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No Reference Perceptual Quality Assessment of Blocking Effect based on Image Compression

By
Jamila Harbi S [1], and Ammar AL-salihi
[1] Al-Mustenseriyah University,
College of Sci., Computer Sci. Dept., Iraq.
E-mail: dr.jameelahharbi@gmail.com
E-mail: remassedra1@gmail.com

Abstract

Without a reference image at hand, NR methods are more challenging. The vast majority of NR IQA algorithms aim to evaluate specific distortion, such as blocking, blur and ringing. Blocking artifacts are mainly caused by block-DCT based coding, such as JPEG and MPEG. The blocking artifacts are first modeled as a 2D step function. The artifacts visibility map is then estimated by oriented activities and the brightness of local background. Blocking artifacts are evaluated using the average difference across block boundaries, and blur is estimated by further combining intra-block activity.

1. Introduction

There has been a tremendous progress recently in the usage of digital images and videos for an increasing number of applications. Multimedia services that have gained wide interest include digital television broadcasts, video streaming applications, and real-time audio and video services over the Internet [1]. Image and video compression continue to be in high demand.

The Compressed images suffer from more blocking. A very well-known problem with JPEG images is blocking artifacts. The compression can leave discontinuities of intensities between adjacent blocks (known as blocking artifacts) [2].

Digital images are inevitably subject to various distortions during their acquisition, processing and transmission. Image quality assessment (IQA) aims to model the distortions and generate a scalar to measure the extent of degradation [3]. Since human eyes are the ultimate receiver, IQA methods should measure the image quality objectively and keep consistent to the subjective ratings. According to the availability of the original image, IQA methods can be classified into full-reference (FR) method, reduced-reference (RR) method and no-reference (NR) method. Most of the existing methods are FR ones, where the original image is used as a reference. While FR methods can achieve very high prediction accuracy, the original image is not always available in practice. By contrast, NR methods generate the quality score using the distorted image only, so they are more useful in quality-aware image applications.

Blurring Effect

Blurring an image usually makes the image unfocused. Blurry images are the result of movement of the camera during shooting (not holding it still) or the camera not being capable of choosing a fast enough shutter speed to freeze the action under the light conditions[5]. In image processing, blurring is generally obtained by convolved the image with a low pass filter.

Blocking Artifact

Blocking artifact is inherent with block-based image compression techniques. JPEG is a block DCT-based lossy image coding technique. It is lossy because of the quantization operation applied to the DCT

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coefficients in each 8x8 coding block. Blocking effect occurs due to the discontinuity at block boundaries, which is generated because the quantization in JPEG is block-based and the blocks are quantized independently.

The features are calculated horizontally and then vertically. The blockiness is estimated as the average differences across block boundaries [4]

$$B_h = \frac{1}{M[\frac{N}{8} - 1)]} \sum_{1}^{M} \sum_{1}^{[\frac{N}{8}]-1} |d_h(i, 8j)| \quad (1)$$

Where we denote the test image signal as x(m, n) for $m \in [1, M] and\; n \in [1, N]$ and calculate a differencing signal a long each horizontal line:

$$d_h(m, n) = x(m, n + 1) - x(m, n) \quad (2)$$

Where $n \in [1, N - 1]$

Then we estimate the activity of the image signal. Although blur is difficult to be evaluated without the reference image, it causes the reduction of signal activity, and combining the blockiness and activity measures gives more insight into the relative blur in the image. The activity is measured using two factors. The first is the average absolute difference between in-block image samples:

$$A_h = \frac{1}{7}\left[\frac{1}{M[N-1)} \sum_{1}^{M} \sum_{1}^{N-1} |d_h(i, j)| - B_h\right] (3)$$

The second activity measure is the zero-crossing (ZC) rate. We define for $n \in [1, N - 2]$,

$$Z_h = \begin{cases} 1 & horizontal\ ZC\ at\ d_h(m,n) \\ 0 & otherwise \end{cases} \quad (4)$$

The horizontal ZC rate then can be estimated as[6]:

$$Z_h = \frac{1}{M(N-2)} \sum_{i=1}^{M} \sum_{j=1}^{N-2} Z_h(i, j) \quad (5)$$

Using similar methods, we calculate the vertical features of $B_v, A_v, and\ Z_v$. Finally, the overall features B, A and Z are given by[6]:

$$B = \frac{B_h + B_v}{2}, A = \frac{A_h + A_v}{2}, and \quad Z = \frac{Z_h + Z_v}{2} \quad (6)$$

There are many different ways to combine the features to constitute a quality assessment model. One method we find that gives good prediction performance is given by[5]:

$$S = \propto + \beta B^{\gamma_1} A^{\gamma_2} Z^{\gamma_3} \quad (7)$$

Where: $\propto, \beta, \gamma_1, \gamma_2, and\ \gamma_3$ are the model parameters that must be estimated by trial and error.

Finally, obtained assessment score SS is derived from the following equation[6]:

$$SS = \frac{4}{1 + \exp(-1.0217(S - 3))} + 1 \quad (8)$$

Information Theory based Metrics

I. Normalized Mutual Information (Q_{MI})

Normalized mutual information (Q_{MI})represent by MI (A, F), entropy with H (A)[7].

$$Q_{MI} = 2\left[\frac{MI(A, F)}{H(A) + H(F)} + \frac{MI(B, F)}{H(A) + H(F)}\right] \quad (9)$$

II. Image Structural Similarity based Metrics

A structural similarity index measure (SSIM) for images A and B defined as[8]:

$$SSIM(A, B) = [l(A, B)]^{\alpha} [c(A, B)]^{\beta} [s(A, B)]^{\gamma} \quad (10)$$

$$SSIM(A, B) = \left(\frac{2\mu_A\mu_B + C_1}{\mu_A^2 + \mu_B^2 + C_1}\right)^{\alpha} \left(\frac{2\sigma_A\sigma_B + C_2}{\sigma_A^2 + \sigma_B^2 + C_2}\right)^{\beta} \left(\frac{\sigma_{AB} + C_3}{\sigma_A + \sigma_B + C_3}\right)^{\gamma} \quad (11)$$

Where μ_A and μ_B are the average values of image A(i,j), and B(I,j) , σ_A and σ_B are the variance and covariance, respectively[8].

1(A,B), c(A,B) and s(A,B) are the luminance, contrast and correlation components, respectively. The parameters $\alpha, \beta\ and\ \gamma$ are used to adjust the relative importance of the three components. The constant values $c_1, c_2\ and\ c_3$ are defined to avoid the

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instability when the denominators are very close to zero.

BY setting [9]

$$\alpha = \beta = \gamma = 1 \; and \; c_3 = \frac{c_2}{2} \quad (12)$$

$$SSIM(A,B) = \frac{(2_{\mu_A \mu_B} + C_1)(\sigma_{AB} + C_2)}{(\mu_A^2 + \mu_B^2 + C_1)(\sigma_A + \sigma_B + C_2)} \quad (13)$$

Error Analysis Techniques

Error analysis techniques can be used for comparison of different image enhancement techniques:

I. Normalized Mean Square Error Method (NMSE)

The NMSE compares the mean of a series against the predicated values. If the NMSE value is greater than 1, then the prediction are going worse than the series mean and vice versa. The following formula id used to calculate NMSE[10]:

$$\text{NMSE} = \frac{\sum_{i=-N/2}^{N/2} \sum_{J=-N/2}^{N/2} [f(i,j) - g(i,j)]^2}{\sum_{i=-N/2}^{N/2} \sum_{J=-N/2}^{N/2} f(i,j)^2} \quad (14)$$

Where f(i.j) is the original image with size NxN and g(I,j) is the filtered image with size NxN.

II. Projected Mean Squared Error Method (PMSE)

Projected Mean Square Error Method (PMSE) is used to study the characteristic of the error overall the filtered image and is calculated using the following formula[11]:

$$\text{PMSE} = \frac{\sum_{i=-N/2}^{N/2} [f(i,j) - g(i,j)]^2}{\sum_{i=-N/2}^{N/2} \sum_{J=-N/2}^{N/2} f(i,j)^2} \quad (15)$$

III. Normalized Cross-Correlation (NCC):

Normalized cross correlation is used to find out similarities between fused image and registered image is given by[12]:

$$NCC = \frac{\sum_{i=0}^{N-1} \sum_{j=0}^{N-1} (f(i,j) g(i,j)}{\sum_{i=0}^{N-1} \sum_{j=0}^{N-1} (f(i,j))^2} \quad (16)$$

IV. Structural Content (SC)

Structural content (SC) is correlation based measure for the original and enhanced image[12]:

$$SC = \frac{\sum_{i=0}^{N-1} \sum_{j=0}^{N-1} (f(i,j))^2}{\sum_{i=0}^{N-1} \sum_{j=0}^{N-1} (g(i,j))^2} \quad (17)$$

Our Proposed Technique

JPEG is a block-based DCT lossy image coding technique. It is lossy because of the quantization operation applied to the DCT coefficients in each 8 *x* 8 coding block. The blur is mainly due to the loss of high frequency DCT coefficients, which smooth the image, signal within each block. In this work, we employ a computationally inexpensive efficient feature extraction method for evaluating the JPEG coded image quality. This model is shown in Fig.1.

Results

The features are calculated horizontally and then vertically using eqs. (1-5). First, the blockiness is estimated as the average differences across block boundaries:

The parameters obtained with all test image are $\propto$= -245.9, β = 261.9, γ_1 = -0.0240, γ_2 = 0.0160, and γ_3= 0.0064, respectively. Fig.2 shows the blockiness effect after convert color image into gray-scale image.

Blur relates to the loss of spatial detail and is observed as texture blur. In addition, blur may be observed due to a loss of semantic information that is carried by the shapes of objects in an image. In this case, edge smoothness relates to a reduction of edge sharpness and contributes to blur.

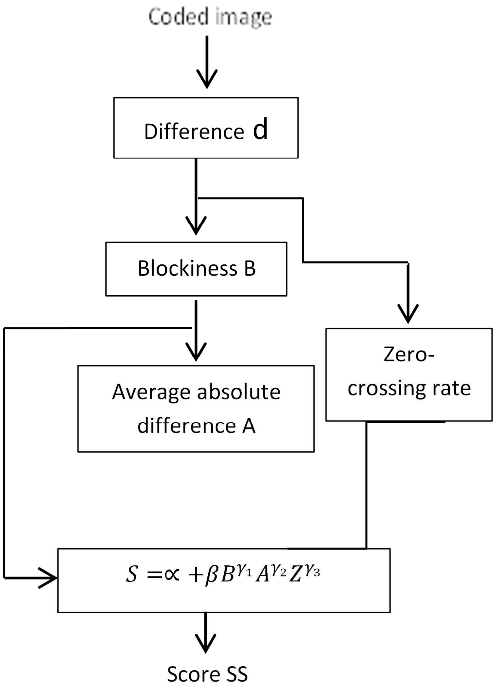

Fig.1: Extraction features diagram

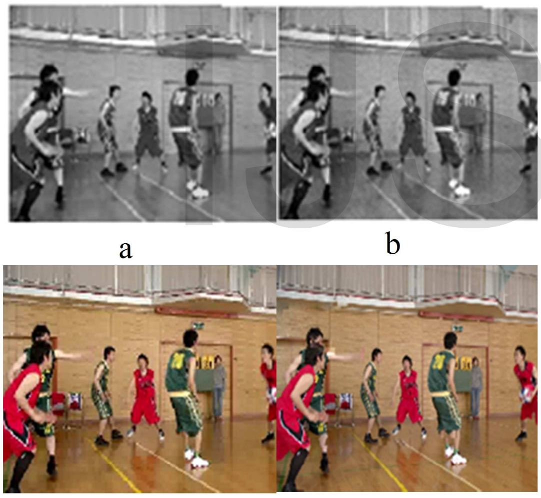

Fig.2: Blockiness effect by applying DCT a) original gray image, b) DCT compressed gray image, c) original color image, and d) DCT compressed color image.

The blurring effect is mainly due to the loss of high frequency DCT coefficients, which smooth the image signal within each block.
As shown by the results for blurring metric in Fig.3 by using Gaussian filter. Increasing mask filter with standard deviation increases blurring, edge was blurring. In our proposed system (5x5) and (15x15) mask size are used with varying standard deviation value between 2 and 10. If the standard deviation value is 2 and the mask size= (5x5) we obtained smoothness degree acceptable. Table1 is statistical features computed for No-reference image.

Fig.3: Blurring effect a) Mask size (5x5),
σ = 5, b) Mask size (5x5) , σ = 0.2 and
c) Mask size (15x15), σ = 10.

Table1: Statistical features computed of NR Image

Distortion Types	Mean	PSNR	Contrast	SSIM	NMSE	PMSE	NCC	SC
Blur	67.21	33.43	152.23	12.246	0.022	0.244	0.561	3.212
Gaussian	89.07	29.97	103.28	7.321	0.045	0.595	0.432	1.266
Blocking	76.65	38.34	172.32	13.6	0.012	0.124	0.292	3.974

Conclusion

A proposed No-reference image quality measurement technique was presented which takes the user perceived quality in to account. It is

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designed to detect and to measure different image artifacts along with the calculation of a weighted sum of respective quality metrics. It was shown by way of experiment that: The proposed system outperforms statistical features with respect to quantifying user perceived quality. The introduced system may be used for NO-Reference in service image quality monitoring. It does not require a reference image to be present at the receiver and is therefore well suited to real-time applications.

References

[1] Muhammad Shahid, Andreas Rossholm, Benny L and Hans-Jürgen Zepernick," No-reference image and video quality assessment: a classification and review of recent approaches”, Shahid *et al. EURASIP Journal on Image and Video Processing* 2014, 2014:40.

[2] S. Alireza Golestaneh and Damon M. Chandler," Algorithm for JPEG artifact reduction via local edge regeneration", Journal of Electronic Imaging 23(1), 013018 (Jan–Feb 2014)

[3] Wei Zhang1, Leida Li1;2, Hancheng Zhu1, Deqiang Cheng1;" No-reference Quality Metric of Blocking Artifacts Based on Orthogonal Moments" Journal of Information Hiding and Multimedia Signal Processing 2014 ISSN 2073-4212,Volume 5, Number 4, October 2014.

[4] Z. Wang, H. R. Sheikh and A. C. Bovik, ”No-Reference Perceptual Quality Assessment of JPEG Compressed Image”, Proc. IEEE ICIP-2002, pp. I-477–480, Sept,2002.

[5] T.Kim and Sabah Mohamed, “Computer Application For Web Human Computer Interaction Signal and Image Processing and pattern Recognition", Library of Congress Cannel Springer, 2012.

[6] Z.Wang,A.C.Bovik,H.R.heihk and E.P>Simoncelli,"Image Quality Assessment From Error Measurement to Structural Similarity", IEEE Trans, Image Processing; vol.1,PP. 1-14,2004.

[7] Robert Meersman, Zahir Tari and Pilar Herrero," On the Move the Meaning full Internet Systems", OTM Work Shop, 2008.

[8] Joseph V. Hajnal- Derak L.G. Hill and David J,"Medical Image Registration",Hawkes , Taylor & Francis Group, LLC, 2011.

[9] Shahriar Akramullah, " Digital Video Concepts, Methods and Metrics", Apress Media LLC, 2014.

[10] K. V . Kale, S.C. Mehrotra, R,R ..Manza, "Advances is Computer Vision and Information Technology", IEEE Section ,I,K , International Publishing House PVT, LTD, 2007.

[11] V. Santhi , D.P. Acharjya, and M. Ezhilarasan,"Emereging Technologies in Intelligent Applications for Image and Video Processing", I.G-I, 2015.

[12] Rajeew Srivastava, S.K. Singh, K.K. Shukla ,"Research Developments in Computer Vision and Image Processing', Cataloguing . I.G.I Global. 2014.