Gradient Domain Blending

Notation

- Source image: g
  - the image we're cutting out and pasting
- Target image: f’
  - the image we're changing
- Blended image: f
  - Final blending result
- Replacement pixels: Ω
  - the pixels in target image that will be blended with source image
- Neighbor pixels: N_p
  - the pixel p’s neighbor pixels

Formula

- Apply source image gradient to target image

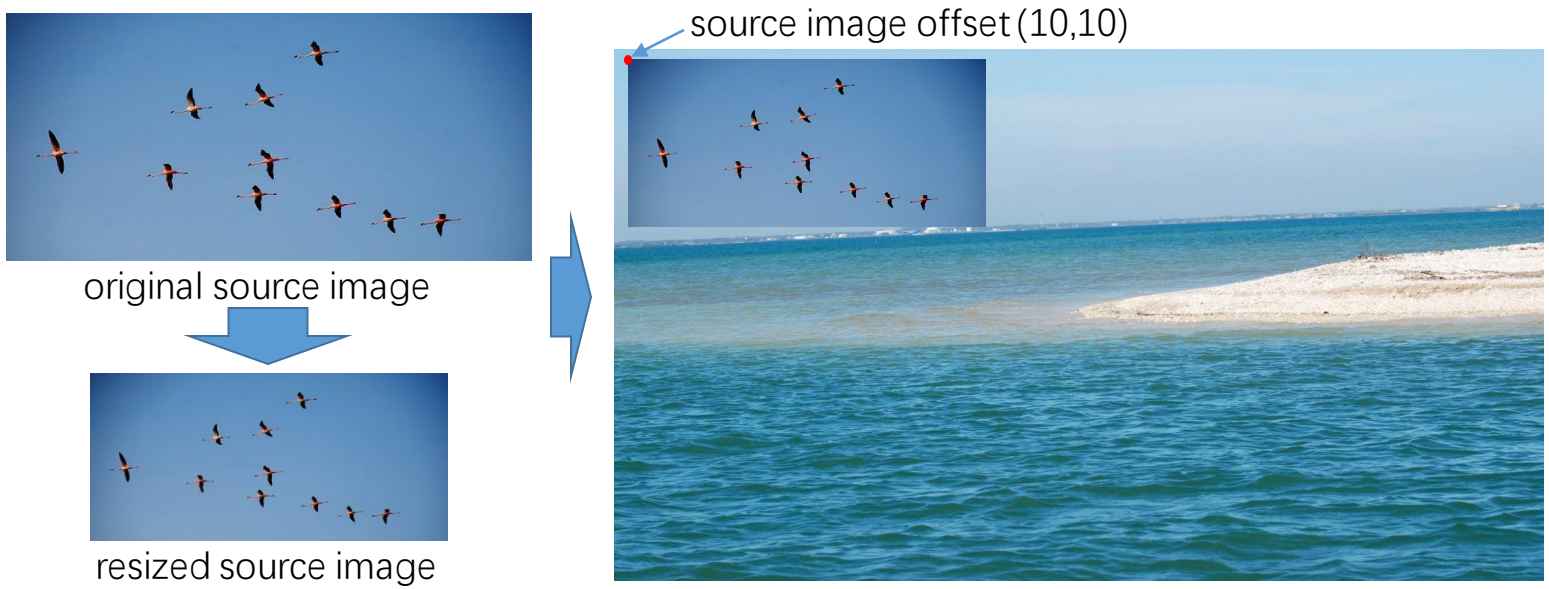
$$\min_{f|_\Omega} \sum_{p \in \Omega} \left(\left(|N_p| f_p - \sum_{q \in N_p} f_q \right) - \left(|N_p| g_p - \sum_{q \in N_p} g_q \right) \right)^2, \quad \text{with} \quad f|_{\partial\Omega} = f^*|_{\partial\Omega}$$

- Convert to linear system

$$|N_p| f_p - \sum_{q \in N_p} f_q = |N_p| g_p - \sum_{q \in N_p} g_q$$

Adjust Image and Create Mask

- Manually adjust source image and offset



- Keep the resized source image and offset

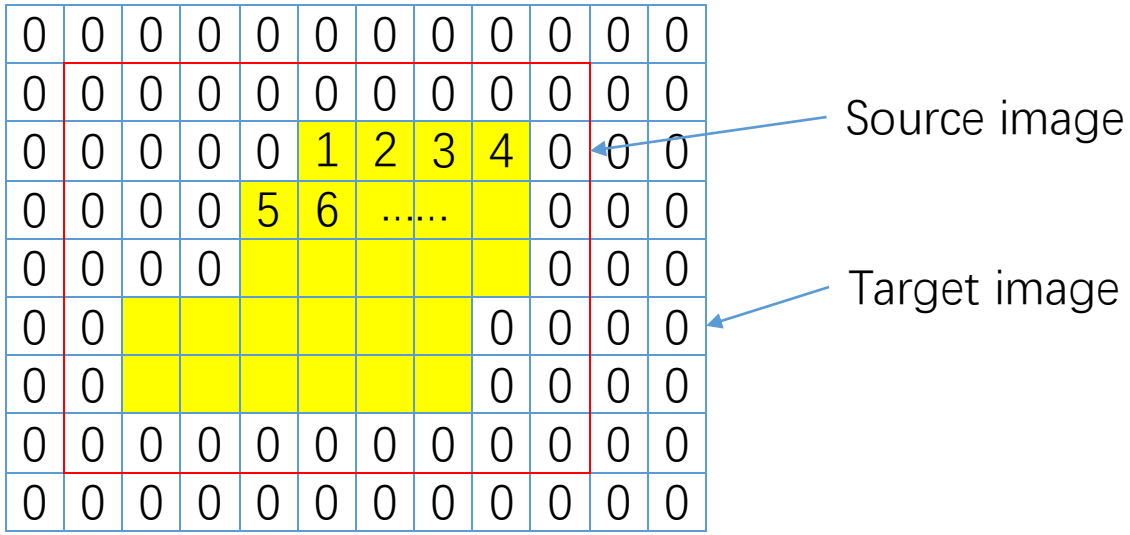
Adjust Image and Create Mask

- Create source image mask using resized source image

- Use matlab function imfreehand and createMask

Index Pixels

- Index the replacement pixels



Compute equation

- Solve Ax=b

$$|N_p| f_p - \sum_{q \in N_p} f_q = |N_p| g_p - \sum_{q \in N_p} g_q$$

  - x: f
  - A: coefficient matrix
  - b: solution vector
- Typically we only consider the N_p=4
  - The up, down, left and right neighbors
- $f_p = f'_p$, when p is not replacement pixels

Compute equation

- For example

	1	2	3	4	5
1	0	0	0	0	0
2	0	0	1	2	0
3	0	3	4	0	0
4	0	0	5	0	0
5	0	0	0	0	0

$$\begin{bmatrix} 4 & -1 & 0 & -1 & 0 \\ -1 & 4 & 0 & 0 & 0 \\ 0 & 0 & 4 & -1 & 0 \\ -1 & 0 & -1 & 4 & -1 \\ 0 & 0 & 0 & -1 & 4 \end{bmatrix} \begin{bmatrix} f_1 \\ f_2 \\ f_3 \\ f_4 \\ f_5 \end{bmatrix} = \begin{bmatrix} \Delta g_1 + f'_{3,1} + f'_{2,2} \\ \Delta g_2 + f'_{4,1} + f'_{5,2} + f'_{4,3} \\ \Delta g_3 + f'_{2,2} + f'_{1,3} + f'_{2,4} \\ \Delta g_4 + f'_{4,3} \\ \Delta g_5 + f'_{2,4} + f'_{4,4} + f'_{3,5} \end{bmatrix}$$

- $\Delta g_p = 4g_p - \sum_{q \in N_p} g_q$

Solve equation

- Use matlab function mldivide
- Use sparse matrix to represent coefficient matrix A