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Content-Aware Image Retargeting and Content Amplification Based on Seam Searching

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Abstract - *Image retargeting is an important tool in the field of image processing applications such as image editing, object removal, image enlargement and content amplification. Image retargeting aims to adapt images to displays of small sizes and different aspect ratio such that they can be viewed on mobile devices, TV, PDA and other devices with varying displays. However, the present methods with low computing ability have limitations for retargeting effectively, which narrows their applications especially on mobile devices. In this paper, a content preserving image retargeting technique has been proposed that retain the content and image structure as best as possible. The technique uses seam searching based pixel fusion which include (a) horizontal (width) retargeting, (b) vertical (height) retargeting, combination of a & b and content amplification. The procedure starts with preparation of an importance map representing the rough location of the image. Then seams are searched on the importance map for pixel grouping. Later, pixel fusion is performed based on the scaling factor. Finally content amplification is performed on the resized image. The retargeted image thus obtained gives better result when compared to the existing methods.*

Key Words:—Image retargeting (IR), seam searching, pixel fusion, scaling factor.

1. INTRODUCTION

The advancement of technology in the field of capturing and displaying digital images is very rapid. Nowadays, various types of displays, ranging from high-resolution computer monitors to low-resolution mobile devices, are used to view the images. Moreover, rapid growth of mobile devices with limited resolution is warranting improvements in image retargeting technology. In order to maintain the desirable visual quality in the various handheld devices and display panels, the appropriate image retargeting or resizing technology is the need of the hour.

Traditional automatic retargeting techniques are broadly classified into two approaches viz., brute force and content-aware retargeting. Brute force technique uses scaling and cropping whereas content aware method involves resizing of the image giving importance to the content of the image. Both these methods are pretty simple and easy to implement. However, these methods have weak performance in resizing since they only focus on the display size without considering the image content. The uniform scaling method always distorts the important regions especially when the change in the aspect ratio is large. On the other hand, the cropping method always loses important regions especially when the target size is reduced sharply. To overcome the limitation of brute force techniques, content-aware image-retargeting approaches have been proposed. These techniques used to resize the image to the display size without losing its contents. They calculate the energy of each pixel in the original image and try to reduce the information loss by retaining high energy pixels in retargeting.

The very first step in a content-aware image retargeting is to prepare an importance map or saliency map of the image. The approaches to measure image importance map can be generally classified into two types, namely bottom-up methods and top-down methods. Bottom-up methods are based on low-level features, such as color, orientation, and intensity, while top-down methods utilize semantic information, such as face and text. The saliency measure in image resizing mainly uses bottom-up methods than top-down methods. The importance map is calculated by gradient, saliency, entropy, segmentation and histogram of gradient.

The major objective of the present study is to develop a new method for content-aware image retargeting and content amplification based on seam. The specific objectives are:

- To retarget the image both horizontally and vertically based on seam searching and pixel fusion
- To amplify the important contents of the retargeted image thereby preserving the important features of the original image in the retargeted image.

This paper is organized in such a way that Section 2 contains literature survey and recent studies on image retargeting techniques, Section 3 presents a detailed description of our proposed image retargeting method, Section 4 shows the experimental results of the present study and the conclusion is presented in section 5.

2. LITERATURE SURVEY

Recently the problem of retargeting images to small screens has been the major research work considered by many researchers. The traditional cropping method is very simple and it simply crops the center of the image by using cropping rectangle. It has limitations of losing the important contents lying on the periphery of an image when the image contains multiple objects. To retain the important contents of an image, a user can directly draw a crop rectangle around them. However, it is time-consuming. An attention based image cropping method [1] selects a rectangular window with a required size from the original image. The non content part is removed and content within the window is kept. Attention based auto image cropping makes use of colour, intensity and orientation filters of the low level features and centre surround computation is performed to determine saliency. Salient regions are detected and compared small regions with others within the image.

The segmentation [2] method segments the image into many parts for extracting the most important objects. Then, background is generated by the same size of target by the technique of inpainting. Later, the segmented objects are placed on the background.

Optimal Scaling Factor Assignment for Patch wise Image Retargeting method [3] has three key areas, viz., partitioning the image into patches, assignment of the scaling factor, and a patch-based image similarity measure. First, identifies the important objects in an input image and divides the image into patches. Then scaling is done. Important objects are identified by image edges or gradients. However, they only work at pixel level and very weak to identify continuous saliency regions. The major drawback is that it produces shearing around the boundary of important and unimportant objects.

Another type of image retargeting algorithm is named seam carving [4], where a seam is defined as eight connected path of pixels (from top to bottom or left to right). One pixel in each row or column of the image contains one of the seams. The seams are identified by dynamic programming algorithm. Seam carving reduces the width or height of an image by removing the unimportant seams. Seam carving for content-aware image resizing include energy calculation, seam identification and seam removal. Seam carving produces best result in certain cases. The main drawback of seam carving is that it breaks the objects of the image. There are mainly two major factors that limit seam carving approach. If the image is too condensed, in the sense that the image contains many important areas . The second type of limitation is the image content layout ie., preventing the seams that are bypassing important parts due to the arrangement of content layout.

A Multi-Operator Image Retargeting Scheme [5]is the method which uses cropping, seam carving, adding seams and direct scaling or normalization to obtain the resultant image. The most critical step is to determine the optimal image resizing operator sequence for image resizing. By using several operators complexity is very high. Another type of image retargeting method include saliency-based mesh parametrization [6]. Here, a saliency map of the input image is generated followed by developing a mesh that associate the saliency information and thereby finding a target mesh with the desired size. The target mesh is solved by constrained stretch-based mesh parameterization scheme. The main demerit of this method is that it fails to retain the saliency and image structure information in the retargeted image, resulting the poor quality of the retargeted image. Another drawback of this method is that it fails to capture some important human bodies with various face poses or illumination and emphasis of relative scale of salient object distort its nearby objects.

In order to solve the shortcomings of the existing image retargeting methods [7], this paper proposes a new seam searching based pixel fusion image retargeting method. In addition to resizing the input image, this method has provision for content amplification on the retargeted image.

3. PROPOSED METHOD

The proposed method include (a) horizontal (width) retargeting, (b) vertical (height) retargeting, combination of a & b and content amplification. The method is performed in five stages. 1st to 4th stages are for resizing the image whereas the 5th stage is to amplify the content of the resized image. The stages are given below.

1. Generation of Saliency Map
2. Pixel grouping based on seam searching
3. Coherence filtering
4. Pixel fusion using scaling factor
5. Content amplification of the resized image

The procedure starts with the generation of an importance map or saliency map of the input image. Then all the pixels in the original image are divided into groups by using seam searching. This is followed by inter-row coherence filtering on importance. Finally, after pixel fusion with the scaling map, a width resized image can be obtained effectively. Then the above mentioned steps are repeated once again, but this time, the seams shall be selected horizontally. The resultant image will be resized both vertically and horizontally. Finally, content amplification is performed on the resized image. The same is depicted in fig 1.

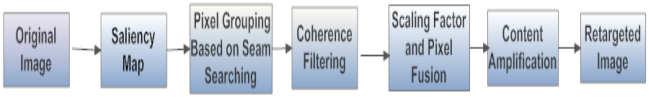

Fig 1. Flowchart of proposed method.

Generation of a saliency map is the most important and primary step in the image retargeting. The concept of saliency map is used to model the human attention. In the image saliency detection, bottom-up model is more common than top-down model. The most standard model is the Itti's model as shown in Fig 2. Based on human visual properties, Itti's algorithm [8] uses Gaussian Pyramid to conduct non-uniform sampling and generates 9-scale images. Then computes the color, luminance and the orientation of this 9 scale maps. Finally, saliency maps according to the center-surround differences is obtained. The saliency measure is accomplished by mapping each pixel of an image to the interval [0, 1], where '1' represents the most important region.

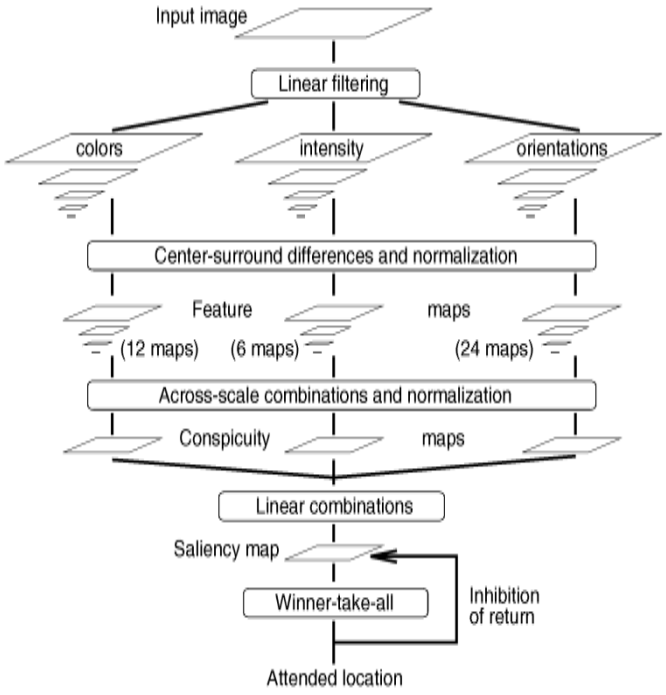

Fig 2. Itti's approach for saliency map.

The Pixel Grouping stage is more time consuming as it is based on seam searching. The seam carving method is used to change the size of the image by modifying the least important pixels in an image by deleting the pixel. In seam searching[9], none of the pixels are deleted. Here, each pixel in each seam will be assigned an ID as i, which can be denoted as Pi(x,y). Then, except for the pixels in seams, each remaining pixel in every row and column will assigned an ID sequentially from left to right and top to bottom. In this way, every pixel in the same group of rows and columns of the original image I(x, y) is assigned a unique ID.

Coherence filtering [10] is done for reducing image noise without removing significant parts of the image content, such as edges and lines. Coherence filtering plays a major role in maintaining the spatial coherence of the retargeted image. The pixel fusion stage is based on the scaling factors. Scaling factor is used to resize the image, that are allocated to each pixel to indicate its resizing degree. An image is made up of large number of pixels. Each pixel is treated as an individual basic unit whose width and height are horizontally and vertically scaled from its original size, which is considered as 1, to the scaling factor value, which is a non negative fractional number. As a result, the sum of the scaling factors in every row and column will be the target size of the image.

Pixel fusion is the process of combining the pixel information in an image. The resulting resized image will be more suitable for display devices than the original image. Pixel Fusion is performed after obtaining the scaling map for each group. Here, the image is resized horizontally and vertically. As a result the width and height of each pixel will be scaled from unity to a fractional number according to the scaling factor of the pixel. Then, the linear combination of pixels, weighted by their width and height, composes the resized pixels. The method of pixel fusion reconstructs the resized pixels from the combination of original pixels instead of certain pixels from the original image. This makes the resized image much smoother.

The resized image is finally subjected to Content Amplification. A combination of seam carving and scaling is used to amplify the image content while preserving its size. This retains the image content as much as possible. The first step is scaling of the entire image in which both the content and non-content areas are subjected to scaling. In the next step Seam Carving is done to shrink the scaled image and to carve the non-content parts of the image.

4. EXPERIMENTAL RESULTS

The proposed method was implemented in MATLAB. The result of the study is depicted in fig. 3. It shows the saliency map of the input image, pixel grouping based on seam searching, coherence filtering and assignment of scaling factor in the input image. The results in fig 3 also shows the state of the image after pixel fusion in which the image was reduced in horizontal direction, vertical direction and a combination of both vertical and horizontal direction.

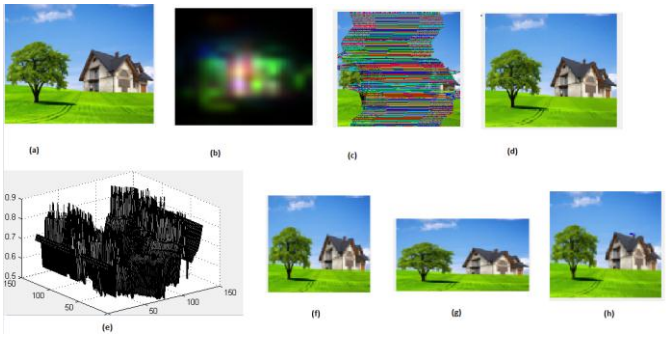

Fig 3. working steps of proposed method. (a) Original Image (b) Saliency map (c) Pixel grouping based on seam searching (d) Coherence filter (e) Assignment of scaling factor. After pixel fusion

image is reduced in (f) horizontal direction (g) vertical direction and (h)Combination of both vertical and horizontal direction.

The retargeted image resulted as above was then subjected to content amplification. This was also done with the help of MATLAB. The result of the same is shown in fig. 4. It shows the final image in which a combination of seam carving and scaling amplifies the content of the original image.

(a) (b)

Fig 4. Content Amplification.
(a) Original image and (b) Amplified image.

When compared to the existing state of the art methods of image retargeting, the present method was found effective and better performing as it is having minimal information loss at the same time preserving the structure, content and composition of the image.

5.CONCLUSION

The proposed method for image retargeting by the present study produced better results compared to common retargeting schemes found in literature. The method developed by this study not only resizing the image horizontally and vertically, but also amplifies the important features of the image. Here, the images with saliency were retargeted by seam searching instead of seam carving. This ensures minimal information loss in the resized image. In addition to this, the content amplification in the resized image highlights the important features of the image.

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