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A Review on Objective Image Quality Assessment Techniques

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Abstract: *Quality assessment plays a crucial role in image analysis. Therefore, many research contributions are focusing on techniques which can provide quantitative assessment of image quality. This study gives an overview of traditional methodologies and techniques employed to obtain image quality measure. Also it highlights on the new image quality measure which is based on the wavelet decomposition of images. Our study represents a wavelet decomposition based IQA metric which takes into accounts sensitivity of human vision to distinct features of image such as sharpness and zero crossing. Edge points obtained by zero crossing and sharp regions are highly attentive to early vision are important as they gives good quality estimation.Four bands are extracted from reference and distorted image by employing 2-D Daubechies wavelet decomposition namely: LL, LH, HL, and HH. Higher weightage is given to sharpness as it captures human attention in early vision.*

Keywords: *PSNR(peak signal to noise ratio),MSE(Mean square error),SSIM(Structural Similarity Index Metric),MSSIM(Mean Square Structure Similarity Index Metric),WASH(Wavelet Based Sharp Features),HWSSIM (Haar Wavelet Based SSIM),DWM(Daubechies Wavelet METRIC),HVS(Human Visual System),IQA(Image quality Assesment).*

1. INTRODUCTION

Image quality degrades in seconds from capturing to displaying to observer. Different distortions during the stages that it might pass through such as storing, processing, compressing, and transmitting etc. So there is need to maintain image quality so that it can be shown clearly to observer and hence there is need to access this quality .There are two methods for assessing image quality, the subjective and the objective method. The subjective methods are considered costly, expensive, and time consuming but the results given by these methods are best correlated with human vision. In subjective method since we have to select a number of observers, show then a number of images and ask them to score images quality depending on their own opinion. The objective evaluation uses automatic algorithms to assess the quality of the image depending on the existence of the original image.

2. CLASSIFICATION OF IQA METHODS

The evaluation of image quality may be classified into two classes, subjective and objective methods as shown in Fig. 1.

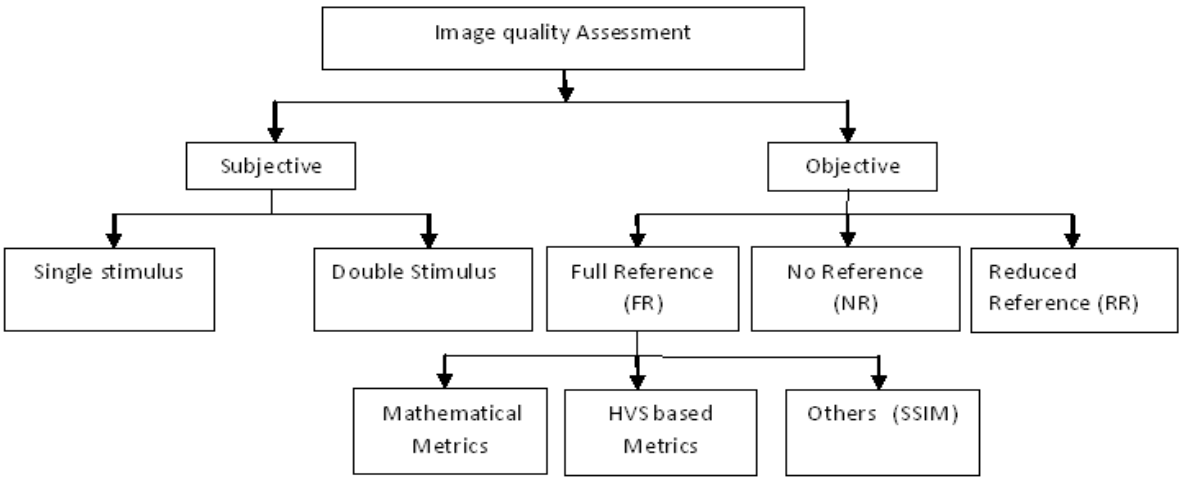

Fig1. *Classification of IQA methods*

2.1. Image Quality Metrics

2.1.1. PSNR

The Peak Signal to Noise Ratio is one of the most widely used metrics until now due to its computational simplicity. Mathematically, PSNR is represented as:

$$\text{PSNR}=10\ \log_{10}\frac{L^2}{\text{MSE}} \tag{1}$$

2.1.2. MSE

It means mean squared difference between the original image and distorted image. The mathematical definition for MSE [2] is:

$$MSE = 1/M \times N \sum_{i=1}^{M} \sum_{j=1}^{N} (a_{ij} - b_{ij})^2 \tag{2}$$

Where a_{ij} is the pixel value at position (i, j) in the original image and b_{ij} is the pixel value at the distorted image.

2.1.3. Limitations of PSNR and MSE

There are a number of reasons why MSE or PSNR may not correlate well with the human perception of quality.

- Digital pixel values, on which the MSE is typically computed, may not exactly represent the light stimulus entering the eye.
- Simple error summation, like the one implemented in the MSE formulation, may be markedly different from the way the HVS and the brain arrives at an assessment of the perceived distortion.
- Two distorted image signals with the same amount of error energy may have very different structure of errors, and hence different perceptual quality.

2.1.4. HVS Based METRIC

As human eye measure image quality this metric measures image quality in same way. Contrast, color and frequency changes are used by human to measure the image quality. The two most important HVS based metrics are SSIM and UQI.

2.1.5. SSIM

The structural similarity index is a method for measuring the similarity between two images [7]. In SSIM, μ_x and σ_x can be viewed as estimates of the luminance and contrast of x, and σ_{xy} measures the tendency of x and y to vary together, thus an indication of Structural similarity. The mean intensity is estimated as [2]

$$u_x = \sum_{i=1}^{N} x_i / N \tag{2}$$

$$u_y = \sum_{i=1}^{N} y_i / N \tag{3}$$

The block diagram of SSIM [2]

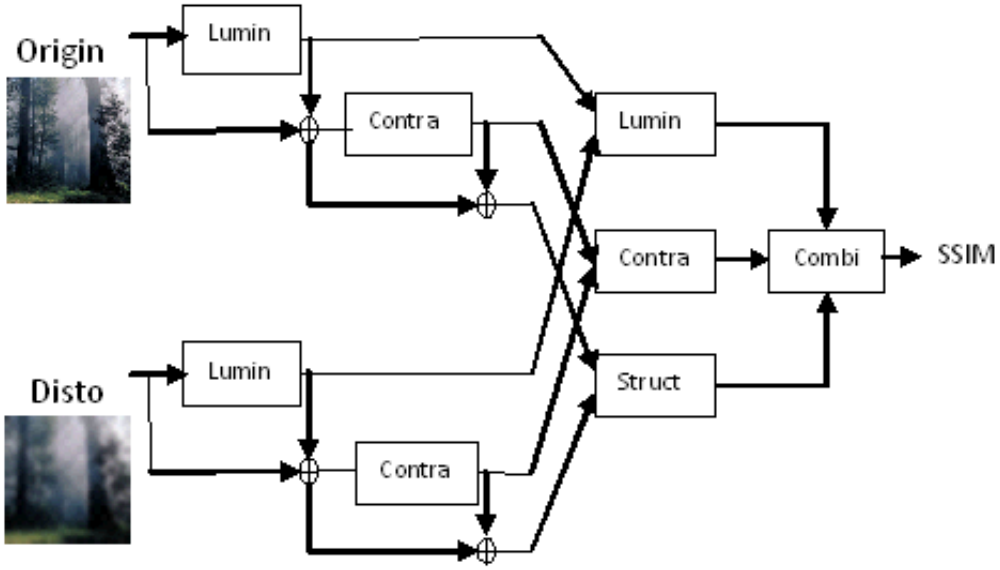

Fig2. *Block Diagram OF SSIM [2]*

2.1.6. Feature Based Method

Feature contains a lot of information about the image and therefore can be used in image quality measurements .Discontinuities in edge, decreases in edge sharpness, offsets of edge positions, missing edge points, falsely detected edge points are some examples of feature degradations.

1) *HAAR WAVELET BASED SSIM(HWSSIM):*It proposes a new full reference based image quality assessment etric.IN this both reference and distorted images are decomposed by 2-D haar wavelet transform: LL, LH,HL,HH. Luminance and contrast information is extracted from LL band and edge information is obtained from other three bands and whole image metric is defined as MHWSSIM [6].

2) *DAUBECHIES WAVELET METRIC(DWM)***:** This Image quality assessment metric based on human visual system which accounts for sensitivity of human vision to distinct features of image e.g sharpness and zero crossing. Edge points obtained by zero crossing and sharp regions are highly attentive to early vision are important that gives good quality estimation .Four bands are extracted from reference and distorted image by employing 2-D Daubechies wavelet decomposition namely :LL, LH,HL,HH. Our metric uses three bands LH, HL,HH bands to calculate sharpness similarity of reference and distorted image and final ratio of zero crossing and this metric is defined as DWM.Fig below shows how wavelet decomposition is applied ,image is decomposed into four bands and from these bands edge information can be extracted[10]

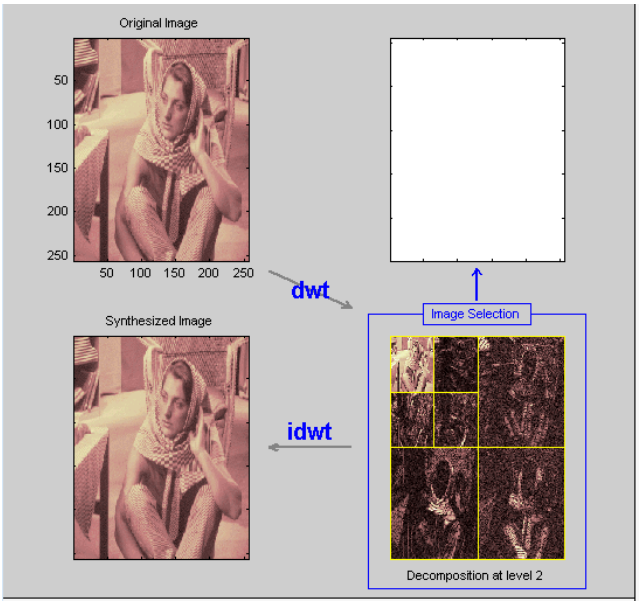

Fig3(a). *Apply wavelet decomposition at level 2*

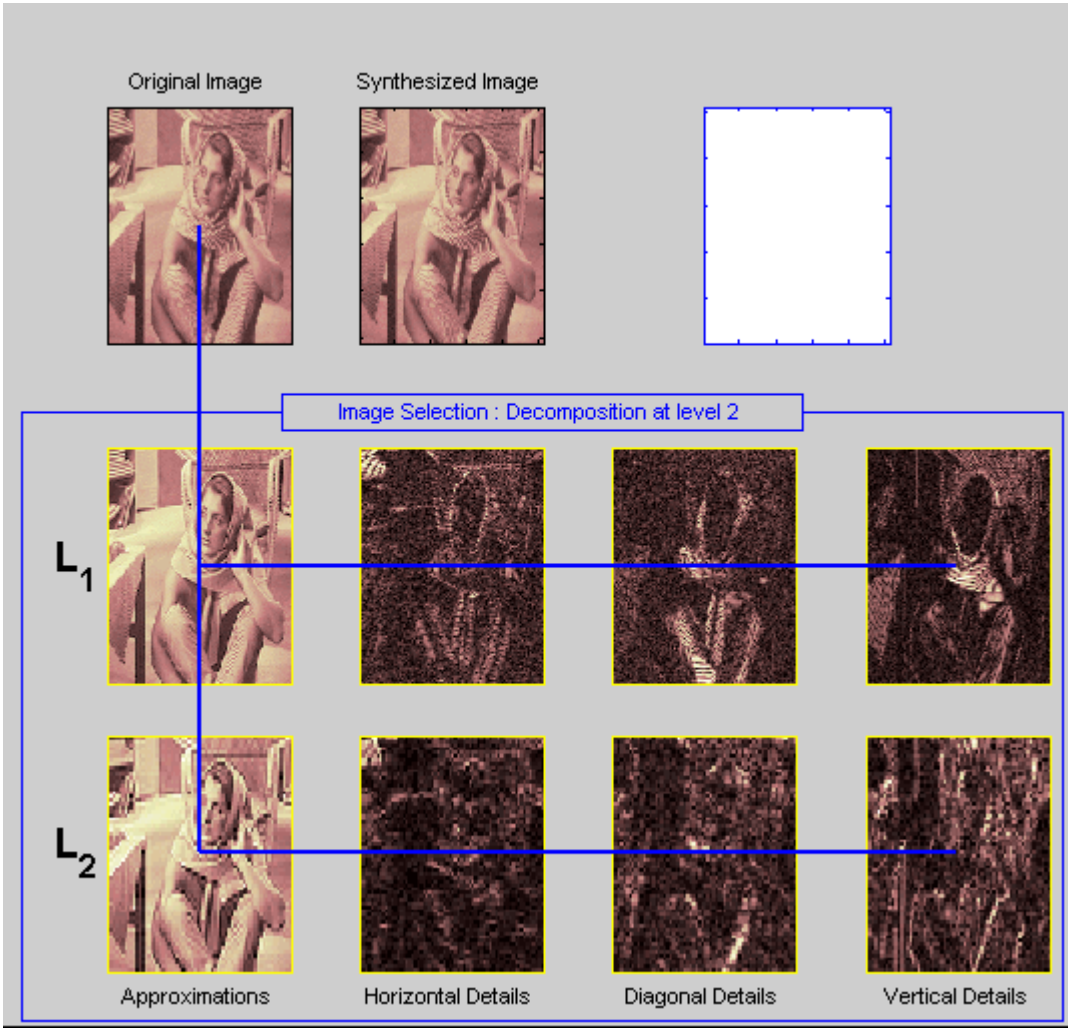

Fig3(b): *Applying wavelet decomposition to extract horizontal, vertical and diagonal detail*

3. RELATED STUDIES

Zhou Wang, Alan C. Bovik in 2002 presented a new universal image quality index.Their experimental results indicate that it performs better than MSE [1].ZhzhongZhe and Hong RenWu in 2004proposederror sensitive pooling algorithms that may be a cause for the reduction of the metric performance[2].Santiago Aja-Fernandez, Raul San Jose Estepar ,Carlos Albrola ,Lopez and Carl-Fredrik Westin in 2006 introduces image quality index based on comparison of local variance distribution of two images. [3].D.Venkata Rao, N.Sudhaka r,B.RavindraBabu, L.Pratap Reddy in 2006 introduces an image quality index Visual region of interest Weighted Structural Similarity. [4].Wan Yang, Lehua Wu,Ye Fan and Zhaolian Wang in 2008 apply method of image quality assessment based on structure similarity index (SSIM) to images including region of interest(ROS) [5].Guo-Li Ji,Xiao-Ming Ni,Hae-Young Bae in 2008 proposes a full reference image quality assessment method with discretehaar wavelet transform(HWSSIM)[6].AlianHore,DjemelZiou in 2010 analyses two well-known quality metric PSNR and SSIM and derived a simple mathematical relation between them which works for various kind of image degradation such as Gaussian blur, AWGN, JPEG and JPEG 2000 compression[7].Reenu M,Dayanadevid,AneeshRaaj introduces a wavelet based perceptive image quality assessment metric based on HVS which accounts for sensitivity of human vision to sharp features of images ,the sharpness and zero crossing [9].

4. CONCLUSION

In this paper, we have summarized the traditional method of image quality assessment based on error sensitivity and its limitations in images. We have also discussed about the structural approaches of image quality measurement. We demonstrate the disadvantages of traditional approach. Our paper introduces wavelet decomposition to access image quality. Experiments results indicate that proposed method is better correlated with HVS and gives comparable results to MSSIM.

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