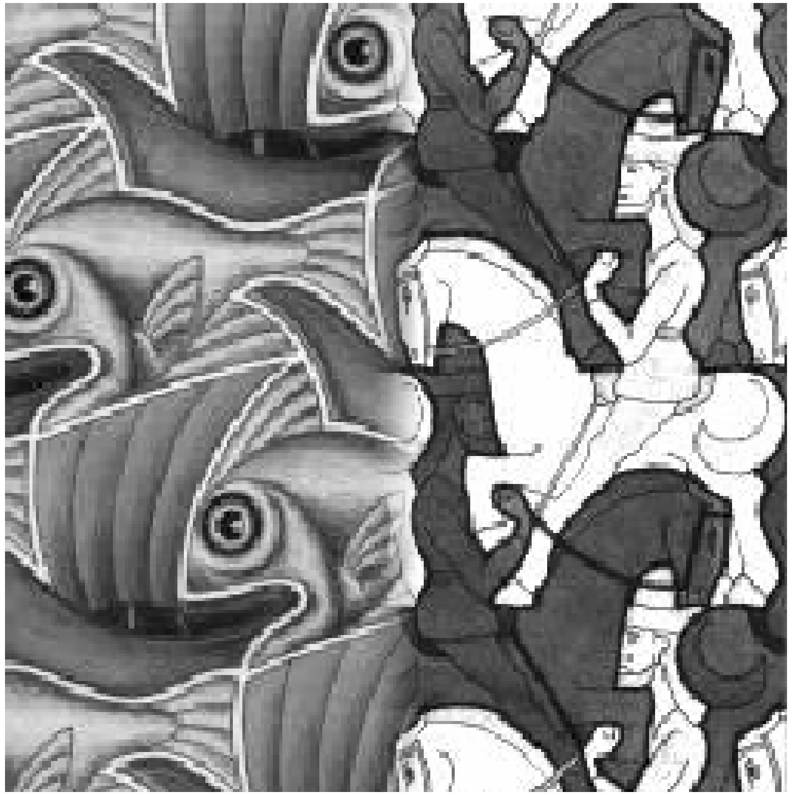


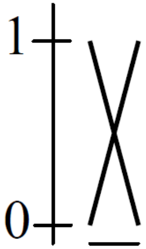


Weighted transition region:



Good window size





Pyramid Blending

- **Better idea: Multi-resolution blending with a Laplacian pyramid.**
  - Idea: wide transition regions for low-frequency component, narrow transition regions for high-frequency component (edges).
  - Gaussian pyramid:

    G = 5x5 Gaussian filter

    $\boldsymbol{I_0}$ = original image (full resolution)

    - $\boldsymbol{I}_{\mathrm{i}} = (\boldsymbol{G} \underbrace{*}_{\text{convolution}} \boldsymbol{I}_{\mathrm{i-1}}) \downarrow 2$ ← Down-sample twice

  - Get a series of smaller and blurry images.

What does blurring take away?

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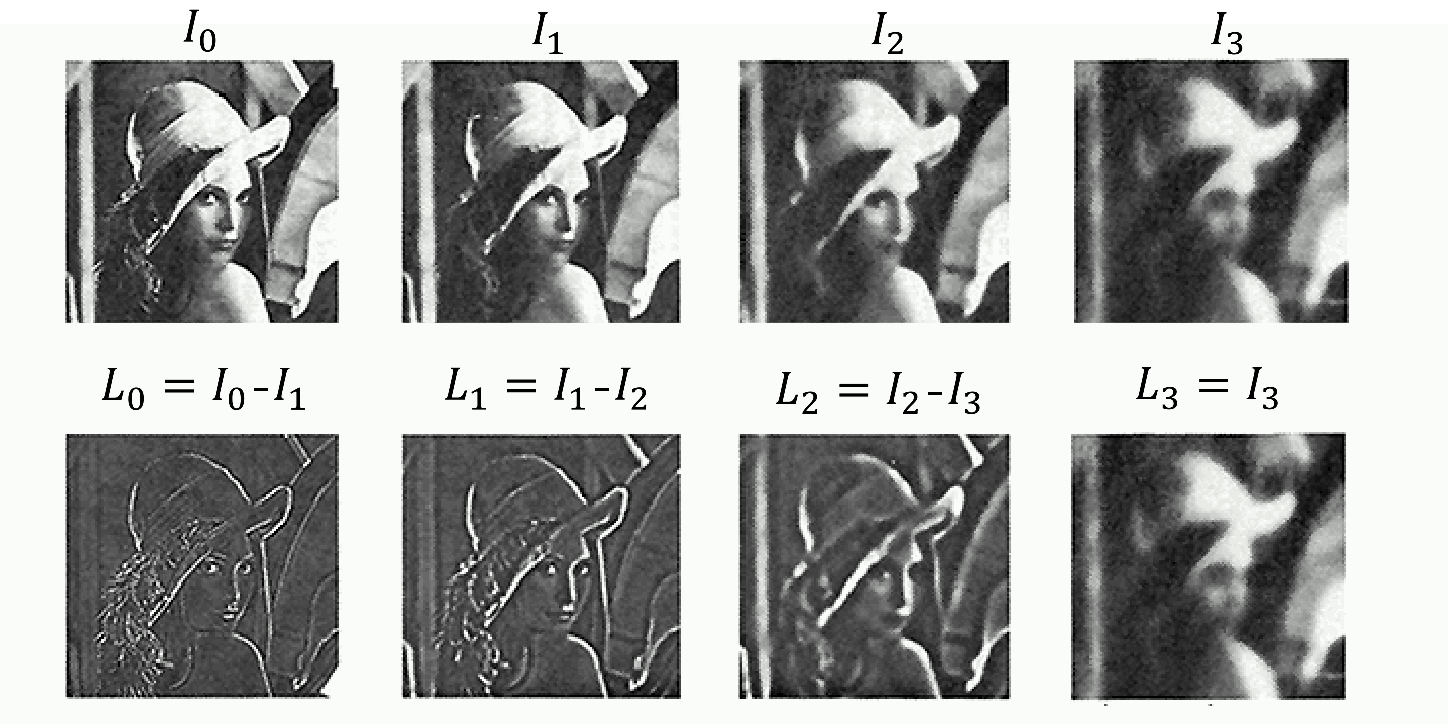
What does blurring take away?

Pyramid Blending

- **Difference of Gaussian at each scale:**

High-pass image at scale i ⟶ $\boldsymbol{L_i} = \boldsymbol{I}_\mathrm{i} - \boxed{(\boldsymbol{G} * \boldsymbol{I}_\mathrm{i}) \downarrow 2}$ ⟵ Blurred version of level i

Gaussian pyramid image at scale i

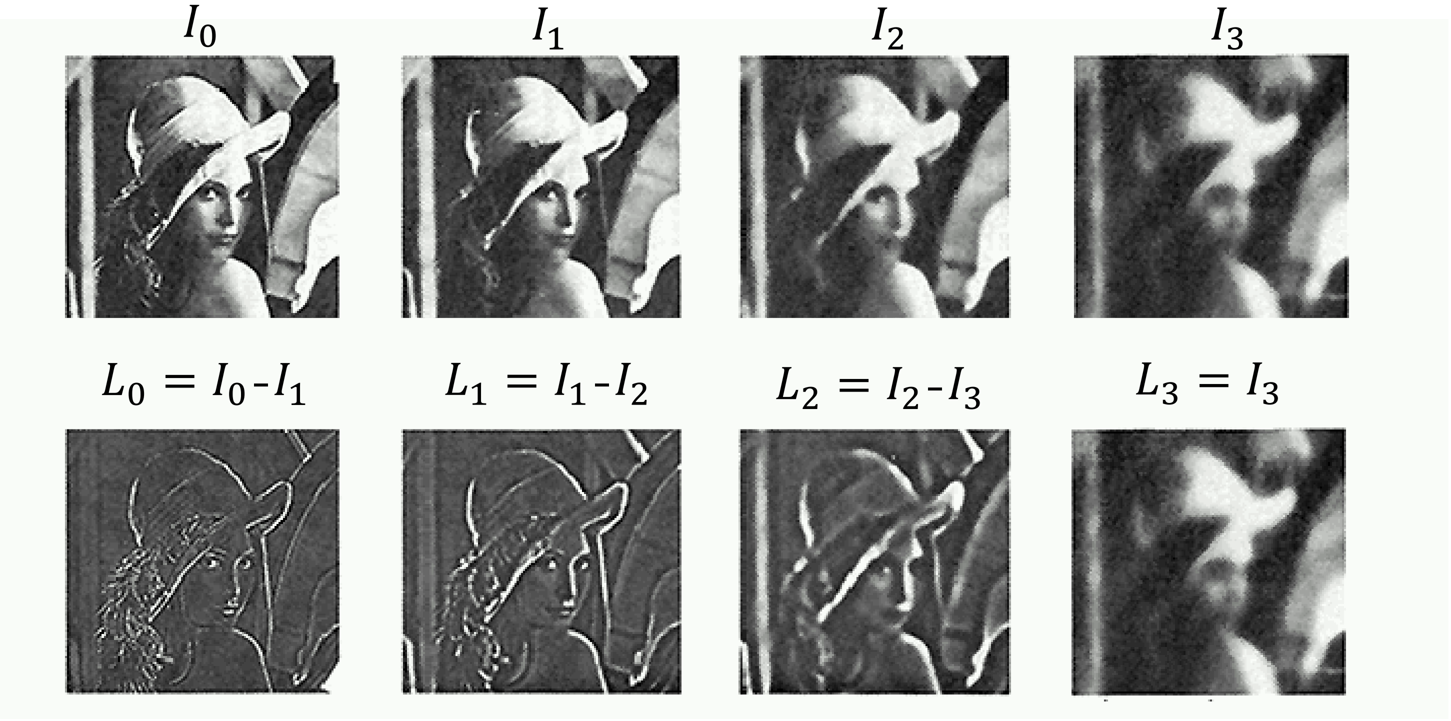


$\{L_i\}$ = the set of L_i form. A Laplacian pyramid $L_1, L_2, L_3 \cdots, L_n$

Pyramid Blending

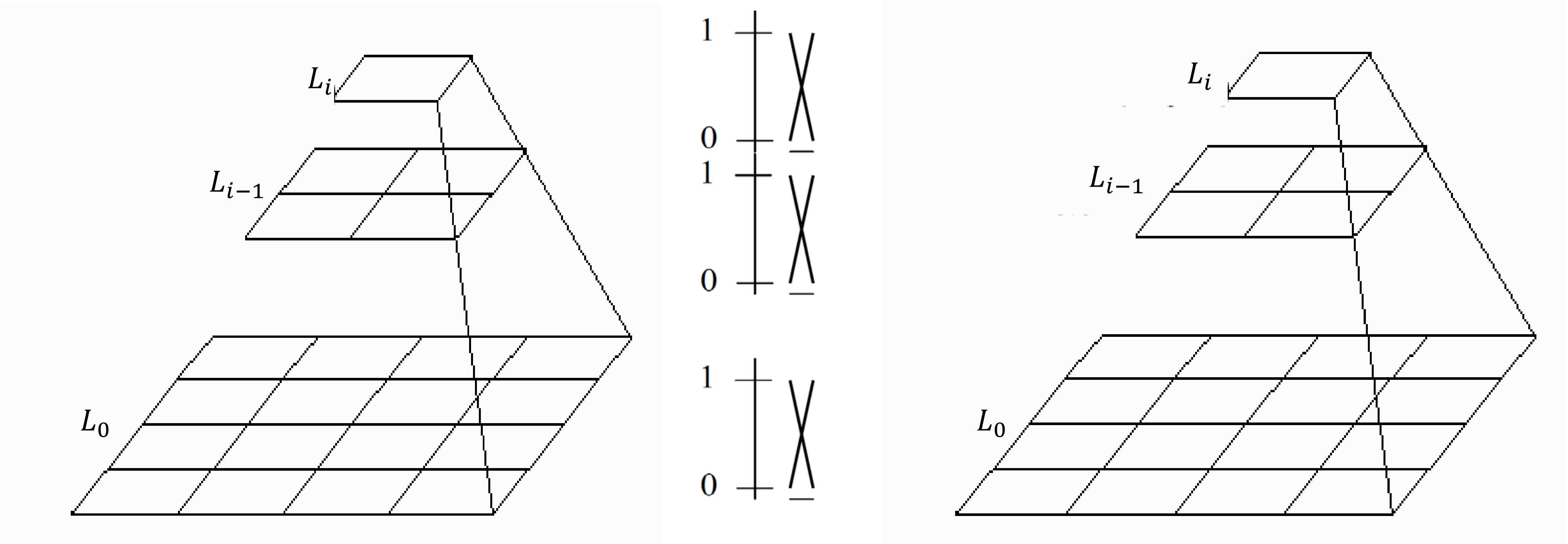
- **We can recover the original as:**

$$I = \sum_{i=0}^{N} (L_i) \uparrow$$



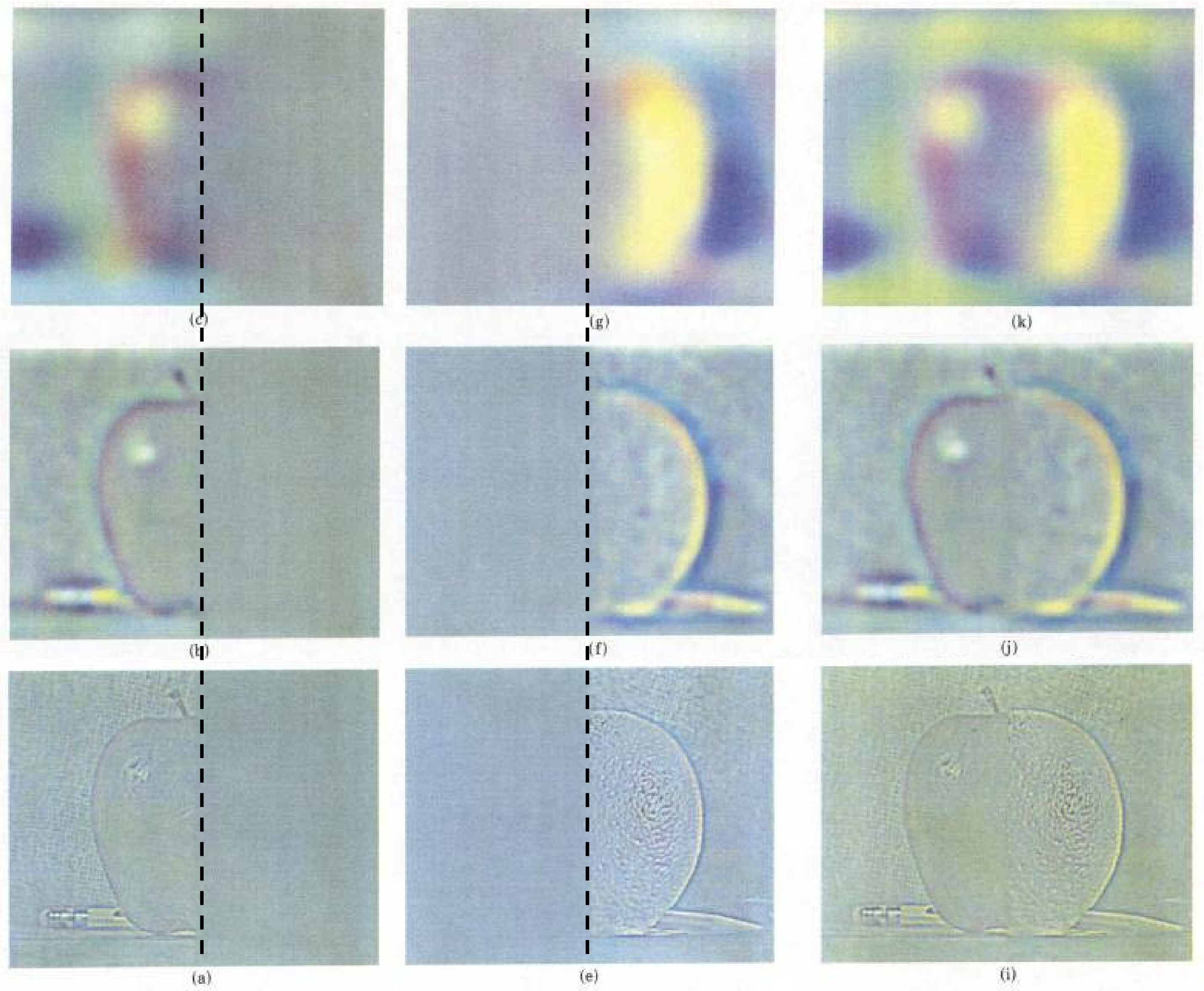
$\{L_i\}$ = the set of L_i form. A Laplacian pyramid L_1, L_2, $L_3 \cdots$, L_n

Pyramid Blending



Left pyramid blend Right pyramid

Pyramid Blending



Season Blending

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Season Blending

Target image

Target image with editing region

Source image

Result of pyramid blending

Poisson image editing

- A even better idea: to reduce the color mismatch between source and target, create composite in gradient domain.

- We want the gradient of the composite inside $\boldsymbol{\Omega}$ to look as close as possible to the source image gradient. The composite must match target image on the boundary $\boldsymbol{\partial\Omega}$.

$\boldsymbol{\Omega}$

$S(x,y)$

$$\min_{I(x,y)\epsilon\Omega} \|\nabla I(x,y) - \nabla S(x,y)\|^2 \, dxdy$$

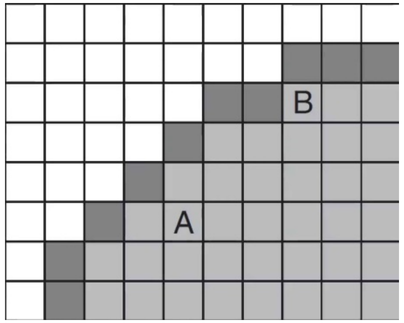
$$s.t. \, I(x,y) = T(x,y) \text{ on } \partial\Omega$$

$T(x,y)$

$I(x,y)$

- We want the gradient of the composite inside $\boldsymbol{\Omega}$ to look as close as possible to the source image gradient. The composite must match target image on the boundary $\boldsymbol{\partial\Omega}$.

Poisson image editing



➢ **Solution for this Pb:**

$$\nabla^2 \boldsymbol{I}(\boldsymbol{x},\boldsymbol{y}) = \nabla^2 \boldsymbol{S}(\boldsymbol{x},\boldsymbol{y}) \ \boldsymbol{in} \ \boldsymbol{\Omega}$$

$$\boldsymbol{I}(\boldsymbol{x},\boldsymbol{y}) = \boldsymbol{T}(\boldsymbol{x},\boldsymbol{y}) \text{ on } \boldsymbol{\partial\Omega}$$

- **Poisson equation**
- **Discretizing and solving the problem:**
- **1) For a pixel A inside $\boldsymbol{\Omega}$,**

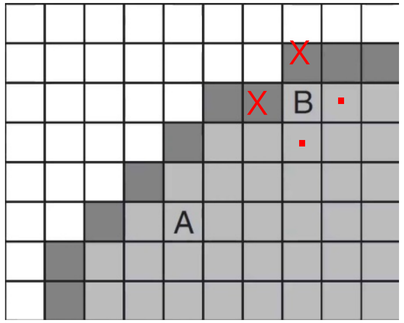
$$\nabla^2 \boldsymbol{I}(\boldsymbol{x},\boldsymbol{y}) = \nabla^2 \boldsymbol{S}(\boldsymbol{x},\boldsymbol{y})$$

	1	
1	-4	1
	1	

$$I(x+1,y)+I(x,y+1)+ I(x-1,y)+I(x,y-1)- 4*I(x,y)$$

$$S(x+1,y)+S(x,y+1)+ S(x-1,y)+S(x,y-1)- 4*S(x,y)$$

Poisson image editing



- For a pixel B not inside **Ω** (whose neighbor is **Ω**).

$$\boldsymbol{\nabla^2 I(x, y)} = \boldsymbol{\nabla^2 S(x, y)}$$

$$I(x+1, y) + I(x, y+1) + \text{ (xx)}$$
$$T(x-1, y) + T(x, y-1) - \text{ (..)}$$
$$4 * I(x, y)$$

$$S(x+1, y) + S(x, y+1) +$$
$$S(x-1, y) + S(x, y-1) -$$
$$4 * S(x, y)$$

- Big linear system

Source image

Target image

Poisson image editing result

Take home message

- Pyramid image blending is able to merge two images with similar background, however is not robust for color mismatch.
- Poisson image edit is more powerful on image blending Pbs with variations on background color.