Seam Carving for content-aware image resizing

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- Based on paper published with same title by Shai Avidan and Ariel Shamir

Image Resizing Methods (Width Reduction) -

- Image Scaling

- Image cropping

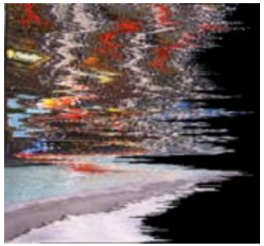
Image Resizing Methods (Width Reduction) -

- Removal of columns with minimal energy

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

- Minimum energy pixels removal from each row

- Minimum energy pixels removal globally

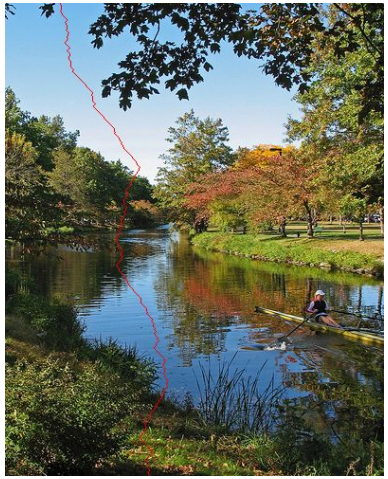


- Seam Carving

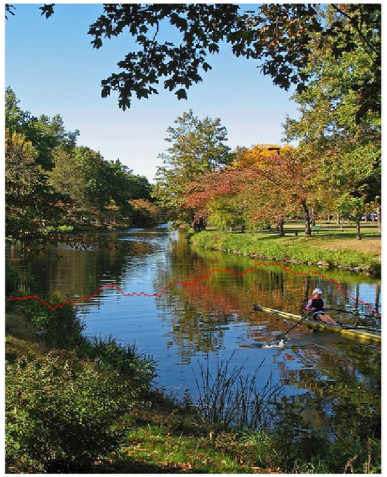
What is Seam Carving ?

A seam is a connected path of low energy pixels crossing the image from top to bottom, or from left to right.

Vertical Seam



Horizontal Seam



Applications of Seam Carving -

1) Reducing size of the image
2) Enlargement of image
3) Content Amplification
4) Object Removal

Reducing width of image -

Image is of size nXm, for removing column using Seam Carving firstly energy function of the image is found .

The vertical seam is defined as $\mathbf{s}^{\mathbf{x}} = \{s_i^x\}_{i=1}^n = \{(x(i), i)\}_{i=1}^n, \text{ s.t. } \forall i, |x(i) - x(i-1)| \leq 1$

Cost of seam is $E(\mathbf{s}) = E(\mathbf{I_s}) = \sum_{i=1}^n e(\mathbf{I}(s_i))$

Optimum seam is found by minimizing the cost function $s^* = \min_{\mathbf{s}} E(\mathbf{s}) = \min_{\mathbf{s}} \sum_{i=1}^{n} e(\mathbf{I}(s_i))$

The optimal seam can be found using dynamic programming.

The cumulative minimum energy M is found as $M(i,j) = e(i,j) + \min(M(i-1,j-1), M(i-1,j), M(i-1,j+1))$

By backtracking from the minimum value of M in last row minimum energy seam can be found.

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

Reducing width of image -

$$M(i,j) = e(i,j) + \min(M(i-1,j-1), M(i-1,j), M(i-1,j+1))$$

Image

	1	2	3	4	5	6
1	30	31	35	43	28	30
2	28	43	26	41	32	45
3	30	31	30	28	30	32
4	30	31	25	35	33	29
5	27	31	29	36	34	32
6	25	35	43	30	35	25

Energy

	1	2	3	4	5	6
1	3	16	17	17	6	6
2	17	29	19	22	15	15
3	1	1	7	9	5	5
4	4	6	14	3	5	5
5	6	6	21	8	3	3
6	6	6	21	8	3	3

Cumulative Energy

	1	2	3	4	5	6
1	3	16	17	17	6	6
2	20	32	35	28	21	21
3	21	21	35	30	26	26
4	25	27	35	29	31	31
5	31	31	48	37	32	34
6	37	37	52	40	35	35

3	16	17	17	**6**	6
20	32	35	28	**21**	21
21	21	35	30	**26**	26
25	27	35	**29**	31	31
31	31	48	37	**32**	34
37	37	52	40	**35**	35

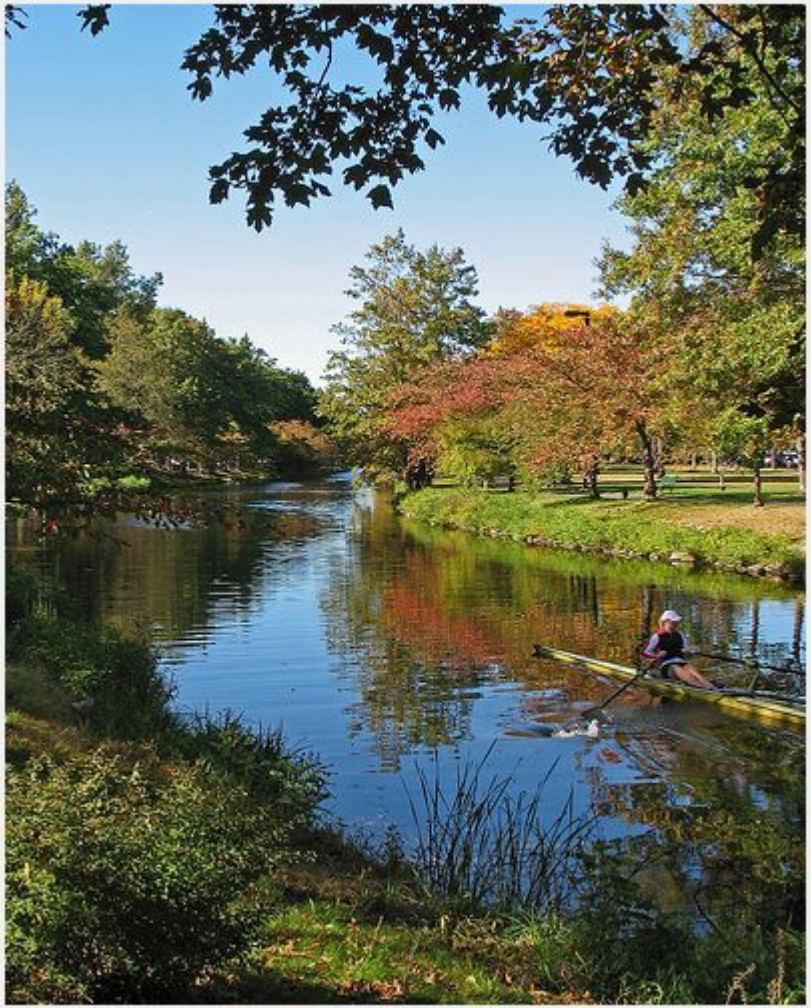
Demo for reducing width of image -

Reducing the width and height of image -

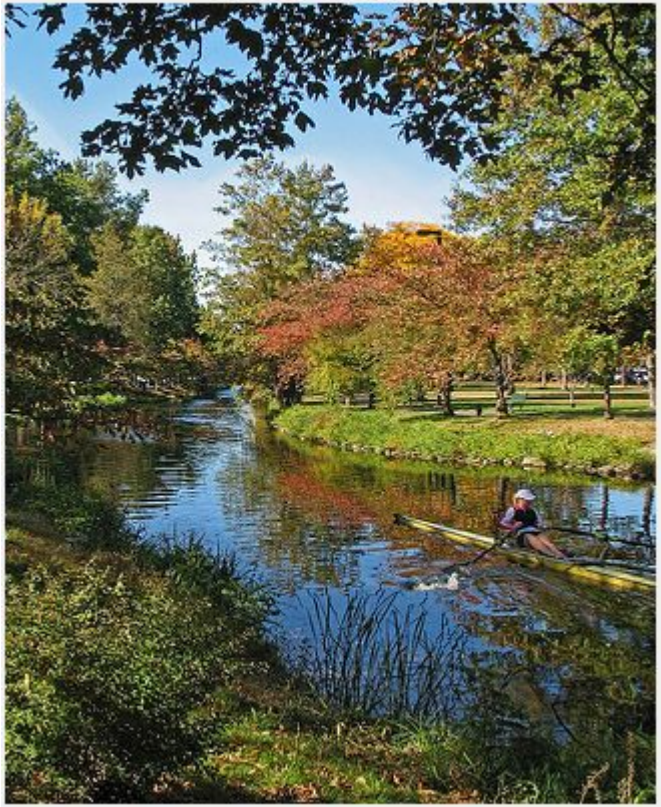
This can be achieved by removing ‘r’ rows and ‘c’ columns. The optimal order is found using transport map T, that specifies for each desired size of image, the cost of optimal sequence of horizontal and vertical seam options.

$$\mathbf{T}(r,c) = min(\mathbf{T}(r-1,c)+E(\mathbf{s^x}(\mathbf{I_{n-r-1\times m-c}})), \mathbf{T}(r,c-1)+E(\mathbf{s^y}(\mathbf{I_{n-r\times m-c-1}})))$$

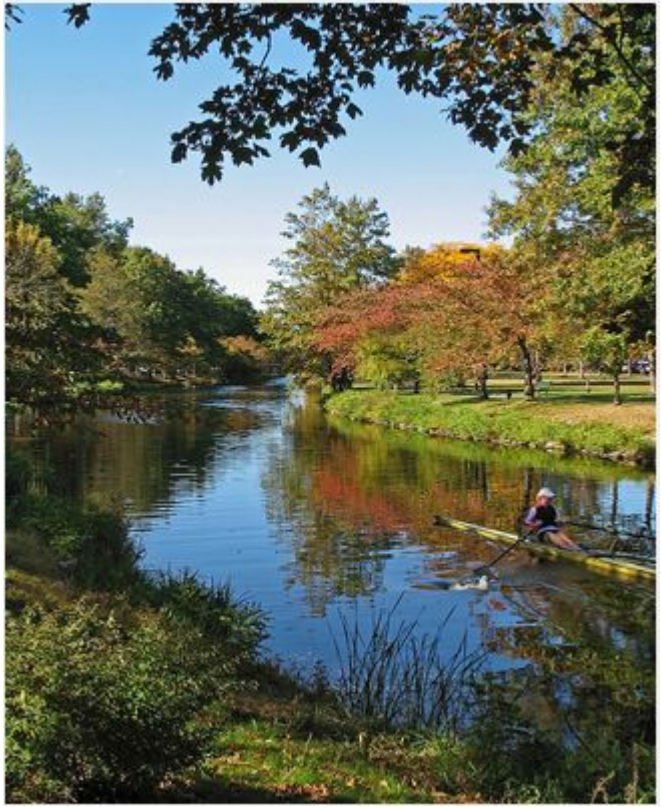
original image



seam carving



simple scaling



seam carving

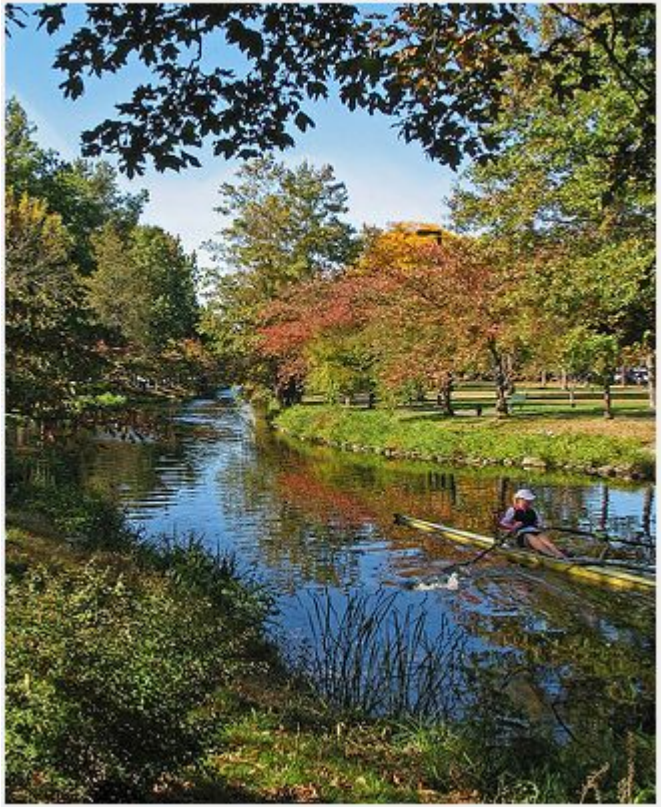


Image enlargement -

For enlarging image the minimum energy seam should be found and an artificial seam parallel to this seam should be added with average value of seam and next pixel.

But if we continue doing this repeatedly, it will create stretching artifact by selecting same seam all the times.

Image enlargement -

We find minimum energy seam, and then set the seam’s pixel energy values very high, so that the second seam doesn’t overlap.

We find the required number of independent seam(s).

Then we add artificial seam(s) parallel to these seam(s) (by computing the average value of each seam pixel and next pixel).

Demo for image enlargement -

Content Amplification

In this application, the content of image is amplified by preserving the size of the image.

This is achieved by firstly scaling the image and after that applying seam carving to reduce image size to the original image size.

Original Image

Seam Carving

Demo for image content amplification-

Object removal -

This can be achieved by finding all the seams which passes through the target object and removing them.

Thank You!!