Report:

Content Aware Image Resizing with Seam Carving

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ABSTRACT:

The process of adding or removing pixels in the image cannot be performed at random. Addition or removal of pixels in the image at random positions would create a distorted image. If we add or remove whole rows or columns with minimal energy, artifacts might arise in the picture. The solution is seam carving which were proposed by Shai Avidan and Ariel Shamir. Therefore, the goal of this project is to perform content-aware image resizing for both reduction and expansion with seam carving method. This allows image to be resized without losing or distorting meaningful content from scaling.

Fig 1: Original Image (1280*960)

Fig 1.2: Cropped Image (1023*1063)

Fig 1.3: Resized Image (1023*1063)

Fig 1.3: seam carved Image (1023*1063)

Introduction:

Adaptive resizing of images is one of the most useful techniques in relevant areas. For example, images can be changed to different sizes or aspect ratios for displaying on devices with various screen resolutions. Designers can provide different previews for photos on a website. A feasible resizing algorithm should be able to preserve the important content in an image as well as the global visual effect.

Seam-carving is a content-aware image resizing technique where the image is reduced in size by one pixel of height (or width) at a time. A *vertical seam* in an image is a path of pixels connected from the top to the bottom with one pixel in each row; a *horizontal seam* is a path of pixels connected from the left to the right with one pixel in each column.

Unlike standard content-agnostic resizing techniques (such as cropping and scaling), seam carving preserves the most interest features (aspect ratio, set of objects present, etc.) of the image.

Algorithm Implementation:

1. ***Energy calculation.*** The first step, energy is calculated. We start processing the image to calculate the energy function by applying a Gaussian filter with a 3 by 3 kernel and standard deviation of 0 to blur the image and reduce noise (this could be optional). We convert the image to greyscale before using Sobel filters to compute the image gradients in x and y directions from the blurred image.

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

Fig 2.0: Energy image both X and Y direction

2. **Seam identification:** The next step is to find a ***vertical seam*** of ***minimum total energy***. (Finding a *horizontal seam* is analogous.). As described in the paper, the ***optimal seam*** can be found using ***dynamic programming***. The first step is to traverse the image from the second row to the last row and compute the cumulative minimum energy M for all possible connected seams for each *pixel (i, j)*:

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

The recurrence relation for our dynamic programming function. *M* is the two dimensional array of cumulative energies we are building up. *E* is the pre-computed energy function as given above.

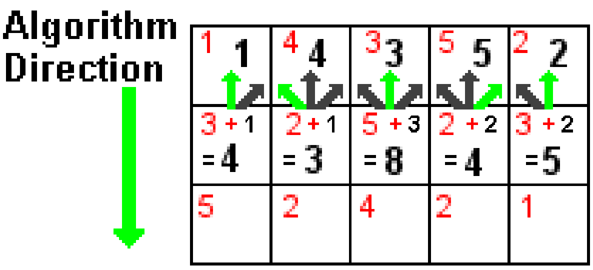

Fig 3.0 Using dynamic programming to compute the second row of the cumulative energies.

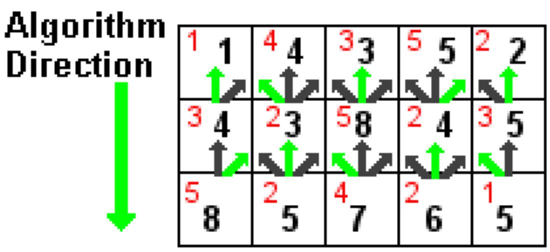

Fig 3.1 Using Dynamic programming to fill out the rest of energy values

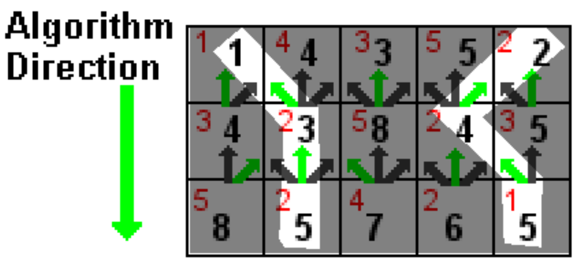

Fig 3.2 Backtracking through the energies table to find the path with minimum energy.

N.B: source of the images Wikipedia

The backtracking step, seen in the third diagram above, starts in the last row of cumulative energies computed with dynamic programming and selects the pixel with the minimum value. From that pixel the backtracking algorithm works up the image row by row selecting the pixel from the three 8-connected pixels above the previous one with the minimum value. This is the pixel that produced the path of minimum energy.

The result of this backtracking is vertical path from the top to bottom of the image with one pixel selected for the seam in each row. When remove the pixels on the seam the image is exactly one pixel less in the x direction. The algorithm works similarly to find a horizontal seam and remove pixels in the y direction. Instead of choosing between the minimum of the three pixels to the top, the algorithm chooses between the three to the left as it moves across columns of the image.

3. **Seam Removal:** After both horizontal and vertical seams are found by cumulative energies the final step will be to remove these seams.

Results:

Original Image (980*588)

Seam Carved image (880*580)

Seam carved image (1770*1000)

Original Image (1920*1280)

Original Image (1280*720)

Seam Carved image (1100*680)

Original Image (1920*1280) **Seam carved image (1700*1000)**

Original Image (1280*960) **Seam carved image (1000*770)**

We can conclude that seam carving algorithm does very good job of resizing images by preserving important contents.

N.B both Demo Video and Code can be found in the folder attached.

Reference:

http://www.faculty.idc.ac.il/arik/SCWeb/imret/imret.pdf