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Article

Content-Aware Image Seam Carving Technique for Object Resizing

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Abstract

Image re-targeting is one of the most popular multimedia contents and manipulation techniques in the digitalized world. Seam carving is used for image retargeting processes. Seams are successfully related or repeated pixels along rows or columns of an image which never impact on an object when removed or resized. The proposed research focus on preserving the objects and its saliency, which includes a facial photographic image, is significant objects in an image and shadows using CRIST (Content Retargeting and Image Seam Carving Techniques). The Image retargeting focuses on image resizing by preserving the quality of actual image objects. The experiment result of proposed system outperforms the rest of the real state of art image retargeting technique. The accuracy is calculated based on resolution and Mean Opinion Score (MOS).

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1. Introduction

The growth of the digital media technology is increasing very festally, a variety of displays devices of various resolutions and sizes such as laptop computer, mobile phones, cameras and televisions have appeared within the recent years [1]. Images and videos have to typically change in size and ratio to completely adapt to different screens ranging from high-resolution laptop monitors to low-resolution mobile devices. For this reason, image retargeting has become a hot topic in the image mining area. Traditional image retargeting process like cropping and undiversified scaling usually cannot end in the satisfactory image result [1]. These methods are not considering the content of the image. Cropping will shield a locality of an image as well as lead to the loss of the different components which can embody valuable data. Undiversified scaling will be successful to retain all the information within the image [1], however, it will cause visual distortions. To address these issues, several content-aware retargeting methods are projected. Many of the researchers are adopting Seam Carving Techniques.

The detection of interesting or salient areas in a picture is critical, and is a part of a PC vision research. A substantial body of labour in graphics focuses on making additional compelling images, and also the human-computer interaction community has an interest in exploring new kinds of interaction for retargeting images, as well as evaluating the effectiveness of retargeting algorithms in different tasks [1],[2].

2. Related Works

The digital image mining and processing started in the year 1920 for sending newspaper picture work tasks. Digital images were displayed in different PDA applications as a diverse variety of image resolutions. The resolution variations will affect the appearance of images in PDA devices.

Numerous content-aware image retargeting techniques have recently been proposed. Cropping has been widely used to eliminate useless information from the image periphery or to improve the overall composition [3], [4], [5]. Seam carving methods iteratively remove a seam in the input image to preserve visually salient contents [1]. Multi-operator algorithms combine seam carving, homogeneous scaling and cropping to optimally resize images [6]. Real-world images usually contain vivid contents and rich textural details for retargeting, they design a new framework based on content-aware synthesis to enhance content-aware image retargeting. Image Retargeting Quality Assessment, a Study of Subjective Scores and Objective Metrics, presents the result of a recent large-scale subjective study of image retargeting quality on a collection of images generated by several representative image retargeting methods [7]. In Perceptual Relevance Based Image Retargeting, two map based retargeting techniques are used; Density map and Region of interest. These techniques compare with benchmark conditions [8]. Some images contain different types of objects in that Yan et.al proposed canny edge detector and Bi-directional seam operations for identifying the region of interest and region of Unimportant [2]. An image is divided into two parts; Real-time image with high dynamic range (HDR) region and Low dynamic range (LDR) region in the presented paper, efficient image retargeting for high dynamic range scenes [9].

An adaptive seam carving algorithm was used for seam carving. This algorithm has taken some feathers for seam carving and detect Gradient magnitude, Saliency, Edge, Face, and Straight lines [10]. 2D images are also used for seam carving [11] [12]. Seam insertion and removal can be done by using reverse seam carving. Reduction, expansion and Forward energy operation are occurring throughout the process [13]. An image may define as a two-dimensional function, f(x, y), where x and y are spatial (plane) coordinates, and the amplitude of any pair of coordinates (x,y) is called the intensity or gray level of the image at that point [1],[13].

3. System Architecture

The system architecture consists of a college of algorithms called CRIST (Content Retargeting and Image Seam Carving Techniques) to focus on preserving the objects and their saliency, which includes a Facial photographic image i.e. significant Objects in images and shadows. The proposed system, having three types of inputs,

bald a person's image. Images contain big objects and last shadows.

A bald person image is taken for resizing the existing systems to produce a wrong result by changing the shape of the head and also the person's round face, losing the face identity. Some images contain two or three big objects. After retargeting operations, the output result looks like cropping and scaling. All the existing resizing does not consider the shadows in the resizing images.

All the three different objective outputs are compared with the height and width parameter, and the result shows that "CRIST" is better than all the other octal retargeting methods. A retargeting image quality evaluation survey was conducted by Mean Opinion Score (MOS) with the help of expert persons.

3.1. Image Retargeting (Resizing)

A common solution to image retargeting is to uniformly rescale the original image according to the target screen size [3].Image retargeting is often mistaken for image cropping and scaling[14]. Epitome (Joji et all) method is a little method of retargeting process. The cropping deals with removing positions of the image with or without considering the important parts of an image, increasing or decreasing the size of objects in an image which may tend to lose its visual originality. The retargeting focuses on resizing the image by preserving the quality of the output result as its original image. The entire process is also termed as seam carving. It is the methodology of dividing images into vertical or horizontal seams. The seams can be represented as single linear thread portions of image containing pixels with unique identity, colour and relationship.Seam carving applications include increasing the size of an image, changing the size of an image in two dimensions and even object [15], and the removal reducing of an image means by removing pixels that will go unnoticed [16]. The Seams can be either vertical or horizontal [17]. A vertical seam is a path of 8 connected pixels from top to bottom, in an image with one pixel in each row. A horizontal seam is similar, except the connection being from left to right [15]. The importance energy function values a pixel by measuring its contrast with its neighbour pixels. Seam carving is a process of modifying the least low energy peals in an image[18]. The typical application of image seam carving is the resizing of an image along its on dimension [19]. This can be done by finding one pixel wide paths from the top to the bottom of the image and removing those paths. If the pixels in those paths are similar to the surrounding pixels, then their removal may be unnoticed.

Let I be an m*n image, then

The vertical seam is defined as

It is an eight connected path of pixels in an N x M image from top to bottom, containing one and only one pixel in each row of in the image [1], [11].

$$s^y = \left\{s_i^x\right\}_{i=1}^{N} = \left\{\left(x(i), i\right)\right\}_{i=1}^{N}, s.t. \forall i, \left|x(i) - x(i-1)\right| \le 1$$

Where x is a mapping x: [1...N] [1...M]. (1)

The horizontal seam can be defined as [1]

$$s^y = \left\{s_i^y\right\}_{j=1}^{M} = \left\{\left(x(i), i\right)\right\}_{j=1}^{M}, s.t. \forall j, \left|y(j) - y(j-1)\right| \le 1$$

Where x is a mapping x: [1...N] [1...M]. (2)

It is an eight-connected path of pixels in an N x M image from left to right, containing one and only one pixel in each column of in the image[11]. The energy of every pixel is measured vertical and horizontal direction [1]. Then the energy operates to reason the energy of each pixel within the image is outlined as:

$$e(I(x,y)) = \sqrt{\left|\frac{\partial}{\partial x} I(x,y)\right|^2 + \left|\frac{\partial}{\partial y} I(x,y)\right|^2} \quad (3)$$

The energy map of the image then may be computed using this energy perform [1]. The seam energy is going to be the total of the energy of pixels constituting the seam.

A cumulative energy cost for the three possible connected vertical seams at each entry M (i, j) can be calculated as follows:

$$M(i,j) = E(i,j) + \min\{M(i-1, j-1), M(i-1, j), M(i-1, j+1)\} \quad (4)$$

Where M (i ,j) is the accumulative energy at the current pixel, energy to each pixel in an image, the energy calculation is based on the sum of X

and Y derivatives of each pixel points [4],[20]. The derivatives are calculated taking the finite divided difference between the pixel and the neighbour.

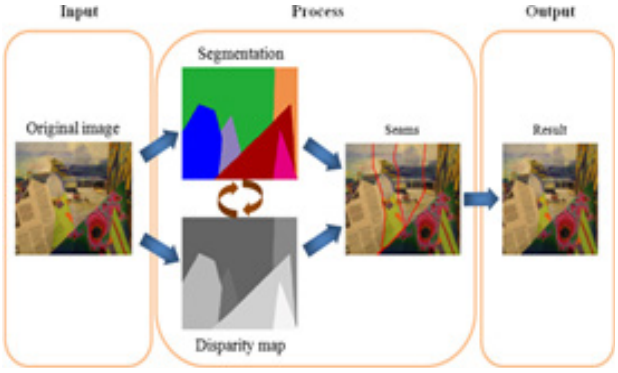

Figure 1 is taken from Dawei Lu, Huadong Ma; Liang Liu, ‚Journal of electronic imaging, and is on visually preserving stereoscopic image retargeting using depth carving April 28,2016, 25(2).

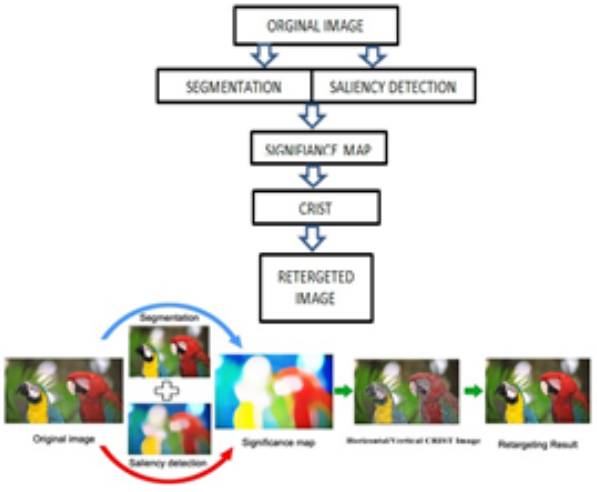

Figure 2: Framework of proposed method

Traditional algorithms work on single criteria and they are focused on expected results. These algorithms are applied on entire processing models with a few sub algorithms. The sub algorithms are existing algorithms without any change in any aspect, such kind of algorithms are least used in the processed models. For preserving the content of the image the entire re-targeting process is carried.

The proposed method first calculates the energy of each input image pixel using equation (3). Saliency detection is a part of segmentation. In calculating the saliency map of the input Image we consider the depth and colour of the image. I_{Col} and I_{Dep} are the two constrains for saliency S detection process. Saliency value at position x is calculated as

$S(x) = \lambda S_{Col}(x) + (1-\lambda) S_{Dep}(X)$ (5), λ is the regularization constant of $S_{Col}(x)$ and $S_{Dep}(X)$.

S is generated and used for foreground extraction. It is observed that foreground has a higher saliency value than background. With the help of saliency map, the proposed method can extract the foreground objects.

Figure 3: Example of input images and their saliency maps.

In the next stage significance map of the processed input image, we proposed a novel significance map which is a combined result of the prepossessing methods and it is a process of ROA (region of attention) extraction.

We define ROA as a rectangle R(C W H), where C denotes ROI centre, W and H are the width and height of the rectangle respectively. Concerning the saliency map and saliency point information, C position should correspond to the maxima of local saliency values. 9 feathers are extracted from the input image such as four gray value statistic feathers mean **m**, variance $\boldsymbol{\sigma^2}$ skewness s, kurtosis **k** two colour feathers. CIE lab is more suitable for image segmentation.

Third stage is the CRIST implementation stage which is a combination of algorithms. After completing all the existing prepossessing stages, we apply the seam carving horizontal equation (1) and vertical equation (2) algorithms for image resizing.

The seam path calculation was carried using the equation (4) findin the lowest energy seam in the entire processed input image and removing the entire lowest seams from the image frame, the image comes into a new size. These iterations are carried many times to get a desired image size output resolution.

4 .Models and Implementations

There are eight existing models for image retargeting Cr-manually chosen cropping windows [Manual] [21], Sv stereo video [Krahenbuhl et

al. 2009] [22], MultiOp multi operator [Rubinstein et al. 2009] [23], Sc seam carving [Avidan & Shamir, 2007] [24], Simple Scaling Operator [Cubic interpolation] [25], Sm-shift map [Pritch et al. 2009] [26], Sns-scale and streatch [Wang et al. 2008] [27], Warp Non Homogeneous Warping [Wolf et al. 2007] [28]. We introduced a new image re-targeting model called CRIST.

The proposed GUI was created in MatLab environment. MATLAB (matrix laboratory) is a numerical computing environment and fourth-generation programming language.

The GUI of proposed model having seven different functions opening; an image reset, the input image, CRIST vertical process, and CRIST horizontal process, State of art resizing function, Gradient and Energy map of input image. First we selected an input image into our GUI, then using the input image we calculated the saliency map and gradient energy in the segmentation function before seam carving. The proposed model focuses on the width and height of the processed image. Horizontal and Vertical CRIST operations are done in third and fourth stage, these stages resized output images are compared with the next stage .The fifth stage in the System model contains state of art methods. The CRIST output image is compared with eight state of art re-targeting methodologies. Finally, the Mean Opinion Score is calculated with the help of 30 expert review comments. The experiment's result shows improved retargeted results.

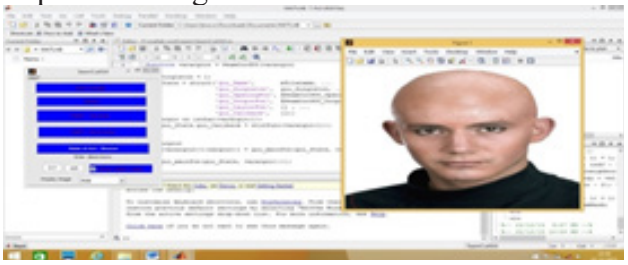

Figure 4: The Mat lab GUI of the proposed method

5. Experiment Measurements

Our proposed approach is implemented in three types of photographic image like facial image shadows, and some big objects. The experiment results show that the proposed algorithm outperforms the relevant state-of-the-arts image retargeting algorithms significantly. Eight output result Mean Opinion Score is calculated based on the state of the art retargeting methodologies.

5.1. Mean Opinion Score

In image retargeting, quality usually dictates whether an expert experience is a good or bad one [29]. Besides the qualitative description the subject expert viewer, like and comment 'quite good' or 'very bad', there is an opinion method of expressing image quality. The opinion method is called Mean Opinion Score (MOS) [29]. MOS gives a numerical indication of the perceived quality of the image after being re-targeted using different retargeted methods. In our research survey MOS is expressed in one number, from 1 to 5, 1 being the worst and 5 the best. MOS is quite subjective, as it is based on figures that result from re-targeting and what is perceived by people during their opinion. Saliency detection and segmentation processes of input images are both carried on the first stage in CRIST. Based on the energy level in the input image pixel, two types of image maps are generated; Significance map and energy map. In the last stage the horizontal and vertical CRIST algorithms are applied and the final retargeted images are obtained.

The Mean Opinion Score Values Taken in whole numbers, the numbers are quite easy to grade. It is shown in table 1. Perfect = 5,Fair. = 4,Not clear = 3,Annoying = 2,Bad = 1

ALGORITHM	RESOLUTIONS	MOS				
Men face		Bad	Annoying	Not Clear	Fair	Perfect
CR	368*387		✓			
SV	138*279				✓	
MULTIOP	368*276			✓		
SC	328*247				✓	
SSL	287*138			✓		
Shift Map	283*247				✓	
SNS	266*146		✓			
WARP	276*149			✓		
CRIST	400*400					✓

Table 1: Model of a mean opinion score calculating chart of an expert comment

$$\text{Retargeted Image Quality} = = \frac{1}{N}\sum_{i=1}^{N} xi \quad (6)$$

The perceptual quality of each image is subjectively rated by at least 30 expert computer science viewers, the mean opinion scores (MOS) were obtained. It is revealed that the subject viewers have arrived at a reasonable agreement on the perceptual quality of the retargeted image. Therefore, the MOS values obtained can be regarded as the ground truth for evaluating the quality metric (resolution) performances [30][31]. In this paper, an output performance study is conducted to as-

sess the perceptual quality of the retargeted images. The study carried over three main objectives of images (in two image resolutions) is generated by different retargeting methods. With the source image as the reference, the perceptual quality of Try objective retargeted image has been subjectively rated by at least 30 human subject expert viewers based on output image resolution scale. After processing the subjective ratings, the MOS value and the corresponding standard deviation are obtained for each image. Based on the MOS values, the output images retargeting data's are analysed from the perspectives of the retargeting resolution scale, the retargeting method, and the source image content [6]. The above figure, 3, explains the three image selected as our three objectives after implementing the CRIST algorithm. The three types of CRIST retargeted image results are better than all other state of art techniques. The study was carried over all these three images and retargeting techniques. The Mean Opinion Score value of CRIST is greater than all other state of art techniques. The algorithm focuses on the superior region of each input image and energy level as well as gradient map of retargeting input images. The systems focus mainly on the resolutions of retargeting images.

Big Objects comparisons chart			
TECHNOLOGY	**HEIGHT**	**WIDTH**	**MOS**
CRIST	400	300	80
CR	365	239	65
SV	368	300	45
SC	351	300	70
SHIFTMAP	391	285	50
WARP	290	239	55
SNS	365	186	40
SSL	333	183	60

Table 2:Compression chart of Big obect image.

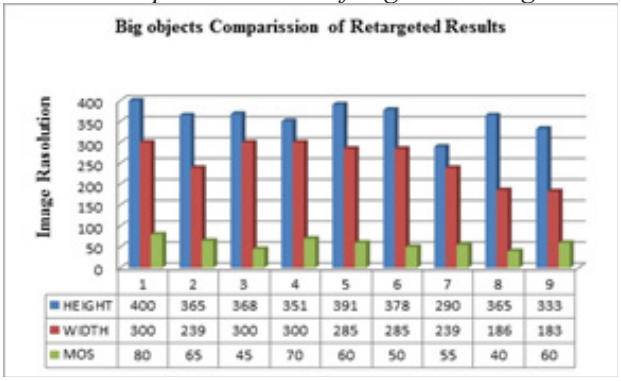

Figure 5: Bar diagram of big object compression result (Height, Width, and MOS)

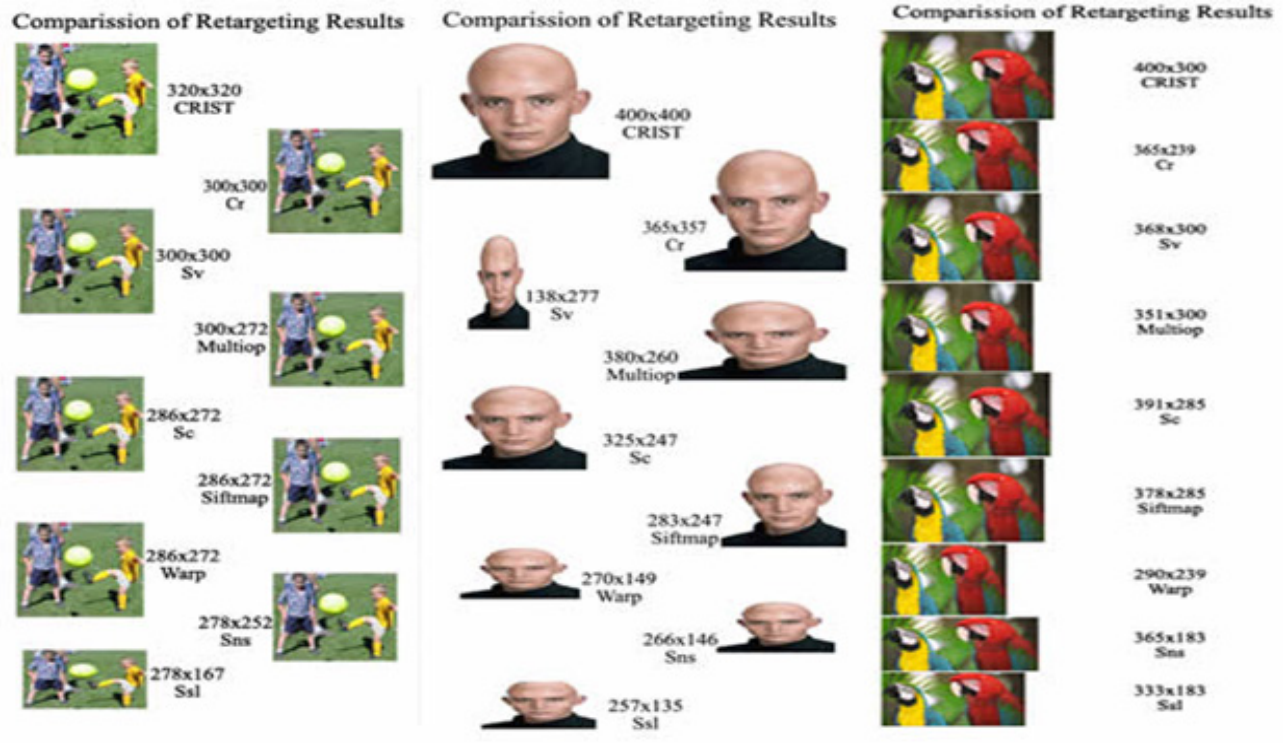

Figure 6: Result of the three input image using different retargeting methods

6. Conclusion

The proposed research focuses on tri objectives' functionalities of digital images. The output result is verified using Mean Opinion Score. Our method, Figure 6, shows three types of image (Shadows, Facial image and big objects).The method works only with a specified data set. The algorithm splits the segmentation and saliency work into different stages, combined result is significance map. CRIST carried Horizontal and vertical ways over an input image. The experimented output is compared with state of the art existing image re-targeting methods; MOS Compares the octal existing algorithms outputs, those objectives never consider the region of meaningful and resolutions of the retargeted images, whereas proposed CRIST categorize the image objects and feathers based on their importance and resolution.

7. Future Works

The future direction of our research work can be carried out by increasing the complexity of data acquisition example videos, and image sequence the CRIST can apply by enhancing the data volume for handling streaming videos. Future research can be made possible with 3D images.

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