

# Image Resizing Using Seam Carving

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## Background

## Outline

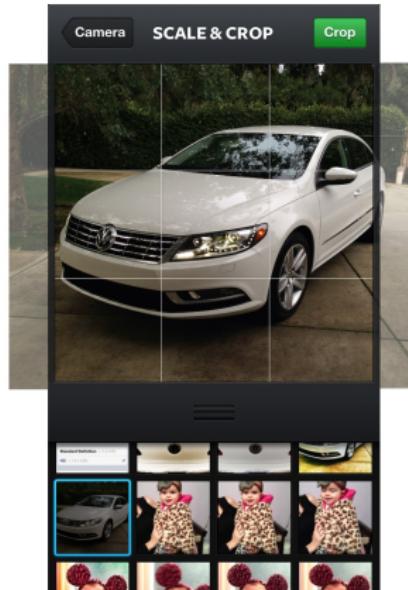
**1** Introduction

- Background

**2** Seam Carving**3** Object Carving**4** Video Retargeting**5** Conclusion

## Background

## The Problem Space



<http://twd3.com/responsive-web.cms>

<http://thenextweb.com/apps/2012/12/18/instagrams-latest-app-update-fixed-my-biggest-pet-peave-and-people-hate-it/>

## Background

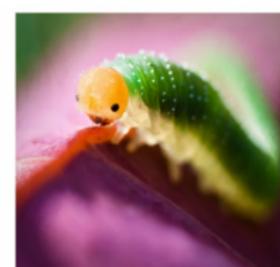
## Traditional Resizing



<http://jeremykun.com/2013/03/04/seam-carving-for-content-aware-image-scaling/>

## Background

# Seam Carving



<http://jeremykun.com/2013/03/04/seam-carving-for-content-aware-image-scaling/>

## Seams

## Outline

## 1 Introduction

## 2 Seam Carving

- Seams
  - Energy Function
  - Computing Seams
  - Results

## 3 Object Carving

## 4 Video Retargeting

## 5 Conclusion

## Seams

## Defining a Seam

- One pixel wide path
  - Traverses the image's width or height
  - Let image  $I$  be a  $n \times m$  image
  - $s^x = \{(x(i), i)\}_{i=1}^n$
  - $\forall i, |x(i) - x(i-1)| \leq 1$



## Seams

## Defining a Seam

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- $\forall i, |x(i) - x(i - 1)| \leq 1$



<http://www.ulfdittmer.com/imagej/seam-carving.html> [1]

## Energy Function

## Outline

## 1 Introduction

## 2 Seam Carving

- Seams
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- Computing Seams
- Results

## 3 Object Carving

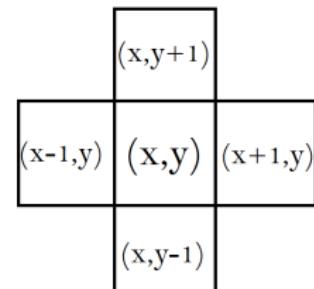
## 4 Video Retargeting

## 5 Conclusion

## Energy Function

# Energy Function

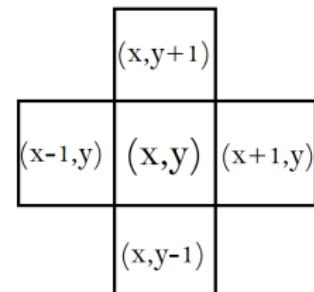
- A pixel's energy is high if its color value is very different from its neighbors.
- A pixel's energy is low if it is similar to its neighbors.
- $dx = |I(x+1, y) - I(x-1, y)|/2$
- $dy = |I(x, y-1) - I(x, y+1)|/2$
- $e(x, y) = dx + dy$



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## Computing Seams

## Computing Seams

12	13	7	5	12	11	9	4
19	5	8	13	9	8	11	12
11	7	6	15	15	7	4	13
6	2	5	14	7	8	8	11
4	9	12	17	19	10	4	5
10	6	8	13	5	7	13	13
11	17	9	15	9	8	4	12
12	15	6	11	14	6	5	6

Energy Values: Each pixel gets a value

## Computing Seams

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12	13	7	5	12	11	9	4
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11	7	6	15	15	7	4	13
6	2	5	14	7	8	8	11
4	9	12	17	19	10	4	5
10	6	8	13	5	7	13	13
11	17	9	15	9	8	4	12
12	15	6	11	14	6	5	6

Use dynamic programming to compute seams from top to bottom.

## Computing Seams

## Computing Seams

12	13	7	5	12	11	9	4
31	5	8	13	9	8	11	12
11	7	6	15	15	7	4	13
6	2	5	14	7	8	8	11
4	9	12	17	19	10	4	5
10	6	8	13	5	7	13	13
11	17	9	15	9	8	4	12
12	15	6	11	14	6	5	6

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12	13	7	5	12	11	9	4
31	5	8	13	9	8	11	12
11	7	6	15	15	7	4	13
6	2	5	14	7	8	8	11
4	9	12	17	19	10	4	5
10	6	8	13	5	7	13	13
11	17	9	15	9	8	4	12
12	15	6	11	14	6	5	6

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## Computing Seams

## Computing Seams

12	13	7	5	12	11	9	4
31	12	13	18	14	17	15	16
11	7	6	15	15	7	4	13
6	2	5	14	7	8	8	11
4	9	12	17	19	10	4	5
10	6	8	13	5	7	13	13
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12	15	6	11	14	6	5	6

Use dynamic programming to compute seams from top to bottom.

## Computing Seams

## Computing Seams

12	13	7	5	12	11	9	4
31	12	13	18	14	17	15	16
23	19	18	29	29	22	19	28
25	20	23	32	29	27	27	30
24	29	32	40	48	37	31	32
34	30	37	45	42	38	44	44
41	47	39	52	47	46	42	56
12	15	6	11	14	6	5	6

Use dynamic programming to compute seams from top to bottom.

## Computing Seams

## Computing Seams

12	13	7	5	12	11	9	4
31	12	13	18	14	17	15	16
23	19	18	29	29	22	19	28
25	20	23	32	29	27	27	30
24	29	32	40	48	37	31	32
34	30	37	45	42	38	44	44
41	47	39	52	47	46	42	56
53	54	45	50	60	48	47	48

Find smallest energy value on bottom row.

## Computing Seams

## Computing Seams

12	13	7	5	12	11	9	4
31	12	13	18	14	17	15	16
23	19	18	29	29	22	19	28
25	20	23	32	29	27	27	30
24	29	32	40	48	37	31	32
34	30	37	45	42	38	44	44
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24	29	32	40	48	37	31	32
34	30	37	45	42	38	44	44
41	47	39	52	47	46	42	56
53	54	45	50	60	48	47	48

Trace seam back up the image.

## Computing Seams

# Computing Seams

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25	23	32	29	27	27	30
29	32	40	48	37	31	32
34	37	45	42	38	44	44
41	47	52	47	46	42	56
53	54	50	60	48	47	48

Remove seam and shift everything else to the left.

## Computing Seams

# Computing Seams

12	13	5	12	11	9	4
19	8	13	9	8	11	12
11	7	15	15	7	4	13
6	5	14	7	8	8	11
9	12	17	19	10	4	5
10	8	13	5	7	13	13
11	17	15	9	8	4	12
12	15	11	14	6	5	6

Reset energy values and repeat.

## Results

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## Results

## Results



<http://www.cs.cmu.edu/afs/andrew/scs/cs/15-463/f07/proj2/www/wwedler/>

## Results

## Image Enlarging



<http://www.ulfdittmer.com/ij/seam-carving.html>

<http://www.ulfdittmer.com/ij/seam-carving.html>

## Results

## Limitations



(a) Original



(b) Cropping



(c) SC



(d) Multi-Op

Reference [4]

## Object Detection

## Outline

## 1 Introduction

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## 3 Object Carving

- Object Detection
- Object Removal

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## Object Detection

# Object Carving



(a) Original



(b) Multi-Op



(c) Object Carving

Reference [2]

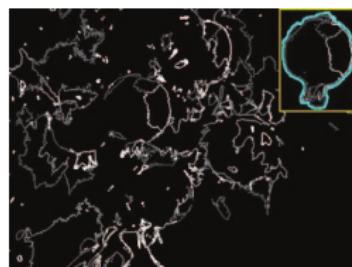
Object Carving: Removing repeated objects in an image to help avoid distortion while shrinking.

## Object Detection

## Object Carving



(a) Paint Selection



(b) Shape Information



(c) Detection Result

Reference [2]

## Object Removal

## Outline

- 1 Introduction
  - 2 Seam Carving
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    - Object Detection
    - Object Removal
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## Object Removal

## Visual Importance



(a) Original Image



(b) Visual Importance



(c) Multi-Op



(d) Object Carving

Reference [2]

Visual Importance: The algorithm measures the layering relation between the different objects and assigns higher importance to images in the foreground.

## Object Removal

## How to Remove Objects



<http://deliveryimages.acm.org/10.1145/1440000/1435437/figs/f13.jpg>

## Object Removal



(a) Current Resizing



(b) Object Carving 1

(c) Object Carving 2

Reference [2]

This displays the importance of evaluating the energy that the seam will carve out as well as the object's energy.

## The Need to Resize Videos

# Outline

## 1 Introduction

## 2 Seam Carving

## 3 Object Carving

## 4 Video Retargeting

- The Need to Resize Videos
- Algorithm

## 5 Conclusion

## The Need to Resize Videos

## Video Resizing



<http://blog.dvdfab.cn/how-to-rip-dvd-to-iphone-4s-with-dvdfab-dvd-ripper.html>



<http://www.installitdirect.com/blog/how-to-create-a-diy-outdoor-movie-theater-in-your-backyard>

## Algorithm

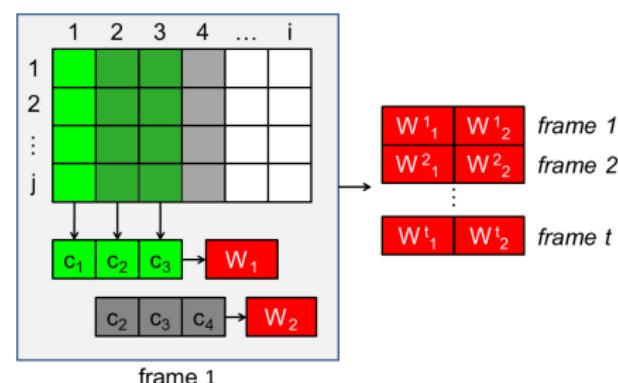
## Outline

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## Algorithm

## Finding Cropping Window

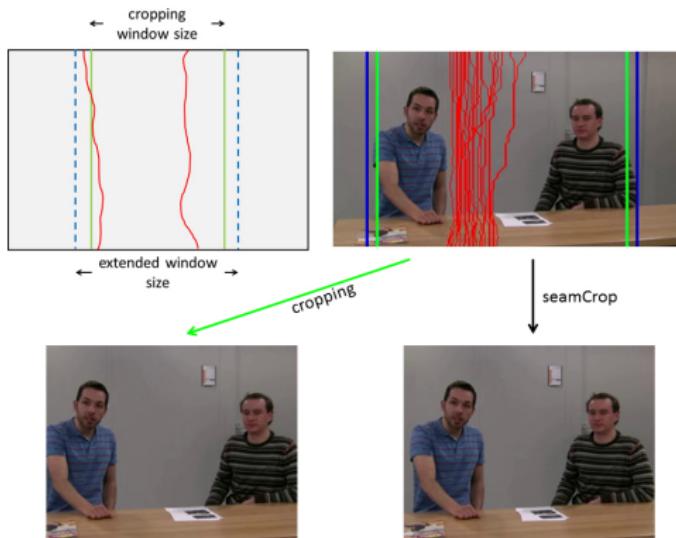
Each column's energy is summed in a value  $C_i$ . Then each of these values are summed into a value  $W_j$  for each cropped window. Finally the values for the positions of all frames are combined to a 2D array.



Reference [3]

## Algorithm

## Seam Carving in Frame



Reference [3]

# In Summary

- Image/Video resizing is becoming more necessary as the number of different screen sizes.
- Seam carving works well on landscapes
- Object carving works well on images with repeated objects or patterns
- Videos can also effectively be resized using seam carving

## Questions?

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# References I



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