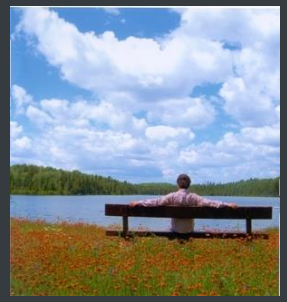
Applications

- Image shrinking

- Image Enlargement

Seam Carving → Seam Insertion



Note : Find seams **in order of removal**

[1] Avidan, S., & Shamir, A. (2007, August). Seam carving for content-aware image resizing. In ACM Transactions on graphics (TOG) (Vol. 26, No. 3, p. 10). ACM.

Applications

- Object Removal

Set certain region of the Energy map to a low value

Original

Mask

Result

[1] Avidan, S., & Shamir, A. (2007, August). Seam carving for content-aware image resizing. In ACM Transactions on graphics (TOG) (Vol. 26, No. 3, p. 10). ACM.

Energy Function

L1 $$e_1(\mathbf{I}) = \left|\frac{\partial}{\partial x}\mathbf{I}\right| + \left|\frac{\partial}{\partial y}\mathbf{I}\right|$$

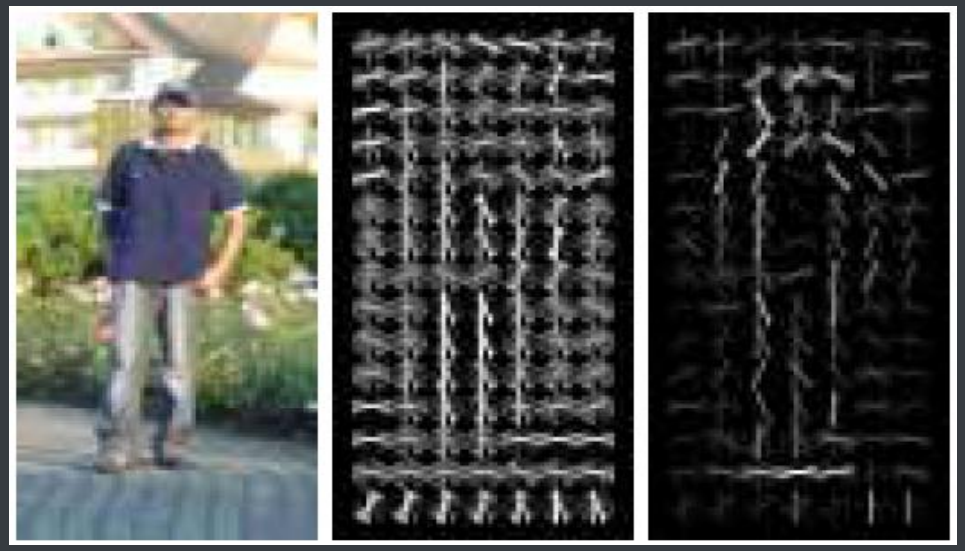
L2 $$e_2(\mathbf{I}) = \sqrt{\left|\frac{\partial}{\partial x}\mathbf{I}\right|^2 + \left|\frac{\partial}{\partial y}\mathbf{I}\right|^2}$$

HoG $$e_{HoG}(\mathbf{I}) = \frac{\left|\frac{\partial}{\partial x}\mathbf{I}\right| + \left|\frac{\partial}{\partial y}\mathbf{I}\right|}{\max(HoG(\mathbf{I}(x,y)))}$$

HoG

$$HoG(\mathbf{I}(x, y))$$

Histogram of oriented Gradients[1] at every pixel



[1] DALAL, N., AND TRIGGS, B. 2005. Histograms of oriented gradients for human detection. In International Conference on Computer Vision & Pattern Recognition, vol. 2, 886–893.

Use Protection

- Object Removal with protection

Set certain region of the Energy map to a high value

Original

Without Protection

With Protection

- Image resizing with object protection

[1] Avidan, S., & Shamir, A. (2007, August). Seam carving for content-aware image resizing. In ACM Transactions on graphics (TOG) (Vol. 26, No. 3, p. 10). ACM.

Accelerate Seam Localization

- Motivation

Calculating cumulative map is time-consuming

- Target

Implement a one-shot method for pinpointing seams

- Restrictions

Seam removal or addition influences cumulative energy map

Same number of pixels removed or added at each row/column

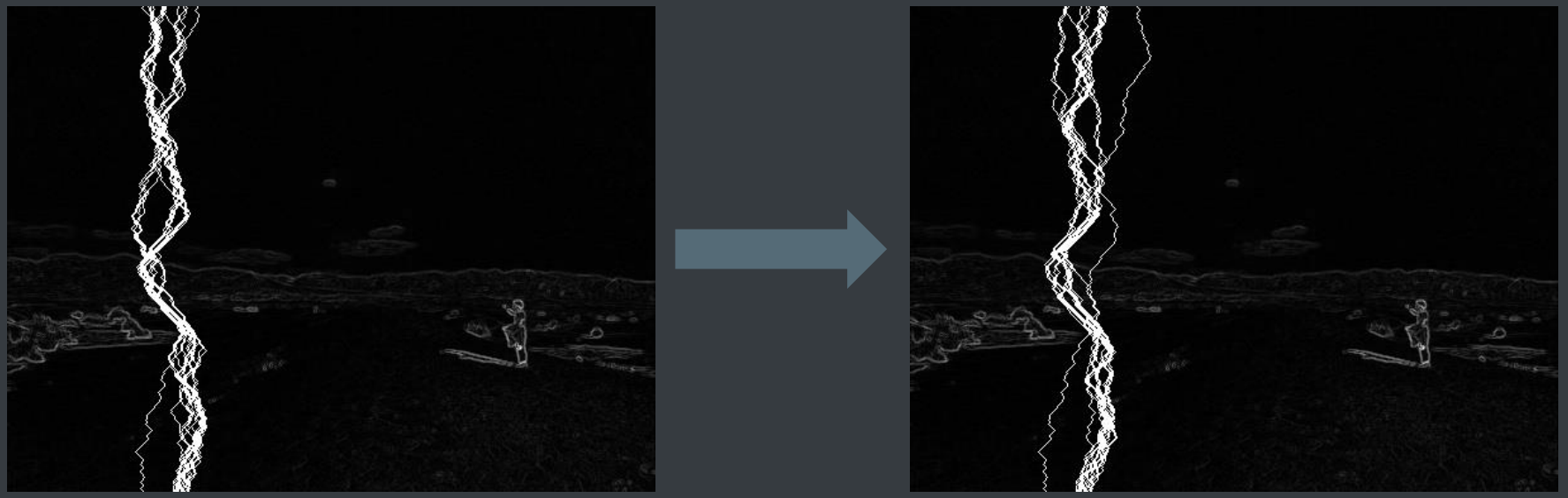
Accelerate Seam Localization

- Improved method

Pinpoint multiple seams with low energy in ascending order

- Typical condition

Two paths share the same pixel that causes distortion
Find a suboptimal solution within its connected area or do back trace



Accelerate Seam Localization

- Multiple seams per calculation

Red curves represent final seams, yellow regions show where back trace occurs

Left: one seam per calculation
Middle: multiple seams per calculation
Right: some pixels that cannot be chosen due to pre-defined restrictions

Accelerate Seam Localization

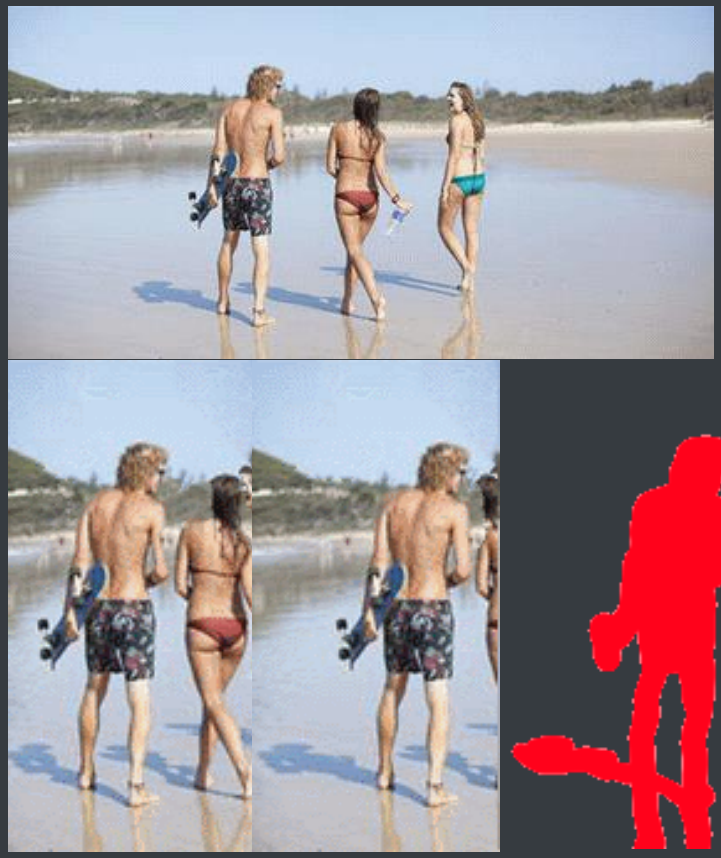
Restrictions

- Top-k optimal solutions energy within range
- Energy increment of suboptimal solution exceeds threshold
- Ratio of remaining effective pixels lower than threshold

Two seams occupy bottom right corner

If parallel, the whole yellow triangle region cannot be selected to construct seams, as invalid pixels

Effect of Protection



Different Speed

- Conclusions on time consumption

Perform best on simple resize task, comparatively weak on tasks with masks for extra restrictions

Task	Origin	Target/Mask	Original/s	Improve/s	Ratio
Resize	(384,512)	(300,400)	114	14	8.14
Resize	(384,512)	(500,700)	334	63	5.30
Protect	(199,399)	(199,100)	55	21	2.62
Protect	(199,399)	(250, 450)	56	21	2.67
Remove	(320,448)	14935	120	67	1.79
Remove	(320,448)	3337	52	34	1.53
Both	(320,448)	3337/14935	50	60	0.83
Both	(320,448)	14935/3337	137	79	1.73

Comparison

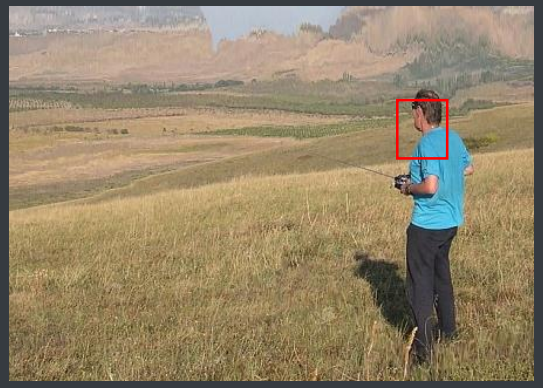
Due to irregular shape of the mask, the accelerated version tends to remove excessive seams.

Seam Carving 137s

Accelerate version 79s

Original image

Seam Carving 50s



Accelerate version 60s

Different Restrictions

- Conclusions on restrictions

Suboptimal energy increment imposes stricter restrictions
Two restrictions are not independent, but promoting mutually

Accelerate	Sub Inc	Eff Ratio	Runtime/s	Ratio
×	/	/	1719	/
✓	×	×	72	23.88
✓	×	✓	109	15.77
✓	✓	×	215	8.00
✓	✓	✓	211	8.15

Different Restrictions

- Examples for different restrictions

Seam Carving

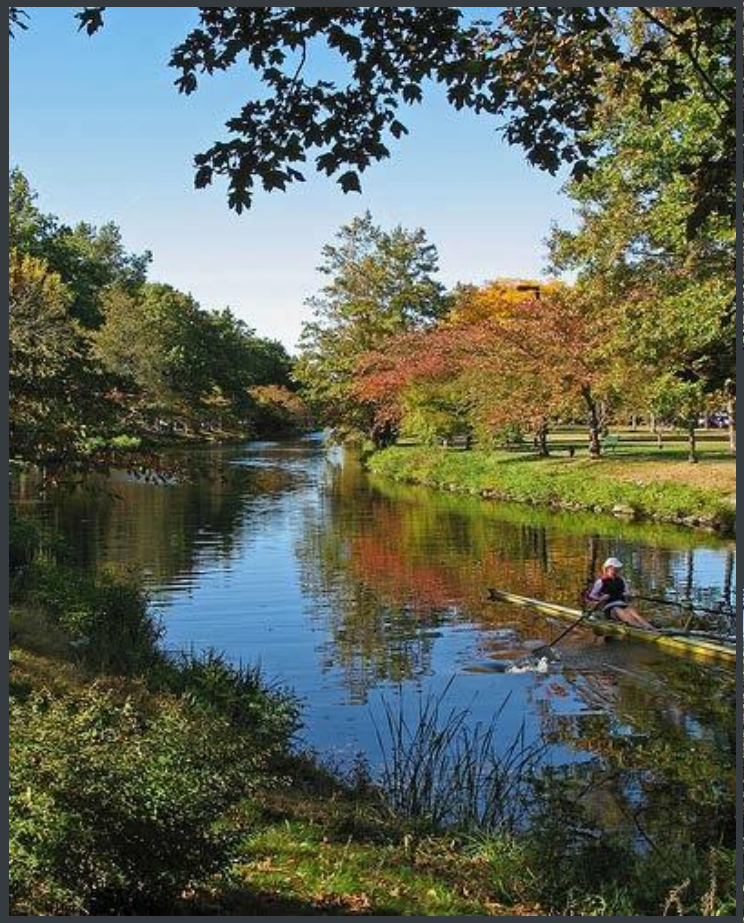
Top-k

Top-k+Eff-rat

Top-k+Sub-inc

All

Different Energy Function



Original

L1

L2

HoG

Different Energy Function

Original

the seam will run parallel to the edge and will not cross it

L1

L2

HoG

Visualization of Seam Picking Order

L1

HoG

A seam is red means we pick it very early;
yellow means the contrary.

Visualization of Seam Picking Order

L1

HoG

A seam is red means we pick it very early;
yellow means the contrary.

Failed Scenario

→

Big Ratio&Crowded

→

Line Structure