International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 7 (2017) pp. 1324-1328

An Improved Image Resizing Approach with Protection of Main Objects

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Abstract

In this paper, we propose an improved content-aware image resizing algorithm with protection of main objects. First, we extract three feature maps, namely, saliency map, the enhanced edge map, and the object map for main objects. After that, we integrate these three feature maps to an importance map by the weighted sum. Finally, we construct the target image using the importance map. Experimental results show that our approach can successfully preserve features and generate desired results.

Keywords: image resizing; feature; saliency map; seam carving

INTRODUCTION

Numerous devices for displaying various images have been developed. To solve various aspect ratios demands, techniques for changing image size have been studied extensively.

Geometrically resizing images is a common approach for solving the screen aspect ratio problem. A minimal difference between the screen size and the image size produces optimal display. However, when the screen size is too small, the image loses some details. Selecting blocks from the image is an approach often used for image resizing. This approach provides a crucial region, but discards the rest of the image.

Several algorithms [1, 4, 7, 9, 10, 12, 13, 17] for resizing images based on image contents have been proposed. Resizing images based on image contents is a method that differs from the previous two methods. This method does not resize the image entirely. It adjusts the image size based on the image contents. In this paper, we present an improved image resizing technique with protection of main objects. We first the extract saliency map, the enhanced edge map, and the object map based on an input image and its depth map. After that, our approach constructs an importance map combining the three feature maps. Based on the importance map, the crucial regions are preserved and less important regions are discarded. Finally, the proposed approach constructs the target image based on the importance map. The results show that our approach can effectively resize images.

The remainder of this paper is organized as follows. In Section 2, we review some related works. Section 3 presents our approach. Section 4 is experimental results. Finally, conclusions are given in Section 5.

RELATED WORKS

Avidan and Shamir [1] proposed a technique for changing image size based on the image content. Their approach resizes the image width or height one pixel at a time by deleting a seam with minimal importance. They used an energy function which defines pixel importance to preserve important area.

Kim et al. [9] used the adaptive scaling function for image resizing. They utilized the importance map of the image to calculate the adaptive scaling function. This function indicates the reduction level for each row of the image. Kim et al. [10] used Fourier analysis for image resizing. After generating the gradient map, they first divided the input image into strips. Then, they compute the scaling distortion of each strip. Finally, it can resize each strip and generate the target image.

Detecting visual salient areas is a part of object detection. The conventional approach for detecting objects in an image is to set parameters and then use the training approach to determine the correct objects [3, 5, 8, 11]. However, the human eye can quickly locate common objects [14, 16].

Hwang and Chien [7] used a neural network to determine the main objects of images. They also used face recognition techniques to determine human faces within images. Rubinstein et al. [13] proposed a method to improve the procedure of seam carving. This technique utilized forward energy and backward energy to reduce discontinuity in images. Wang et al. [15] proposed an approach that utilized techniques of stereo imaging and inpainting. Their approach can fill in the missing color and depth information caused by removing foreground objects from stereo images.

Wang et al. [17] proposed a warping technique for resizing images. Using a combination of gradient and salience features, they computed an importance map for the deformation of the image. Mishiba and Yoshitome [12] proposed a warping technique for image retargeting. They found an optimal

International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 7 (2017) pp. 1324-1328

transformation by solving an energy minimization problem. It can preserve the relative arrangement and protect important regions.

THE PROPOSED APPROACH

A. Feature Maps

We first use the Kinect [18] camera to generate a color image and its depth map. The higher gray value of a pixel of the depth map represents that the pixel is father from the camera, and vice versa. Therefore, the pixels with deeper depths are farther to the human eye. They are not important areas for the human eye. In our approach, to combine with other feature maps, we compute the complement of the original depth map as the converted depth map.

Then, we generate a saliency map from the color image based on the technique of Goferman et al. [6] since it performs well for complex scenes. After that, we compute the edges of the depth map based on the Sobel edge detector. Moreover, we apply the dilation operation on the edges to obtain the enhanced edge map.

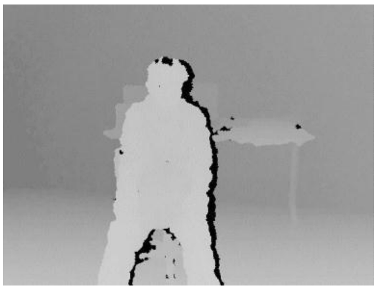
Third, we remove the background from the depth map to obtain the object map. We use a mean shift algorithm [2] to subtract the background and obtain main objects. Given a depth map, we define a window and compute the mean of pixels of the window. Then the mean shift algorithm shifts the center of the window to the mean and repeats the algorithm till it converges to a peak. The peak indicates the main object in the depth map. Hence, we can subtract the background by setting the values of the pixels whose values are smaller than the peak to 0.

Finally, the importance map is defined as a combination of the three feature maps: the saliency map, the enhanced edge map, and the object map. The importance map is defined by

$$E_{imp} = w_{so}(E_{saliency} * E_{object}) + w_e E_{edge},$$

where $E_{saliency}$ is the saliency map, E_{object} is the object map, and E_{edge} is the enhanced edge map. Moreover, w_{so} and w_e are the corresponding weights. Fig. 1 shows (a) an input image, (b) the depth map, (c) the saliency map, (d) the enhanced edge map, (e) the object map, and (f) the importance map.

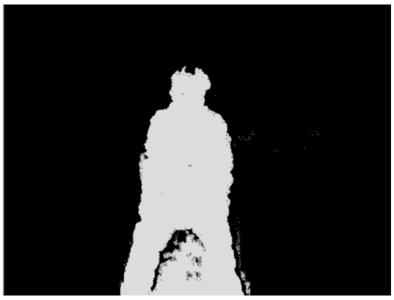
(a)



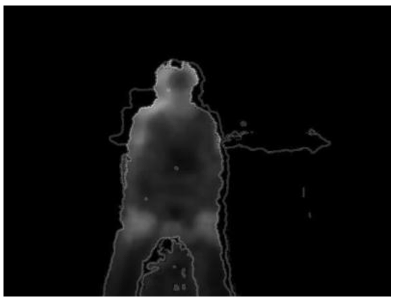
(b)

(c)

(d)



(e)



(f)

Figure 1. (a) an input image, (b) the depth map, (c) the saliency map, (d) the enhanced edge map, (e) the object map, and (f) the importance map

B. Image Resizing

The proposed approach applied the seam carving [1] for image resizing. When computing a vertical seam of lowest energy, for each pixel in a row, we compute the energy of the current pixel plus the energy of one of the three averaged values of three possible pixels above it. The three averaged values can be obtained as follows: For each of three pixels above the current pixel, we compute the average of the pixel and its left and right pixels. In Fig. 2, let the current pixel be X. Pixels B, C, D are three pixels above pixel X. The averages values of pixels ABC, BCD, CDE are the three averaged values above pixel X.

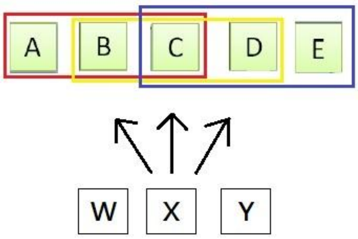


Figure 2. Three averaged values

Fig. 3 shows (a) a vertical seam by the original seam carving and (b) a vertical seam by the improved seam carving. Since the energy of the main object is higher than the other pixels, our approach can take into account more pixels. The energy of the pixels close to the main object can be higher than other pixels. Hence, the seam is farther away from the main object.

(a)

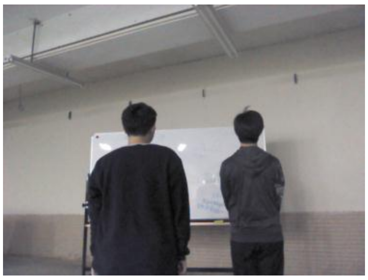
(b)

Figudre 3. (a) a vertical seam by the original seam carving and (b) a vertical seam by the improved seam carving

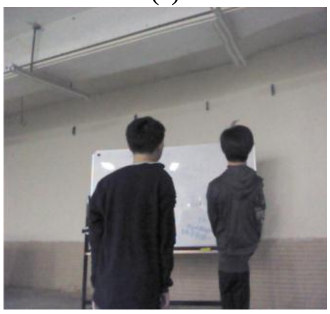
RESULTS

In the experiments, the platform is a PC with an Intel Core2 Quad CPU Q6600@2.40Hz and 4.0 GB of memory, running the Microsoft Windows XP 7.

Our approach was compared with the seam carving [1]. Figs. 4-6 show (a) the original images, (b) the resized results by the seam carving (80% reserved), and (c) the resized results by our approach (80% reserved). From the results, our approach performs better than the seam carving.



(a)



(b)

(c)

Figure 4 (a) original image, (b) resized image by seam carving, and (c) resized image by our approach

(a)

International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 7 (2017) pp. 1324-1328

(b)

(c)

Figure 5. (a) original image, (b) resized image by seam carving, and (c) resized image by our approach

(a)

(b)

(c)

Figure 6 (a) original image, (b) resized image by seam carving, and (c) resized image by our approach

CONCLUSIONS

We have proposed an improved image resizing technique with protection of main objects. We compute three feature maps including the saliency map, the enhanced edge map, and the object map. Moreover, different types of feature maps were integrated as the importance map for image resizing. Therefore, we can achieve a perfect protection of the main objects.

ACKNOWLEDGMENT

The authors would like to thank the Ministry of Science and Technology of Taiwan for financially supporting this research under Contract No. MOST 104-2221-E-239-025-.

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