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A Novel Hybrid Image Quality Assessment Algorithm

KEYWORDS: image quality assessment, no reference image quality assessment, blur.

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ABSTRACT *Image quality assessment has a very important role, especially because the impact that the quality of images have on a viewer is significant. This makes it important that visual information is assessed for quality every now and then. Images can be distorted with different types of irregularities like noise, blur, blocking etc. No - reference image quality assessment methods does not need a reference image for assessment, this is particularly helpful when there is no reference image available. The method proposed in this paper makes use of a combination of blurriness and blockiness measurement in an image .This paper also provides an evaluation of the correlation of the results of the proposed no – reference quality assessment method with a well known blind image quality assessment algorithm.*

INTRODUCTION

Images of good quality have come to be of great importance in our day to day life. Statistics suggest that an average person comes across 400 to 600 advertisements in a day. Pictures form a major portion of advertisements. Advertisement is just one area that makes use of images.

There are a lot of image quality assessment techniques available today. No-reference image quality assessment (NR-IQA) is one of the types in which the quality is estimated without the use of any reference image, whereas full reference image quality assessment (FR-IQA) makes use of a reference image for quality assessment. In this paper, a combination of blur measurement and blockiness measurement is used for IQA. Blurring is caused due to attenuation of high frequency components. Blurring makes an image unfocused and fuzzy. A fuzzy image is of lower quality and it becomes difficult to distinguish between features in an image. Block based compression techniques like Discrete Cosine Transform (DCT) introduce blockiness in images. JPEG uses block based DCT compression and it suffers from blockiness. The degree of quantization determines the degree of blockiness. The results are evaluated by comparing the results obtained from the proposed method with the results obtained from the Natural Image Quality Evaluator(NIQE) as proposed in [1] on images from the LIVE database [2].

ALGORITHM OF PROPOSED IQA

Hybrid approach or image quality assessment

The quality metric proposed in this paper combined both the above mentioned blur and block estimation techniques in a weighted approach. The flow chart for this method is shown in Fig.1.

Algorithm:

- The blur metric is computed using the no reference multi-scale quadrature filter blur estimation method.
- The blocking metric is computed using the no reference blockiness metric described earlier.
- Using appropriate weights, the blurriness and blockiness metric is combined to reduce the error.

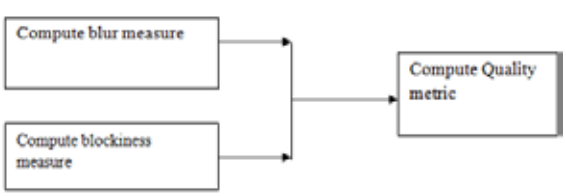

Fig 1. Flowchart of method to estimate quality metric

No reference blur estimation method

The blur estimation method proposed by [3] is a multi scale quadrature filter based method of blur estimation. Use of quadrature filters instead of only first order derivatives of Gaussian for multi-scale edge detection ensures scale independent responses. The blur estimation methodology employs modeling the image into transition and line type. The energy of the image response to the pair of first and second derivatives of the Gaussian is given by Eq. 1.

$$E(x,y,s,\theta) = (f'(x,y,s,\theta))^2 + (f''(x,y,s,\theta))^2 \quad (1)$$

where,

$$f'(x,y,s,\theta)$$

is the first order derivative of the image f(x,y) at scale s and orientation

$$f''(x,y,s,\theta)$$

the second order derivative of the image f(x,y) at scale s and orientation

Algorithm

f_x , f_y, f_{xx} and f_{yy}

are calculated in several scales.

The energy extrema is found in every scale.

Extrema functions of the models are fitted to the extracted extrema functions for classification to transition or line and also to estimate the blur level.

The average of blurriness of all detected edges is calculated.

No reference Blockiness estimation method

The blockiness measure is calculated using various features of the image like edge amplitude, edge length, background luminance and background activity as proposed by [4].The algorithm is as described below.

Algorithm

- Obtain the horizontal map (Eh) using thresholding.
- Obtain the horizontal activity mask (Mh).
- Perform masking the edges using a threshold.
- Obtain the background Luminance weight () .

Compute Quality metric

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- Obtain final weighted edge image in horizontal direction as in Eq. 2.

$$E_H(i,j) = E_h(i,j) \times M_H(i,j) \times W_l(i,j) \quad (2)$$

where,

$E_h(i,j)$ is the horizontal map

$M_H(i,j)$ is the horizontal activity mask

$W_l(i,j)$ is the background luminance weight

Obtain vertical profile as in Eq. 3.

$$P_v(i) = \sum_{j=1}^{N} E_H(i,j) \quad (3)$$

Horizontal blockiness measure is calculated as in Eq. 4.

$$B_H = \frac{1}{M}\sum_i |P_{v1}(i) - P_{vm}(i)| \quad (4)$$

$$P_{v1} = P_v(8n) \quad (5)$$

and

$$P_{vm}(n) = \overline{P_{vc}}(8n) \quad (6)$$

$$P_{vc} = \text{median}(P_v) \quad (7)$$

In the same way as above obtain the vertical blockiness measure using vertical map

Calculate total blockiness measure as given by Eq. 8.

$$\hat{B} = \sqrt{B_H + B_V} \quad (8)$$

The final blockiness measure is given by Eq. 9

$$B = 10(1-\hat{B}) \quad (9)$$

NIQE ALGORITHM

This IQA model is an Opinion-Unaware-Distortion-Unaware model. It assesses image quality without knowledge of anticipated distortions or human opinion. The quality of the distorted image is expressed as a simple distance metric between the model statistics and those of the distorted image. Algorithm is as described below.

Algorithm

- Preprocess the image by divisive normalization and local mean removal and then compute image coefficients.
- Partition image into P x P patches.
- Compute NSS features of each patch.
- Select the patches of richest source of structural information.
- Characterize the patches using Generalized Gaussian distribution (GGD).
- Capture the deviations caused by distortions using asymmetric generalized Gaussian distribution (AGGD).
- Fit the features from natural image patches with Multivariate Gaussian Mode to obtain the model of natural scene statistics (NSS) features
- Extract the estimates along 4 orientations, 2 scales by low pass filtering and downsampling to obtaining 36 NSS features.
- Fit the extracted NSS with the MVG model.
- Obtain the MVG fit of the image to be analyzed.
- Compare MVG fit to natural MVG model.
- Quality is computed as distance between the quality aware NSS feature model and the MVG fit to the features extracted from the distorted image.

PERFORMANCE EVALUATION

The images are taken from LIVE database and they are evaluated in stacks. A stack contains the same image but with different levels of irregularities in them. Each image in the stack is evaluated with the proposed quality metric as well as the NIQE. The correlation between the outputs was evaluated with the Spearman correlation coefficient. The output is shown as below in Fig 2. The image stacks are explained in Table 1 below.

STACK	IMAGE
Stack1	Buildings.bmp
Stack2	Monarch.bmp
Stack3	Rapids.bmp
Stack4	Dancers.bmp
Stack5	Carnivaldolls.bmp

Table 1. Table describing image stacks

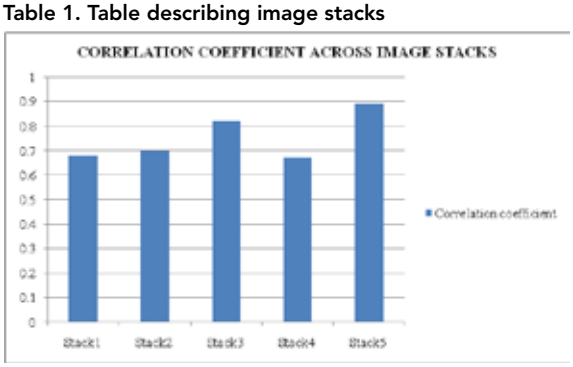

Fig 2. Graph showing plot of correlation coefficient across various image stacks

CONCLUSION

A set of 5 stacks of images with 7 same images each, that only vary in different level of distortion is used for evaluation. The correlation between the output obtained from proposed method as well as the NIQE method is obtained and represented graphically. The proposed hybrid IQA provides good correlation with quality assessment of NIQE.

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