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Support Vector Machine Based Quality Evaluation of Seam-carved Images

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Abstract: Seam-carving is one of the widely used content aware image resizing methods. According to the image content, the output of the algorithm sometimes may not be satisfactory visually. In the presented study a machine learning method for detecting visually impaired images after seam-carving procedure is proposed. For this purpose a training set that is constructed by good and visually bad examples which are obtained by examining the seam-carving images. Features from the sample set are extracted and a Support Vector Machine is trained for determining whether the quality of the examined image is good. According to experimental results using four fold cross-validation, the method produced 65% success.

Keywords: Seam-carving, Support Vector Machine, Image Resizing, Local Binary Patterns.

I. INTRODUCTION

Content-aware image resizing methods provides a way to protect image content from the effects of resizing. Seam-carving is one of the most important content-aware image resizing methods. The main idea in this method is to remove the least important pixel paths for size reduction or add new pixel paths to between two less important pixel paths. These pixel paths are called as seams which are described as optimal 8-connected path of pixels on a single image from left to right or from top to bottom [1]. Therefore the aim of seam-carving is to preserve the quality of the image by removing or adding the most negligible paths for resizing the image. In order to provide better visual quality of the seam carving, improved versions of the approach such as; importance diffusion [2], multiple operators [3], combination of direct and indirect seam carving [4] and image diffusion [5] are the examples developed by researchers. Due to its nature, seam-carving has a potential to cause unexpected disturbances in output image depending on the image content. Instead of detecting manually, it may be important to detect these types of disturbances automatically. Especially when a large sum of images are seam-carved, it is a difficult task to detect visually impaired images manually. In literature there are a number of blind methods to detect seam-carved images for forensic purposes [6]–[8]. These approaches decides whether an image is seam-carved and utilizes some features extracted from the test images. In one of the successful approaches, initially Local Binary Patterns (LBP) of the image is obtained.

Therefore emphasized local distortions helps to improve the success of the features obtained from the LBP image [9], [10]. These features are usually seam based and helps to find seam carved images for forensic purposes. A similar approach can be used to decide if the content of a seam-carved image is corrupted or not. In the presented study a machine learning method for detecting visually impaired images after seam-carving procedure is proposed. For this purpose a training set that is constructed by good and visually bad examples which are obtained by examining the seam-carved images. Features from the sample set are extracted and an SVM (Support Vector Machine) is trained for determining whether the quality of the examined image is good. The results were tested by four fold cross-validation and the success of the proposed approach reaches up to 65%.

II. BACKGROUND

A. Seam-carving

Image resizing using seam-carving algorithm depends on finding unimportant pixel paths. These paths are used for adding new pixels for enlarging or removing existing pixels for lessening. This is repeated till desired size is obtained. A seam is described as an optimal 8-connected path of pixels where the optimal path is determined by means of an energy function [1]. A number of energy functions for example, gradient magnitude can be used [11], [12]. If the image width is going to be resized, then the seams in the vertical dimensions are detected. In the same way, if the image height is going to be resized, then the seams in the horizontal dimensions are detected. For resizing in both dimensions, both horizontal and vertical operations are applied.

When pixel costs are determined from energy map, minimum cost table is constructed from top to bottom for vertical seam or from left to right for horizontal seam. Fig 1 shows an example for computing minimum cost table for finding

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optimal seams in the vertical direction. As can be noted, the first row of minimum cost table is copied from the energy map without changing. The elements of the second row are computed according to the first row. Each element in the

Pixel Costs

30	20	10	80
10	70	50	10
10	20	60	30
20	10	70	20

First row iteration

30	20	10	80
10+20	70+10	50+10	10+10
10	20	60	30
20	10	70	20

Second row iteration

30	20	10	80
30	80	60	20
10+30	20+30	60+20	30+20
20	10	70	20

Completed minimum costs

30	20	10	80
30	80	60	20
40	50	80	50
60	50	120	70

Fig. 1 Example Computing minimum cost table

second row is compared with left, top and right neighbor value and the minimum one is added to the element. This is repeated till the last row in the minimum cost matrix. Then back tracking is started from last row to first row as shown by Fig 2. The minimum value in the last row is selected as the starting point. All consecutive pixels are selected from the minimum of neighbors until first row is reached. An example seam-carved image and its energy map where the route of an optimal seam is drawn are shown in Fig 3.

Find minimum

30	20	10	80
30	80	60	20
40	50	80	50
60	50	120	70

Back-tracking

30	20	10	80
30	80	60	20
40	50	80	50
60	50	120	70

Fig. 2 Determining minimum (optimal) seam

Fig. 3 A seam path on a test image and its gradient (right)

B. Local Binary Patterns (LBP)

LBP is defined as a non-parametric descriptor to reveal the local structures of images and is of importance in extracting image features. It labels each pixels according to neighbourhood of each pixel [13]. Since LBP depends on neighbour values, neighbours of a seam path may change significantly when an image is seam-carved. Neighbourhood of a pixel can be selected in various sizes or shapes. According to comparison results an 8-bit binary number is obtained within the neighbourhood of the selected cell. The size of the cell can be selected in various sizes keeping equal distance to the pixel at the centre. Figure 4 shows example selections for 3×3 and 5×5 neighbourhoods.

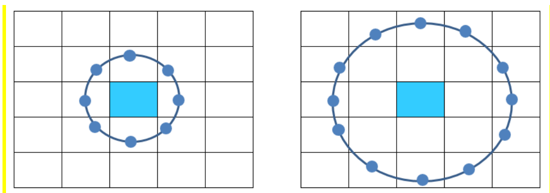

Fig. 4 Example cell sizes for LBP operation

All neighbour pixels are compared with the pixel at the centre. If the value of the compared neighbour is lower than the centre then its value is set to zero. Otherwise it is set to one. When all neighbours are compared the results of the

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comparisons are written in clockwise direction as a binary number. Fig 4 shows a numerical example for a selected pixel within the neighbourhood of 3x3 cell.

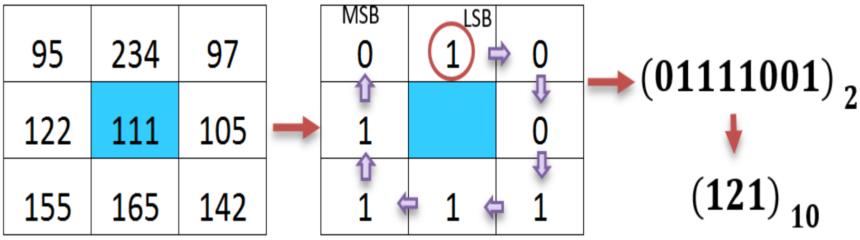

Fig. 5 An example LBP transform

III. PROPOSED METHOD

The result of the seam-carving may not always be satisfactory and therefore it may not be desired to use distorted image for scaling. For this purpose, an automatic detection approach may be useful when a large number of images are need examined. Also it gains importance when another scaling should be applied automatically if the result is not satisfactory. In the presented study a machine learning method for detecting visually impaired images is proposed. Fig 4 shows the basic idea of the implemented method. In this approach SVM is the main component for deciding and used for the classification of seam-carved images. SVM is such a classification mechanism that separates the input data into two class by means of a hyper plane which can also be non-linear in structure[14]. For this purpose, kernel functions which can be non-linear functions can be used to map non-linearly separable classes of data into a linearly separable space.

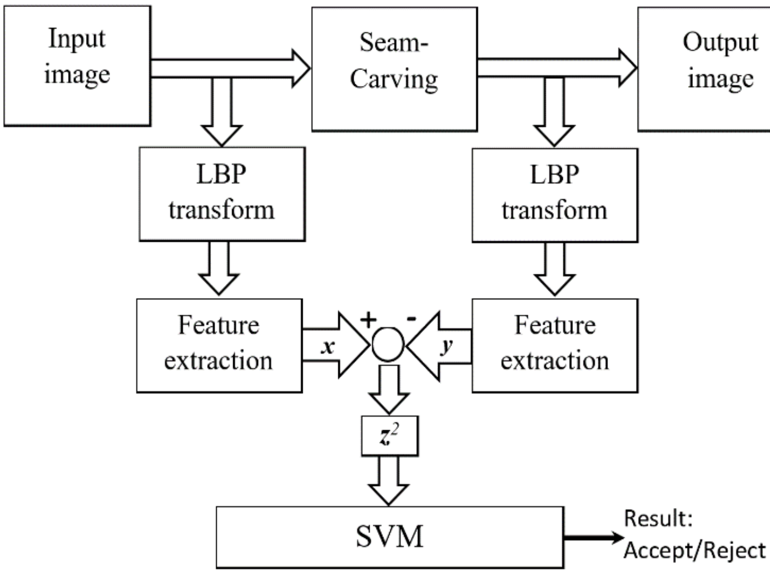

Fig. 6 Block diagram of the proposed method

The problem considered in this study is a two-class classification problem and hence, the algorithm can produce accept or reject as a test results for the seam-carved input image. Several features are extracted from the input image and resized image using seam-carving are comprise the input of SVM. Before using SVM it should be trained by a sample set of input and output vectors. For this purpose a training set that is constructed by visually good and visually bad examples which are obtained by visual examination of the seam-carved images. Initially features of the input image are extracted and the square of the difference of the features of input and seam-carved images are used as training vector in the data set. After SVM trained it can be used for determining whether the quality of the seam-carving image is good. The features used in this work are selected from the seam-carving detection approaches used in literature [6], [9], [10]. The features used in this study to train SVM are listed in the Table 1. All the features are seam based and involves computing some equations for seam paths such as minimum, maximum, mean, standard deviation and difference between maximum and minimum. These computations are realized for both vertical and horizontal dimensions. Minimum, maximum and mean values are also obtained for half seams. Therefore there are total 16 features used in this study extracted from the training and test images.

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TABLEI SEAM-BASED FEATURES USED FOR TRAINING SVM

Description	Expression
Maximum value of a vertical seam path	$max_{i=1}^{m} C_{vs}(i,n)$
Maximum value of a horizontal seam path	$max_{i=1}^{n} C_{hs}(m,i)$
Minimum value of a vertical seam path	$min_{i=1}^{m} C_{vs}(i,n)$
Minimum value of a horizontal seam path	$min_{i=1}^{m} C_{hs}(m,i)$
Mean of a vertical seam path	$\frac{1}{m}\sum_{i=1}^{m} C_{vs}(i,n)$
Mean of a horizontal seam path	$\frac{1}{n}\sum_{i=1}^{n} C_{hs}(m,i)$
Standard deviation of a vertical seam path	$\sqrt{\frac{1}{m}\sum_{i=1}^{m} Mean - C_{vs}(i,n)^2}$
Standard deviation of a horizontal seam path	$\sqrt{\frac{1}{n}\sum_{i=1}^{n} Mean - C_{hs}(m,i)^2}$
Difference between maximum and minimum values of horizontal seam paths	$max_{i=1}^{m} C_{vs}(i,n)$-$min_{i=1}^{m} C_{vs}(i,n)$
Difference between maximum and minimum values of vertical seam paths	$max_{i=1}^{m} C_{hs}(i,n)$-$min_{i=1}^{m} C_{hs}(m,i)$

IV. EXPERIMENTAL RESULTS

Constructing the image set for training SVM is of crucial importance for the success of the method. For the experimental result total 60 test images are used from the UCID [15] database are selected according to seam-carving results. 30 of the test images are bad images which easily perceptible as defected images and the other 30 visually good images that have no significant defects. The experimental results are obtained for seam-carved images with the scaling ratio of %20 reduction. Vertical seam removal where width reduction by seam carving is performed has been realized in all experiments. Figure 7 and 8 shows some bad and good examples respectively from the training set. In this Figures, input images and their seam-carving resized versions are given. The features given by Table 1 are obtained for each of the test images and the resized images obtained from test images using seam-carving. Cell size for LBP is selected to be 3×3 for feature extraction. The experimental results were obtained on Octave [16] version 4.2.1 using LibSVM 3.21 for SVM classifier[17]. Kernel function for SVM is selected as Radial Basis Function (RBF). Using SVM with RBF involves determining c (Cost) and γ (Gamma) parameter in its formulation and in order to work an SVM efficiently optimal values should be determined. After a grid search, the optimal parameters for c (Cost) and γ (Gamma) of RBF were determined as 0.35 and 0.90 respectively. SVM trained and tested using four fold cross-validation method [18]. According to experimental results, the quality estimation method produced 65% success.

Fig. 7 Seam-carving examples accepted as bad for the training and testing

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Fig. 8 Seam-carving examples accepted as good the training and testing

V. CONCLUSION

In the presented study a machine learning method for determining a seam-carved image is whether visually impaired or not is developed. For this purpose a training set that is constructed by good and visually bad examples which are obtained by examining the seam-carved images. Features from the sample set are extracted and a support vector machine is trained for determining whether the quality of the examined image is good. The result of the proposed approach is promising and can be improved by deriving new image features that emphasize the defects in the image. When a large sum of images are seam-carved, it is a difficult task to detect visually impaired images. For this purpose, an automatic detection approach may be useful when a large number of images are need examined. The algorithm can be used in combination with another scaling algorithm to produce better results. For example if the result of seam carving is not satisfactory, then an alternative approach can be applied.

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BIOGRAPHIES

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