Seam Craving For Object Removal

A Report of the Mini Project submitted in partial fulfillment of the requirements of completion of Image And Video Processing Course

by

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1 Introduction

Has it ever happened that you took a photo in front of Taj Mahal but it has so happened that there is always some crowd in it other than you? If it has, after reading this report you need not worry of those unwanted objects in your image. The answer to the above demand is alteration of photo by removing certain objects without altering the content of the image.One of the method is cropping.But cropping is limited since it can only remove pixels from the image periphery.We propose a simple image operator, we term seam-carving, that can change the size of an image by gracefully carving-out or inserting pixels in different parts of the image.Here we try to explain the application of seam carving in objecy removal.

2 Theory

Seam carving uses an energy function defining the importance of pixels. A seam is a connected path of low energy pixels crossing the image from top to bottom, or from left to right. A seam is an optimal 8-connected path of pixels on a single image from top to bottom, or left to right, where optimality is defined by an image energy function Our approach to content-aware resizing is to remove pixels in a judicious manner. Therefore, the question is how to chose the pixels to be removed? Intuitively, our goal is to remove unnoticeable pixels that blend with their surroundings. This leads to the following simple energy function

$$e(I) = |\frac{\partial I}{\partial x}| + |\frac{\partial I}{\partial y}| \tag{1}$$

Given an energy function e, we can define the cost of a seam as

$$E(s) = E(I_s) = \sum_{i=1}^{n} e(I(s_i)) \tag{2}$$

We look for optimal seam that minimizes the seam cost:

$$s^* = minE(s) = min\sum_{i=1}^{n} e(I(s_i)) \tag{3}$$

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 entry (i, j):

$$M(i,j) = e(i,j) + min(M(i-1,j-1), M(i-1,j), M(i-1,j+1)) \quad (4)$$

At the end of this process, the minimum value of the last row in M will indicate the end of the minimal connected vertical seam. Hence, in the second step we backtrack from this minimum entry on M to find the path of the optimal seam.The definition of M for horizontal seams is similar.

Object removal can be achieved by marking regions to be removed by (very) low negative energies and use seam carving on modified energy function. This ensures that the pixels marked are removed. It also removes low energy paths around these regions. While removal of pixels, some areas of importance are also removed. These may be marked by higher energies.

3 Method of Implementation And Results

We use a simple user interface for object removal. The user marks the target object to be removed and then seams are removed from the image until all marked pixels are gone. The system can automatically calculate the smaller of the vertical or horizontal diameters (in pixels) of the target removal region and perform vertical or horizontal removals accordingly. As an additional feature: Sometimes it is probable that, the removal of the object can lead to removal of another object if it is present in the minimum energy path.In order to avoid this protection of object can be implemented by increasing the energy of the protected object.

Various steps involving object removal is as shown below

Figure 1: Input Image

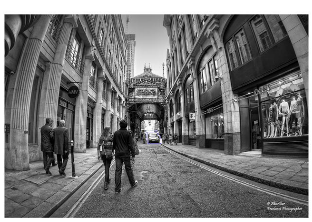

Figure 2: Selected Area to Remove

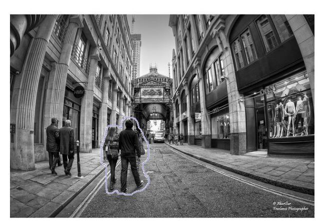

Figure 3: Selected Area to Protect

Figure 4: Minimum Energy Path-1

Figure 5: Minimum Energy Path-2

Figure 6: Output Image

Some Other Test Images and their Output are as follows:

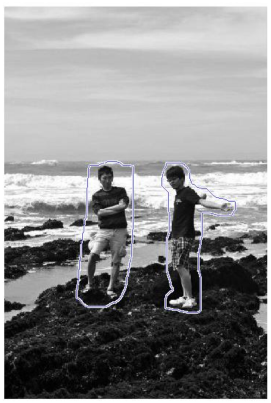

Figure 7: Input Image 2

Figure 8: Output Image 2

Figure 9: Input Image 3

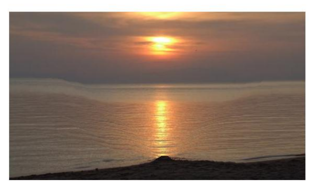

Figure 10: Output Image 3

Figure 11: Input Image (Natural)

Figure 12: Output Image (Natural)

4 Conclusion and Future work

We have observed that the approach mentioned works well for most of the images we have tested on. But in images where there's a lot of variation around the region to be removed, there is a noticeable distortion. However it is better than method of cropping for removing unwanted features in the image.

The approach suggested takes $O(n * m * \sum_i \sum_j (mask(i, j) == 1))$ time. This complexity is inevitable. But it can be improved by using parallel processing. The algorithm used is suitable for parallel processing. In images, it is usually desired that part of the image containing faces is not distorted. Using machine learning techniques for face detection, pixels may be automatically marked for protection.

5 References

[1] Avidan, Shai and Ariel Shamir. "Seam carving for content aware image resizing." ACM Transactions on graphics(TOG), Vol. 26. No. 3. ACM, 2007