Analysis of Content Aware Image Retargeting Technique

Sahil Sharma
Research Scholar
Amity University, Haryana

ABSTRACT
Nowadays, images are being viewed on the slimmest and the smallest display devices which is a challenge for various image resizing techniques and algorithms. Traditional methods have been used to change the height and width of the image which are ignorant to the content of the image. Effective resizing of images should focus on image content more than anything else. A manageable technique called seam carving is used for image and video retargeting. Seam carving is therefore used in the reduction or expansion of the height and width ratio known as the aspect ratio. The most important objects in an image are conserved and the inessential objects are edited by placing seams across, which remove the pixels of that object and hence reduce the size of the image. This method can be used for object removal, image enhancement, reducing the size of image, expanding or enlarging the size of image. This article looks upon the basics of seam carving, its types, its basic algorithm, problems in object exclusion and reduction in size of different images.

General Terms
Image resizing, retargeting, aspect ratio

Keywords
Energy function, content aware image resizing, pixel, dynamic programming.

1. INTRODUCTION
Seam carving, a content-aware image retargeting technique or algorithm was developed by Ariel Shamir of Mitsubishi Electric Research Laboratory (MERL) and Shai Avidan of the interdisciplinary and MERL in the year 2007. Later solutions were given by Wolf et al [1], Simakov et al [2] and Guo et al. [3]

The display devices are usually burdened to fit images of high resolution and a content aware image resizing method is required to sort out this problem. A method is required that can resize the image by taking care of the important objects and reducing the pixels of the path having low energy function. All this can be achieved by a concept known as seam carving. Algorithms are set to choose and remove the less important objects automatically, that is, the objects with low energy function. Objects can be removed manually too. The pixels of an important object can be secured manually with an additional feature of removing the entire object from an image.

People generally go for cropping and stretching which results into undesirable losses of information. Cropping an image results into the content loss whereas stretching makes the objects look unappealing. The most beautiful image would seem unattractive by using stretching, scaling or cropping alone. To overcome this shortcoming, many approaches have strived to eliminate the unimportant information or objects from the image periphery [10][11][12][13]. Seam carving approach is hybridized with other resizing methods to efficiently use the positive aspects and effectively minimize the negative impacts of each other [4].

Researchers have proposed various approaches for image resizing and the solution for it has been contributed and calculated by human computer interaction, computer graphics and computer vision. Seam carving requires heavy calculations. It is certainly computation intensive [9]. The importance map is basically a saliency map, which tells about that region of image which produces human attention. Various saliency detection approaches are there which helps to know about the target object or the main object in the picture. A widespread saliency measure approach is proposed by [5] which tells about the low level feature of the image. Some techniques are furthermore available for evaluating saliency based on dissimilarities between neighborhoods in the image [6].

Seam carving has some limitations in object removal technique. The image may get distort when a large object is removed from the image because the seams are inserted into and excerpted from any part in the image. The major drawback of seam carving technique is that it fails to safeguard the completeness of the image [14].

Everyday researches are being made for the advancement of seam carving to gain maximum output from it. Developers always keep the image content in mind along with the geometric constraints during the polishing of the algorithm. The energy function is the facet to look for, which defines the significance of object. In simple words, higher the energy, greater is the worth of the object and vice versa.

At a high level, seam carving is an algorithm that preserves the size and shape of "important" objects, while resizing "unimportant" or less important parts of the image [8]. Seam carving has surpassed other resizing methods like scaling, cropping or stretching and with improved algorithms it might reach new heights.

Seam carving is, at heart, a pretty simple or non-complex process to resize an image arbitrarily while preserving major assets of the image [16].

We intend this review to be useful to researchers, practitioners and for everyone who is interested in image retargeting [7].

2. MAIN FEATURE OF SEAM CARVING

The main feature of seam carving is to reduce the size of image so that the image can be viewed in a smaller device. People usually come across problems when they can't fit an image in their device. For example, consider an enlarged image of the world's tallest prairie dog (Figure 1). It is definitely too large to be viewed on a cell phone. The possible techniques that are usually applied is cropping and scaling. As discussed, cropping and scaling does not give appropriate results. The technique

which we have can not only decrease pixels from our enlarged image but can remove the unwanted or undesirable objectsaswell.

Fig.1: Original image

Fig.2:Seamcarved image

This is the seam carved picture (Figure 2) of the same image. The difference is easily spotted. The most important objects of the picture have been conserved i.e the tallest prairie dog and the four people standing before it.

Pixels have been removed from the less important parts of the image and hence we have been able to reduce the size of the image. Also, in this image, pixels from the height of the image couldn't be well removed as that would affect the prairie dog which is the most important part of the image. Therefore, this is the best reduced size possible by this method.

3. TYPES OF SEAM IN SEAM CARVING

Seams consist of finding the path of minimum cost or minimum energy from one end of the image to another. The seams are placed in a connected path so that the image does not distort after deletion and the quality of the image remains the same. The seam can travel from any corner of the image to any other corner. As this can happen either vertically or horizontally seams can be classified as:-

1) **Vertical Seam**- As the name suggests, vertical seams refer to the path of pixels from top to bottom in an image.

For example: A picture of a man having a white background. To reduce the size vertical seams are inserted into the white area as it is of no importance and the size is reduced.

2) **Horizontal Seam**- When the seams are placed from left corner to the right corner the seams are termed as horizontal seams.

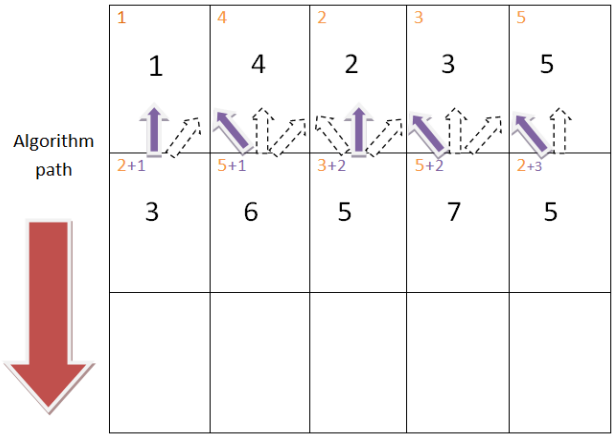
For example: Consider an image of a man having sky as the background, obviously sky is the object or part of image having less importance and is of minimum energy. To minimize the pixels in that image horizontal seams are inserted which takes off a large amount of pixels from the area where the sky is.

4. SEAM CARVING ALGORITHM

The idea is to locate the image's optimal seams, connected pixel paths going from top to bottom or left to right, also to remove or insert while preserving the photorealism of the image [15]. The concept of dynamic programming is used in seam carving. That is, to solve the entire problem by breaking down entire frame of pixels to various short frames and consider each and every pixel in an image. Every pixel is computed keeping in mind the cumulative energy of each pixel. When each and every pixel is sorted out then the minimum energy path is very easy to discover in any image. To actually remove a seam, the objective remains to create a new image of the right size and shape, and shift the pixels to the right or left of the image into place [17]. Here, let us consider the direction of the path as well as which pixels are selected to be removed.

Fig.3: Computing cumulative energies

Every single square (Figure 3) represents a separate pixel showing how the combination of energies is stored in every pixel. This rule applies for each pixel of an image when seam carving comes into play. The top left value in orange represents the energy value whereas the black part represents the cumulative sum of all the energy function in an image. The first row has no row above it hence the cumulative energy (black) is just the energy value of the pixel (orange).



The cumulative energy of pixel in the second row (Figure 4) is calculated considering the pixels of the above row. For example, looking at the first pixel in the second row we see the energy value 2(orange). Looking at the pixels above it, it has a choice to choose either 1 or 4(black). Since 1 is less than 4 or in other words it is the minimum of the values, 1 is added to the energy value of the current pixel. Similarly, in third

pixel of row two, it has a choice to choose either 4, 2 or 3. The minimum value is 2 here and is added to the energy value to find the cumulative energy of this pixel. Now, the same procedure is followed for every pixel of the image. The same steps are repeated in row 3 to get the eventual cumulative sums for seams. The seams having the minimum value are the seams with minimum energy. In row 3, the minimum value is 6 and hence that will be the lowest energy. Finally, the aim path is to trace minimum energy path. The purple arrow is followed which will lead to the minimum path which is the aim of the algorithm. Therefore, the idea of the algorithm of seam carving is to identify the path of minimal energy and delete the path using vertical seam or horizontal seam as per the demand. It reduces the size of image by removing pixels that will go unnoticed.

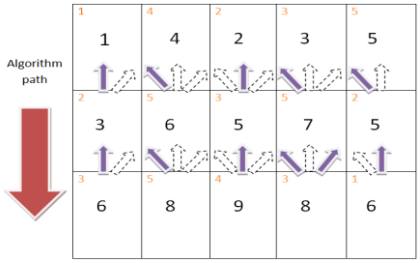


Fig.4:Minimum Energy pixels are chosen

Fig. 5: Important object is kept intact

Here, Lord Shiva (Figure 5) has been protected and seams have been inserted in the path of minimal energy or the unimportant parts to reduce pixels and eventually reduce the size.

Fig.6: Important objects are protected

The above image (Figure 6) is a typical case where not much size can be reduced as the essential components have to be conserved, that is , the title name of 'Lord Hanuman', the website name on extreme right, the two clipart on the lower left of the picture and finally the most major part of the image, the portrait of the lord. Hence there are only a few seams that can be inserted to resize it and reducing it.

5. OBJECT EXCLUSION

For removing the object from an image, the object is masked or selected and the seams related to the target object are removed completely. This object removal is done by the system or the software on its own as the system calculates the optimal seams and automatically removes it off. When the object is removed the size of the image is reduced, as the pixels have been reduced from the image. For getting back the original image or an enlarged image, seams can be inserted. Algorithms have been set where the user can choose the object to be removed manually from a particular image. The object is masked well and the user decides whether he wants to carve vertical seams or horizontal seams. Consider the following image where the task is to remove the second flower from the right.

Fig.7: The flower to be removed is masked

Fig.8: Flower removed

Here, object has been successfully removed although there is noticeable distortion.

6. LIMITATION OF SEAM CARVING

Object removal can be a pretty tough task when large objects are removed from an image. This is because both the inserted and deleted seams may collide with each other which results in unexpected results and bad way of editing an image.

Fig.9: Original Image

Fig.10: Object removal leads to distortion

In the following picture, the gardener behind the main object needs to be removed. By applying seam carving the result comes out to be unpredictable. This assures that seam carving is not dependable in this case.

7. IMAGE ENLARGEMENT

Seam carving is pretty good at enlarging the aspect ratio or the dimensions of an image. Consider the image which needs to be enlarged. For enlarging an image seams can be inserted in an image or the aspect ratio of an image is transformed.

Fig.11: Original Image

Fig.12: Enlarged Image

This is the change in the aspect ratio, that is, 16/10 of the original image which results in image enlargement.

8. CONCLUSION

As different display devices are used for displaying images in various formats such as landscape portrait etc , a mechanism is required to view these images in smaller devices like PDA's and mobile phones. Seam carving works on the pixels of the image. The image is retargeted by removing area of low energy pixels by which the aspect ratio of the image can be changed. Seam carving helps in other areas like object removal and image enlargement. Hence, nothing better than seam carving can be appointed in image resizing till date because seam carving is ideal for reducing the image size as we can modify the least noticeable pixels of the image easily. If you want to remove small objects from the background of an image, seam carving is worthy but if the object to be removed is in a complex textures it will not work well at all. Enlarging an image can also be done pretty accurately using seam carving.

A user-controlled tool can be used to protect the most important objects of an image, not allowing the pixels to be reduced on that part. As everything comes with limitations, seam carving has a few as well like seam carving doesn't work very well with high energy seams. It doesn't support well when you need to remove large objects. Therefore, seam carving is the best method in its league with a few disadvantages that can be corrected with a few more researches and algorithms. It leaves behind the conventional and outdated methods like scaling and cropping in most of the aspects.

9. FUTURE WORK

After removing seams successively, the content of the image is affected. Even the portion of the image which is protected gets influenced due to large removal of pixels. Therefore, a certain stopping criteria should be produced, which need not apply seam carving further if it ruins the image content. Seam carving algorithm will not work correctly or efficiently at all times. There is a possibility of distortion and blockiness when this algorithm is applied up to a higher extent. A limit should be set or the algorithm should be able to suggest dimensions to the user, informing that after those particular dimensions the image will distort. This will inform the user of the scope the algorithm can be applied without any problems or distortion. Multiple seams should be removed from a particular path where at times single seam pass. The images that do not contain straight lines are resized pretty well using this algorithm. However, when straight lines, regular shapes or regular patterns are encountered this is not the efficient as distortion may occur. It is also time for an advanced algorithm through which the execution time of the software should be extremely small.

10. ACKNOWLEDGMENT

I would like to put on record, my appreciation and gratitude to all those who have furnished their support and input. I have received tremendous guidance from my guide Mr. Ankit Garg, Assistant Professor, Amity University, Haryana. Without him, it wouldn't have been possible to shape this study. I would like to thank my parents and all my family members for their encouragement.

11. REFERENCES

[1]LWolf,M.GuttmannandD.CohenOr.NonHomogeneoucontnt-drivenvideo-retargeting.InProceedingsof the 11th IEEE International Conference on Computer Vision, 2007.

[2] D.Simakov, Y. Caspi, E. Shechtman and M. Irani. Summarizing visual data using bidirectional similarity. In Proceedings of CVPR,2008.

[3] Y.Guo, F. Liu, J. Shi, Z.H. Zhou and M. Gleicher. Image retargeting using meshparametrization.IEEE Transactions on Multimedia,2009. Vol. 11, No. 5.

[4] Ms. K. Thilagam, Dr. S. Karthikeyan, Optimized Image resizing using piecewise seam carving, International Journal of computer applications (0975-8887),Volume 42-No-14, March 2012.

[5] Itti, L., Koch, C., and Niebur, E., \A model of saliency-based visual attention for rapid scene analysis,"IEEE Trans. on Pattern Analysis and Machine Intelligence 20(11),1254{1259(1998).

[6] Stentiford, F., \An attention based similarity measure with application to content based information retrieval,"in [SPIE Storage andmRetrieval for Media Databases], 5021(2003).

[7] Daniel Vaquero ; Matthew Turk ; Kari Pulli ; Marius Tico and Natasha Gelfand "A survey of image retargeting techniques", Proc. SPIE 7798, Applications of Digital Image Processing XXXIII, 779814 (September 07, 2010).

[8] Bryce AebiCS129 Project #3: Seam Carving, October 7, 2012

[9] K.Thilagam,S.Karthikeyan Article:Optimized Image Resizing using Piecewise Seam Carving, Volume 42-Number 14, 2012

[10] Chen, L., Xie, X., Fan, X., Ma, W., Zhang, H., and Zhouh, H. 2003. A visual attention model for adapting

images on small displays. ACM Multimedia Systems Journal 9, 4, 353–364.

[11] Liu, H., Xie, X., Ma, W.-Y., and Zhang, H.-J. 2003. Automatic browsing of large pictures on mobile devices. In MULTIMEDIA '03: Proceedings of the eleventh ACM international conference on Multimedia, ACM, New York, NY, USA, 148–155.

[12] Suh, B., Ling, H., Bederson, B. B., and Jacobs, D. W.2003. Automatic thumbnail cropping and its effectiveness. In UIST '03: Proceedings of the 16th annual ACM symposium on User interface software and technology, ACM, New York, NY, USA, 95–104(2003).

[13] Santella, A., Agrawala, M., Decarlo, D., Salesin, D. and Cohen, M. 2006. Gaze-based interaction for semiautomatic photo cropping. In CHI '06: Proceedings of the SIGCHI conference on Human Factors in computing systems, ACM, New York, NY, USA, 771–780.

[14] Cho, T. S., Butman, M., Avidan, S., And Freeman, W.T.2008. The patch transform and its applications to image editing. In IEEE Conference on Computer Vision and Pattern Recognition 2008 (CVPR 2008)., 1–8.

[15] Seam Carving, Xiaofeng Tao(taox http://cs.brown.edu/courses/cs129/results/proj3/taox

[16] Seam Carving for Content-Aware Image Re-sizing, Ty Jones, November 14, 2014.

[17] Seam Carving for Content-Aware Image Scaling, j2kun, March 4, 2013