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A Method for Quality Assessment of Image Resizing Algorithms

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Abstract

In this paper, a novel technique for quality assessment of image resizing algorithms is proposed. The technique is based on consecutive application of a resizing algorithm with different resizing coefficients so that the size of the last image coincide with the size of the original image. The Mean square deviation between the last and the original image characterizes the quality of applied resizing algorithm, which can be called the "backlash" of that algorithm. Numerical results of experiments are given to show the effectiveness of proposed technique.

1. Introduction

Image resizing algorithm is a method for transformation of an image of a certain size to another of an arbitrary size by keeping the quality of notable regions of the original image. Creating an effective resizing method is one of the most difficult problems because the diversity of image types, application areas and quality requirements are too large.

There is a huge number of scientific publications devoted to resizing methods [1] and the quality assessment of the resized image [2]. There were also created many software systems for image processing which includes procedures for image resizing.

Any technique of quality assessment of algorithm resizing is based on the comparing of the resized and original image. However, it is well known that formal methods of images comparing based on the mean square criterion or the peak signal to noise ratio (PSNR) are not applicable to images with different sizes [3-5]. Therefore the quality assessment of resized image is mostly realized by using the visual analysis and estimation.

A new approach to this problem is proposed in [6]. The quality measure proposed in that paper is based on using statistical properties and structural features for comparing images of different sizes and/or of mutual orientation. Thus it becomes possible to estimate the quality of numerous existing and anew designed resizing algorithms and software systems as well.

In [7] the results of comparison of some well known algorithms of image resizing based on different interpolation techniques were considered. The quality measure proposed in [6] is quite applicable for investigation of different resizing algorithms.

In this paper, a novel method for quality assessment of resizing algorithm is proposed.

2. "Backlash" Estimation Algorithm

The "backlash" estimating algorithm is based on multiple and subsequent increasing or decreasing an image using different resizing coefficients. To provide the possibility of comparison of resized image with the original the resizing procedure is performed in order that the size of the last image coincide with the size of the original image. In this case the mean square or PSNR criterion can be used for image quality assessment. It is clear that the distortion of resized image depends on used resizing procedure. Therefore the distortion measure is called "backlash" of resizing algorithm.

It can be noticed that in general case due to the multiple resizing, the last image can be of another size, so the mentioned criterion are not applicable. In this case the quality measure proposed in [6] can be used.

Let's describe briefly the quality assessment measure proposed in [6]. The related algorithm consists of the following steps:

Step 1. Calculate the gradient magnitudes $\|M_j(m,n)\|$, $j=1,2$ for considered images;

Step 2. Assume that the gradient magnitudes $\|M_j(m,n)\|$ are two-dimensional independent random variables with Weibull distributions $F_1(x;\eta_1,\sigma_1)$ and $F_2(x;\eta_2,\sigma_2)$. The parameters η_1,σ_1, η_2,σ_2 are estimated by gradient magnitude samples;

Step 3. Calculate the proximity of the images by formula

$$W^2=\frac{\min(\eta_1,\eta_2)\min(\sigma_1,\sigma_2)}{\max(\eta_1,\eta_2)\max(\sigma_1,\sigma_2)},\ 0\le W^2\le 1. \quad (1)$$

The analogous algorithm was successfully applied in [8] to estimate the "backlash" of image rotation algorithms and software systems.

3. Results of Numerical Experiments

A series of numerical experiments on image resizing was performed. The resizing of each image is performed twice; firstly the image is decreased at resizing coefficient β, then the image is increased at coefficient $1/\beta$. Thus we can calculate the proximity measure, which characterizes the "backlash" of used resizing algorithm.

In this paper, two questions are answered: how much is distorted an image at one-fold resizing and how much at two-fold resizing?

The experiments are performed over the standard images of sizes 512x512 *Cameraman, House, Lenna, Peppers and Blonde Woman.*

The resizing is performed by use of the software system Photo Zoom Pro 4 [9], in which 12 well known and most distributed interpolation methods are realized. In this series of experiments the following methods were chosen: S-Spline_Max, Bilinear, Bicubic, Nearest Neighbor и Lanczos. The decreasing coefficient β was varied in the interval of [0.3; 0.9] with a little step. The increasing coefficient was equal to $1/\beta$. The derived and the original images were compared using PSNR and measure (1).

As an example, the result of experiment with the image Blonde Woman is shown in Figure 1. We can with difficulty detect the distortions of two-fold resized image of Figure 1c by visual analysis but PSNR=25.7 dB, which indicates significant distortions in that image. However, as it is shown below $W^2=0.89$, which means that the structure of the image is not changed significantly in result of resizing. This example shows the capability of proposed "backlash" method for assessment of quality of resizing algorithms and software systems.

a b c

Figure 1. Two-fold resizing of Blonde Woman image by use of Bilinear algorithm at β=0.3; a - original; b – decreased image at coefficient β; c - increased image (b) at coefficient 1/β.

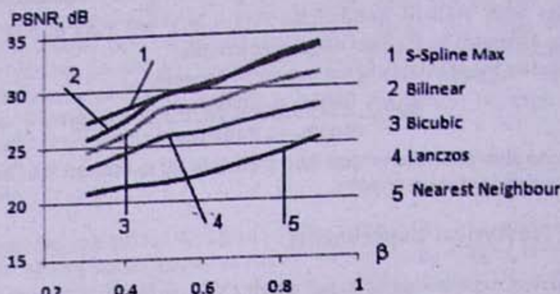

Figure 2. Dependence of PSNR between two-fold resized and original images at resizing coefficient β, and different resizing algorithms.

The dependence of proximity measure PSNR between two-fold resized and the original images Blonde Woman on resizing coefficient β, and different resizing algorithms, are shown in Figure 2. We can note that the dependences of PSNR are significantly different for different resizing methods. Analogous results are obtained for images specified above.

The calculated values of image proximity measures PSNR and W^2 are collected in Table. These data characterize the "backlash" of corresponding resizing algorithms at the least favorable value of resizing coefficient in this series of experiments, i.e. for β=0.3.

As it can be seen from Table there are significant differences between values of PSNR for different resizing methods. The same can be noted for values of W^2. These data is also sensitive to type of resizing image, however they allow to classify nearly identically the specified resizing methods by quality. Notice the high enough values of W^2 for all considered images at a Bilinear method. This observation testifies that the structural properties of that images are preserved at this resizing method.

Thus, the proposed approach to the quality assessment of an image resizing method based on "backlash" estimation is a new way to improve the existing and anew designed resizing algorithms and software systems.

Table. PSNR (dB) and W^2 for five images and six resizing methods, obtained during the two-fold resizing experiments at β=0.3.

Resizng method	Image									
	Cameraman		House		Lenna		Peppers		Blonde Woman	
	PSNR	W^2	PSNR	W^2	PSNR	W^2	PSNR	W^2	PSNR	W^2
S-Spline Max	29.8	0.78	33.7	0.91	30.8	0.80	31.0	0.72	27.3	0.74
Bilinear	28.7	0.88	35.5	0.92	28.9	0.90	29.0	0.90	25.7	0.89
Bicubic	27.5	0.70	33.5	0.74	27.4	0.72	27.7	0.69	24.6	0.72
Lanczos	26.1	0.57	31.7	0.60	25.7	0.58	26.1	0.51	23.2	0.56
Nearest Neighbor	21.9	0.65	25.4	0.61	22.2	0.60	22.4	0.55	20.9	0.59

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Պատկերի մասշտաբավորման ալգորիթմների որակի հետազոտման եղանակ

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Ամփոփում

Պատկերի մասշտաբավորման տարբեր ալգորիթմների որակի գնահատման առաջարկված մեթոդիկան հիմնված է այդ ալգորիթմների՝ տարբեր գործակիցներով բազմակի և հաջորդաբար կիրառման վրա այնպես, որ վերջում ստացված պատկերի չափերը համընկնեն բնօրինակի չափերի հետ: Այս եղանակով ստացված պատկերների միջին քառակուսիական շեղումը բնորոշում է կիրառված մասշտաբավորման ալգորիթմի որակը և կոչվում է ալգորիթմի "խաղացք": Բերվել են առաջարկված մեթոդիկայի արդյունավետությունը ցուցադրող փորձերի արդյունքներ:

Метод исследования качества алгоритмов масштабирования изображения

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Аннотация

Предложен метод оценивания качества различных алгоритмов масштабирования изображения, основанный на многократном и последовательном масштабировании этих алгоритмов с различными коэффициентами масштабирования таким образом, чтобы размеры полученного в конце изображения совпали с размерами оргинала. Среднеквадратическое отклонение полученных таким способом изображений характеризует качество алгоритма масштабирования и называется «люфтом» алгоритма. Приведены результаты численных экспериментов, иллюстрирующих эффективность предложенного подхода.