LITERATURE REVIEW ON IMAGE RETARGETING

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Abstract : Image retargeting is a key technique in image processing for displaying images on various display devices of different sizes. This area becomes attracted in past few years. The key requirement for image retargeting is to preserve the object in the image and minimize the visual distortion. To achieve this goal various image retargeting methods such as scaling, cropping, seam carving, warping and multi-operator are developed. In this paper we are reviewing these methods and tries to understand each methods and reveals its challenges. We also focus on saliency based method and segmentation based method to evaluate the performance base on the quality of image retargeting. Furthermore, we believe that this review can help the researchers to solve the existing limitations and introduce new idea to make an efficient content aware retargeting method

Index Terms **– Image-Retargeting, Content-Aware-Retargeting, Seam-Carving, Warping, Multi-operator**

I. INTRODUCTION

Image retargeting is a technique that adjusts the images into different form factors based on the size of the displaying devices and simultaneously preserve salient features of the image. The basic idea behind the technique is to identify the important features in the image, then expand or shrink the image using less important regions in the image.. Due to the importance and broad applications of the image retargeting techniques this area become attractive.

For retargeting the images traditional methods are used commonly, these methods are scaling and cropping. These methods are easy to implement, however they have some limitations. For example, scaling distorts the important areas especially when the aspect ratio is large. On the other hand, cropping method losses some region especially when the size is reduced. Thus both these solutions are not suitable for display devices of different sizes. This give content aware methods more attention.

Traditional scaling [1] and cropping [2] [3] sometimes don't produce an efficient result. Safin [1] proposes a scaling method by using high boost filter. Similarly to make cropping efficiently Santella [2] and Seltur [3] proposed a retargeting method which gives importance to region of interest for an efficient result. However, these methods have certain limitation. Thus lots of works have been carried out in this retargeting process. Thus, retargeting methods can be classified into four categories traditional, content-aware, saliency based and segmentation based approaches. The traditional methods are simple however it doesn't give much importance to the objects in image and it includes scaling and cropping. Content aware methods give importance to the objects in the image. It includes seam-carving warping and multi-operators. To make seam- carving more efficient Shafieyan et al. [4] proposes an improved seam carving algorithm on energy map. While, Thilagm [5] proposes an piece wise seam carving for improved result. Wang et al. [6] and Jin et al. [7] propose a warping method for an optimal result. Zhang et al. [8] and Fang et al. [9] proposes multi-opertor method to get efficient results. Saliency map gives the region in the image which gives more visual attention. Jaiswal et al. [10] and Abaydev et al. [11] propose a saliency based method for image retargeting. Thus, these methods help to identify the important objects, reduce the distortion and also ensure image quality. Segmentation based method ensures more image quality than other method since each segment get retargeted efficiently. This method is little complex but the resultant image have some quality. Liang et al. [13] and Lee et al. [14] propose a segmentation based method. These methods utilize the structural as well as semantic information for better optimized result.

The goal of this review is to describe the basic problem of image retargeting and a detailed study of different techniques such as scaling, cropping, seam carving, warping and multi-operator. Here, we discuss some method to improve the efficiency of these methods and also give importance to the objects in the image. For this we focus on saliency based and segmentation based image retargeting methods.

Rest of the paper is organized as follows section II describes the various image retargeting methods and section III draws our conclusion of this review

II. IMAGE RETARGETING METHODS

The retargeted methods can be classified into four categories based on the quality of resized image. They are traditional, content-aware, saliency based and segmentation based approaches. The traditional methods are simple however it doesn't give much importance to the objects in image. This method includes scaling and cropping. Content aware methods give importance to the

objects in the image. It includes seam-carving warping and multi-operators. Saliency map [10] gives the area in the image which gives more visual attention.. Thus, this method helps to identify the important objects, reduce the distortion and also ensures image quality. Segmentation based method [14] ensures more image quality than other method since each segment get retargeted. This method is little complex but the resultant image have some quality.

2.1 Traditional Methods

The traditional methods are popular due to its simplicity however; it doesn't give much importance to the objects in image. This method includes scaling and cropping.

2.1.1 Scaling

Scaling refers to the technique to enlarge or reduce the physical size of an image by changing the number of pixels. It is the simplest retargeting method. This method fails if we are giving more importance to the contents since, the output of scaling removes important objects too. Scaling has some advantages due to its simplicity. In scaling a homogeneous map exists between pixels of the original image and pixels of the targeted image. Interpolation is the most common approach in scaling. By using these interpolation technique scaling can preserve some important objects in the image. But in some cases it brings artifacts such as aliasing and artificial blocking. The different interpolation techniques are bi-linear interpolation, nearest neighbor interpolation, bi-cubic interpolation etc. Due to information loss research works based on scaling gives importance to the ROI by using some new interpolation techniques however the research works based on scaling are less compared to other methods.

Safinaz [1] proposes a retargeting method based on scaling using high boost filter (HBF). This is a non- adaptive image interpolation algorithm to scale image in any scaling size and it also ensures the image quality metric of the output image. In this method, two reference images are generated i.e., high resolution and low resolution from the original image and a scaling factor obtained using Lancoz3 resampling method. High resolution image is obtained by increasing the scaling factor twice and low resolution image is obtained by reducing the scaling factor of its half. These reference images are used for linear interpolated to scale the output image using interpolation equation. The last stage of this method involves a high boost filter. This HBF ensures the quality of scaled images. The scaled image obtained from the interpolation is then passed through the enhancement phase HBF which helps to obtain final scaled image. The resultant image is compared with other scaling methods in terms of image quality metrics.

2.1.2 Cropping

Cropping is the one of the important image retargeting technique to obtain an optimal image by removing unwanted areas from the image, and thus improves the presentation of visual elements in an image. Cropping uses a rectangular window with a desired size. The content within the window is saved and others are removed. In most cases this cropping window is placed in the center of the image and crops the image. Thus sometimes may loss important objects from the image. But due to its simplicity more research work based on cropping is carried out by giving more attention to ROI.

Santella et al.[2] proposes a method in which image content has given importance than cropping. This approach removes important content less often than automatic cropping. This method is beneficial for manually interactive and full volume cropping. Here eye movement of the user is tracked to find the important object in the image which means user have to look to the image for few seconds to track eye movement. Computation saliency model is an interactive approach which is used to predict what people think. Gaze application is used to evaluate what the user is thinking by tracking the eye movement. This interaction can be called as an implicit attentive interface. After generating a model that explicitly represent important image content. Then selects the best crop from large set of possible crops. To select the best crop an objective function is used which assigns a score to each crop based on general rules for creating attractive crops. Fine segmentation and coarse segmentation is done to identify the important objects.

Vidya Setlur et al.[3] propose a non-photo-realistic algorithm for image retargeting particularly for small size devices such as mobile devices. Retargeting an image to small size may cause distortion however using this algorithm important objects are recognizable even if distortion occurs. In this method the input image is segmented. This segmentation helps to identify important objects easily. Here three parameters are taken into account for segmentation they are spatial radius, color radius and mean of pixels. After this step an important map is generated by combining saliency and face detection i.e., a scaled sum of visual saliency algorithm and face detection algorithm. This method also employs a semi-automatic fashion which means user can specify the ROI. If all important objects are included in specified size simply crops the image. Else remove the important objects and resultant holes are removed using background creation technique such as im-painting. This method adds pixels from the input image with some texture as input image. Then updated background is resized to desire size and ROI are pasted back onto the new background and it also ensures relative topology within the scene. If this important region is not able to fit with the new background then resize the region inversely proportional to their importance.

2.2 Content Aware Methods

Content aware methods give importance to the objects in the image. It includes seam-carving warping and multi-operators.

2.2.1 Seam Carving

Seam Carving is a simple image retargeting methods which give importance to the contents in an image. This method uses a image operator called seam. The seam should be monotonic and 8 connected path of pixels. In this method, resizing is done by removing or adding seams to the input image. The process is done repeatedly to change the aspect ratio or resize the image to new size. The optimal seam can be obtained by dynamic programming. This method is a recent image retargeting technique. However this method is time consuming and also occurs little distortion. Thus many research works are carried based on seam carving to reduce the time complexity as well as distortion.

Shafieyan et al.[4] proposes an improved seam carving algorithm on energy map. The energy map helps in identifying important objects. An edge preserving algorithm is used to prevent the passage of seams through the salient pixels. This seam algorithm produces better result by combining energy map and edge preservation algorithm. In this framework, an energy map is determined using saliency map, gradient map and depth map. Depth map gives information about object distance to the camera, this can be obtained using kinect sensor or directly by the user in the scene. Gradient map give the information about the edges of the object which helps to avoid distortion. Saliency map is obtained using color, intensity and orientation to get the noticeable region in an image. Seam selection is obtained using the equation of the seam carving and dynamic programming is performed to get the optimal seam. The seam is deleted from the input image and resized image is compared with target size. If resized is larger, the energy map is re-calculated. This process continues until the resized image attains the largest size.

Thilagm [5] proposes a retargeted method which resizes the stego images by preserving the contents using seam carving algorithm. Here the stego images are segmented applies seam carving algorithm to each segments. To overcome the limitation of stego image retargeting, proportional seam carving method is used. Here the stego images are segmented based on the extent and orientation of ROI and apply seam carving to each segments in varied proportion which helps to preserve ROI. This method is good retargeting process and preserves the ROI and also the hidden message.

2.2.2 Warping

Warping method is defined using a warping function such that it maps the position in input image to the position in the target image. This method is also content aware so it emphasis on ROI. This method is a recent technique in content aware, so many research works on these methods are carried out to make efficient result in retargeting. Sometimes inconsistent deformation may occur.

Wang et al.[6] proposes a warping method to retarget the image to desired size by preserving the objects. These techniques allow distortion to occur in a homogeneous manner, so that effects on important objects can be minimized. For this an optimal scaling factor is computed. To prevent deformation, significance map is used. Significance map can be obtained as the combination of gradient and salience map which helps to denote the important objects. Then warping function is used to add a mesh to the image which satisfies the new boundary and check whether the quad deformation matches the local scaling factor. If it doesn't match the process continues until an optimized scale image is formed. This method can also be used in video retargeting. This method is good to preserve the objects in the image since distortion occurs uniformly but sometimes it may introduce some discontinuities.

Jin et al.[7] proposes a novel method to retarget an image which give importance to the contents. Here retargeting is performed by warping a triangular mesh over the image which helps to extract the image saliency as well as the image features. By solving the sparse linear system, warped triangular mesh and also the horizontal and vertical scale of the triangle can be obtained. This system is useful for real time image resizing. For this first step is the creation of triangular of the input image by including image features which is generally used in content aware methods. This triangular mesh can capture visual saliency and the features of the input image. After that a non-homogeneous scaling is performed to warp the triangular mesh. This method preserves every small feature so that it can carve efficiently. But these triangular mesh have the problem of inconsistency.

2.2.3 Multi-Operator

Till now no single operator gives an optimal result, thus some researchers proposes a multi operator method such that the advantages of each operator is taken and disadvantages are discarded. Many research works are carried out to make an optimal result. The main limitation with this method is its time consumption. Thus works have to be carried to reduce the time consumption.

Zhang et al.[8] proposes a hybrid use of seam carving and scaling. The main difference from other multi-operator which depends upon heuristic criteria to determine the switching, this method solves it dynamically by closed form optimization. This optimization determines no of seam operation have to be performed. Here importance map is generated which determines the switching point optimization. The importance map is generated by combining gradient map, saliency map and canny edge map. This importance map is more effective in preserving the prominent regions of the image. This method switches to scaling if the average energy pixel on minimum energy seam is above threshold. This process is carried out such that seam carving is followed by a uniform scaling.

Fang et al.[9] proposes a multi-operator retargeting algorithm using 4 operators such as scaling, cropping, seam carving and warping. The structural similarity determines which operator should be used at each iteration, Scale invariant feature transform flow is used for the dense correspondence of input image and retargeted image. In this framework the operator is used iteratively, and the selection of each operator is done dynamically from the candidate operators. This framework search for the best operator in each iteration. Thus this retargeting task is divided into subtask in which each operator is assigned to each operator which makes a small

change in aspect ratio. Perceptual similarity picks the best operator from the iteration i.e., in the nth iteration. The iteration continues until target size is obtained.

2.3 Saliency Based Methods

Saliency measure is a vital step for resizing in order to preserve the salient region of the image during image resizing. The saliency map defines the region which gives more human attention. This is an important research area in computer vision. To measure saliency, there are 2 methods they are top-down approach and bottom-up approach. Bottom-up approach is based on color, intensity, orientation while top-down approach includes face and text. In most cases of resizing, to reduce the complexity bottom-up approaches are preferred.

Jaiswal et al.[10] proposes a saliency based method for image retargeting using the operator cropping. The saliency map is created by considering the color, intensity and orientation. Here the generation of saliency map is taken place in three steps. The first step is the extraction of feature vector at the location. Then using this feature vectors the maps are activated. Finally normalize the activation map. These three steps are combined for the generation of the saliency map. The otsu threshold is applied to separate high intensity cluster of saliency map. After thresholding the resultant binary image has highest intensity for prominent region and low intensity for background or un-important regions. The otsu threshold helps to calculate the threshold value and segment the image into back and white or foreground and background. Then cropping can apply to the resultant binary image either in vertical or horizontal profiles. If background or un-important region is higher in the input image, then it is not an optimal cropping. Then perform the steps iteratively until two consecutive results are obtained.

Abaydev et al.[11] proposes a retargeting method based saliency which include facial photographic image. For this an architecture called CRIST (content re-targeting image seam carving technique) is developed. Since this method uses seam carving, first step is the calculation of energy of each pixel. Here saliency detection is a part of segmentation. The saliency map of the input image is formed by considering depth and color of the image. By using saliency map, this method can extract the foreground objects. Next step is the generation of significance map of input image. Significance map is the combination of preprocessing ROA extraction. Here 9 features are extracted and are used for the generation of significance map. Final step is to apply seam carving algorithm in both direction. The process continues until the desired output is obtained.

Papadopoulus et al.[12] an efficient image resizing method for linear deformation. This method enhances prominent region based on underling hierarchical significance map. This method can distribute the distortion to the region of low significance, while important neighboring region are homogeneously resized. But sometimes it suffers from inconsistent scaling and deformation. In this method, significance map generation is the first step, ie. by combining saliency map and gradient map. Then multiple grids of different resolutions of the significance map is considered to generate hierarchical significance map. The advantage of hierarchical significance map is that low resolution layer gives larger significant region while higher resolution gives smaller significant objects. After the generation of hierarchical significance map, apply warping method for image resizing.

2.4 Segmentation Based Methods

Segmentation is the decomposition of the image into several segments. This method ensures more image quality than other method since each segment gets retargeted. It is little complex but the resultant image have some quality.

Liang et al.[13] presents a resizing method by patch-wise deformation of the input image using different scaling factor. in this method the input image is segmented into small patches and compute the most suitable scaling factor for each patch such that important objects are preserved. First step is the generation of importance map to identify important area. Here importance map is the combination of image edge and saliency measure. Then segmentation of the input image is done based on the importance map. Each map area are covered using a rectangle. Thus it is able to assign scaling factor for each small rectangle patch. Image distance measure is used for the computation of the scaling factor. After assigning the scaling factor to each patch shrink or enlarge using interpolation method. Thus important area is proportionally deformed. And the final out image has the most suitable scaling factor for each patch which is obtained using minimizing the image distance.

Lee et al. [14] proposed a method based on segmentation sing the image retargeting operator warping. The main steps in this method are image preprocessing and warping. In image preprocessing segmentation using graph based method is the first step. Merge process is used to avoid segmentation. merging occurs when no of pixels of the patch is smaller than the defined threshold. It is based on the average color assignment to each patch. After segmentation, saliency detection is performed to generate significance map. Each segment has a significance value, which is obtained by taking the average of the pixels in the patches. The patches with high significance value undergo deformation. The result produced from this method is similar to those generated by linear scaling.

Zhang et al.[15] proposes a method to improve a retargeting quality and to reduce complexity. To do so, a patch-wise method is introduced to generate sparse image grid based on visual saliency and gradient magnitude. the quad grids are placed onto the image and then deformation is optimized using energy minimization problem. The first step is the generation of importance map by combining saliency and gradient map. Then segmentation is applied. For this, first locate important objects. Pixels whose importance value larger than a threshold is considered important. These grids serve as a quad for optimization deformation using the image retargeting operator warping

III. CONCLUSION

This paper review different image retargeting techniques. And identify the problems in these methods. The key problem is the distortion of the objects in the image and information loss. The traditional methods are easy to implement. It is a good option when contents are not considered. The content aware methods give importance to the ROI of the image. These method are complex in nature but it resolves all retargeting problem to an extent. The saliency based and segmentation based methods can be incorporated with content aware methods to overcome these challenges. Thus images with a more semantic, complex structure and different topology relationship could be researched to retain their important contents and prevent deformation during the retargeting process. Recently, image retargeting criteria are generally subjective. Thus more objective criteria should be considered for the evaluation of retargeting quality.

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