Liquid Rescaling of Images

Team 11

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1 INTRODUCTION

The objective of this seam carving algorithm is to perform content aware resizing of images. This allows image to be resized without losing meaningful content from cropping or scaling. The idea is to locate the image's optimal seams, connected pixel paths going from top to bottom or left to right, to remove or insert while preserving the photorealism of the image. Furthermore, manipulating the gradient energy map that describes how optimal a seam is allows for functionality such as object removal.

2 LITERATURE REVIEW

Image retargeting techniques find least energy pixels which can be removed or inserted without making much change in the total energy of an image. Avidan et al. [1] have defined an image operator called 'seam carving' which when applied on an image finds an optimal 8-connected pixel path of least energy in either vertical or horizontal direction using dynamic programming. Rubinstein et al. [3] have improvised seam carving operator by minimising energy inserted into the image along with energy to be removed using graph cut formulation. In this paper, Rubinstein talks about removing 2D seam manifold from 3D space-time volumes instead of removing 1D seams from 2D images. Lu and Wu [2] proposed an active forensics method, Hash-based forecasting and discrimination method, which has some limitations in application. Forensic hash can be easily deleted, and that must be built in advance because of the active forensic techniques. Sarkar et al. [4] talks about detection method which is based on the Markov feature, it considers the correlation between adjacent pixels only and ignores the correlation between nonadjacent pixels. Thus, accuracy comes out to be low. Regarding [4], Sheng et al. [5] talks about a detection method based on extended Markov characteristics. The Markov features which can describe the correlation between nonadjacent pixels with different step sizes were added, and the detection effect was improved. Thilagam et al. [6] proposed optimized image resizing using piecewise seam carving which preserves ROIs of low energy and reduces shape distortions. It takes advantage of parallel algorithms to improve speed which is further optimized by using a saliency map to automatically identify the ROIs and segment the image. It is hybridized with a shift map editing approach to adjust structure deformations.

3 MILESTONES

S. No.	**Milestone**	**Status**
1	Calculate weight/density/energy map	Done
2	Generate cumulative energy map using DP	Done
	Mid evaluation	
3	Remove low energy seams	Done
4	Generate the final resized image	Done
	Final evaluation	

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4 APPROACH

Liquid re-scaling or content-aware resizing is to remove parts of the image having the least importance. Important parts are associated with rapid changes of pixel values (intensity, gradients, etc.). An intuitive way to think of it, a object in an image would contain lot more detailing than plain background. There will be rapid changes in pixel values on and near the object.
We will use the energy function given in [1] to calculate important parts in the image. The parts with high energy being most important. To calculate the energy map of the image we first calculate gradients in x and y directions by applying Sobel filters -

$$G_x = \begin{bmatrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{bmatrix} * I \qquad G_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ +1 & +2 & +1 \end{bmatrix} * I$$

Energy (Gradiant) G is taken as combining both Gx and Gy as -

$$G = \sqrt{G_x^2 + G_y^2}$$

After energy values are calculated for each pixel, we now need to obtain the cumulative energy values. We use dynamic programming to speed up the computation. Starting from the top of the image, the cumulative minimum energy of pixel(i, j), denoted by M(i, j) can be calculated as -

$$M(i, j) = G(i, j) + min\{M(i-1, j-1), M(i-1, j), M(i-1, j+1)\}$$

where G(i, j) is energy of pixel(i, j).
Now to generate seam, we start iterating from the ***bottom*** of the cumulative energy map and choose the pixel with minimum energy value. The next "step" forward, if we are at pixel(i, j) would be choosing the pixel with the minimum energy among pixel(i-1, j-1), pixel(i-1, j) and pixel(i-1, j+1). This generates a connected line (seam) of pixels with minimum energy. Finally we remove the pixels lying on this seam to obtain image with width reduced by 1 pixel. Basically, we find the pixel lying on the seam at every row, remove this pixel and join the left and right parts of the image. To reduce the width of the image by n pixels we apply the algorithm n times. Note that this process was for reducing the width of the image, same process can be applied for reducing the height.

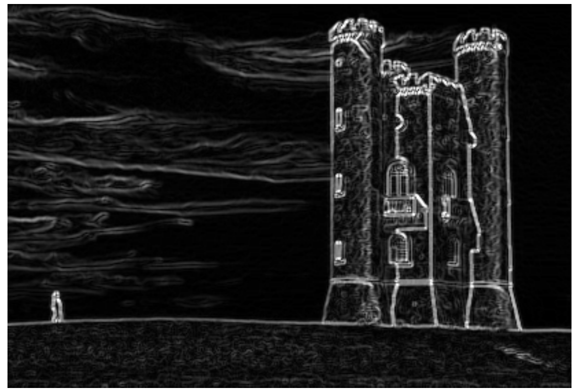
5 RESULTS

The algorithm of Seam Carving is visualized in Fig. 1, shows all the intermediate steps. Starting from an image (Fig. 1 (a)), we apply Gaussian blur on the image to reduce noise. We then convert the image to gray scale and apply Sobel operator for edge detection (Fig. 1 (b)). Next we compute the Cumulative Energy Map (Fig. 1 (d)) using dynamic programming. Using this cumulative energy map we generate seam path (Fig. 1 (c)). The white parts in the cumulative energy map are important parts. We generate optimal seam path using this map (Fig. 1 (e)) and remove this from image. The resulting image obtained, has width reduced by 150 pixels, in other words, 150 optimally generated seams were removed.

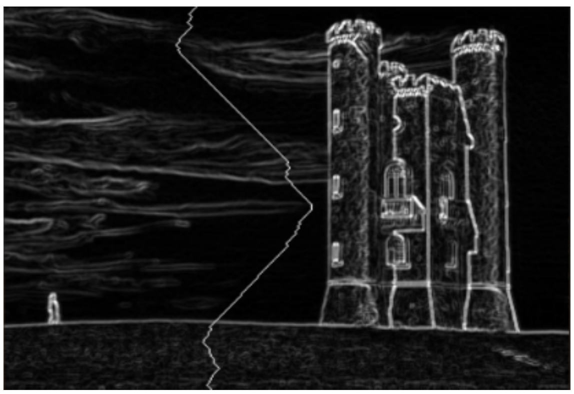
6 CONCLUSION

We implemented Liquid Re-scaling of images using very popular computer vision library, OpenCV. OpenCV in python is fairly easy to use and debug, however, in C++, the installation and configuration was very complex. Adding to this complexity, debugging using usual debuggers was not possible, also C++ compiler doesn't escalate

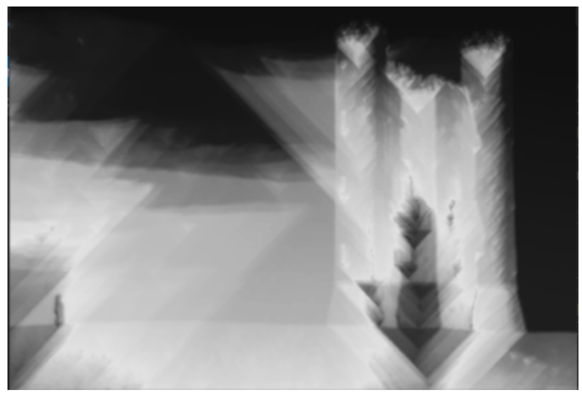
(a) Original Image



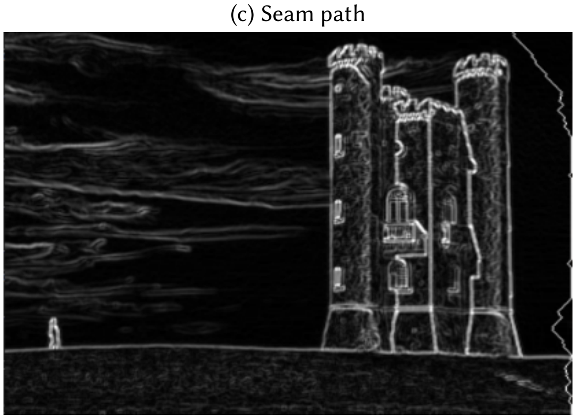
(b) Energy Map



(c) Seam path



(d) Cumulative Energy Map



(e) Optimal Seam Path

(f) Result

Fig. 1. The process of seam carving starting from an image, to obtaining the final resized image showing all the intermediate steps involved. Final image was produced after removal of 150 optimal seams

in which line the error has occurred. I had to manually using print statements for debugging purposes.
One limitation of the approach might be, if the background is also very detailed, it could happen that the implementation removes seams containing the important objects, thereby. distorting it. In such cases, we could combine seam carving with other techniques like face-detection if the object of significance is human, or artificial intelligence.

REFERENCES

[1] Shai Avidan and Ariel Shamir. 2007. Seam carving for content-aware image resizing. In *ACM SIGGRAPH 2007 papers*. 10–es.

[2] Wenjun Lu and Min Wu. 2011. Seam carving estimation using forensic hash. In *Proceedings of the thirteenth ACM multimedia workshop on multimedia and security*. 9–14.

[3] Michael Rubinstein, Ariel Shamir, and Shai Avidan. 2008. Improved seam carving for video retargeting. *ACM transactions on graphics (TOG)* 27, 3 (2008), 1–9.

[4] Anindya Sarkar, Lakshmanan Nataraj, and Bangalore S Manjunath. 2009. Detection of seam carving and localization of seam insertions in digital images. In *Proceedings of the 11th ACM workshop on Multimedia and security*. 107–116.

[5] GR Sheng, TG Gao, L Fan, L Gao, FS Yang, and S Zhang. 2014. Seam-carving forgery detection based on expanded Markov features. *Journal on Communications* 35, 6 (2014), 39–46.

[6] K. Thilagam and S. Karthikeyan. 2012. Article: Optimized Image Resizing using Piecewise Seam Carving. *International Journal of Computer Applications* 42, 14 (March 2012), 24–30. Full text available.