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Article · August 2019

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Iman Hussein AL-Qinani
Mustansiriyah University
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Scientific Journal Impact Factor (SJIF): 5.278
International Journal of Modern Trends in Engineering and Research
ISSN (ONLINE) : 2349 - 9745 ISSN (PRINT) : 2393 - 8161

A Review Paper on Image Quality Assessment Techniques

Iman Hussein AL-Qinani[1]
[1] *Department of Computer Science, College of Education, Al -Mustansiriyah University*

Abstract—*Image quality measures (IQA)* presentation a significant function for a types image processing treatment. At purpose for the IQA is to run quality evaluate that apply up for estimate operation image processing procedures.

A big work of exertion has been built in latest years to progress objective IQA that associate fit with objective human quality metrics or subjective styles. Furthermost *full reference (FR)* procedure were resulted built on pixel to pixel error for example *peak signal to noise ratio* or *mean square error, structural similarity index metric etc*. Such work offers several procedures performed for *IQA*.

Keywords— Image Quality Assessment; similarity; subjective methods; objective; full reference.

I. INTRODUCTION

At image processing and computer vision, image quality valuation has a major and difficult problem including interests thru a type of usages, for example enhancement image property and dynamic monitoring, it is so far an effective field of research.

Quality of image is a feature for image which valuation discovered image distortion. The quality valuation is a significant branch of image processing and computer vision. For ration volume of corruption in filtering image, compressed image area, and estate enhancement techniques are a lot used. compression of image decreases the quality of the picture and some criterion to calculate this image corruption is required.

The image quality valuation gives computational patterns to scale the quality of an images.

IQA may be done subjectively method or objectively way. Objective image optical quality evaluation may be into categories: first category, no-reference (NR); second category, reduced-reference (RR); third category full-reference (FR) depend on present of original image. At FR measure, quality of an exam image is metrices by matching it with a reference (original) image. RR approaches have limited information from the original image. However, NR approaches go to evaluation the quality of an image lacking original image. Benefit from objective quality valuation study is been offer quality measures which may be guess image quality mechanically [1].

II. IMAGE QUALITY ASSESSMENT METHODS

The estimation of quality can be split into categories; subjective and objective approaches.

2.1 Subjective Approaches

Subjective approaches are depending on human decision. These approaches troublesome, time uncontrollable and without giving mechanization for scheme [2]. Subjective approaches are usable anywhere images, it finally to watch through human; technique of measure visible image quality is

during subjective assessment. In *Human Vision System (HSV)* based measure, variance between the test images and the original images is uniform based to its visibility, as controlled by psychophysics of person perception. Even so lead to some disadvantages, they are difficult simply achieved due to several scenarios, for example; real time applications, works are not possible to be contained within automatic systems, ect. [2].

2.2 Objective Method

Objective technique is a quantifiable method everywhere we are operating two images in that intensity of original and damaged image, they kind are applied to compute a number that show image quality [3].

An objective image quality measure can performance a form of roles in image processing purposes. First, it can be used to dynamically monitor and modify image quality Such as, a network digital video server can be studying the quality of video being conducted for control and assign flowing resources. Second, it can be used to optimize procedures and factor settings of image processing functions. For example, in a visual communication organization, a quality measure can support in the best design of prefiltering and bit give algorithms in encoder and of best reconstruction, error coverup, and postfiltering procedures in decoder. Third, it can be used to standard image processing schemes and procedures [4].

Objective technique is classed into three kinds' *no-reference (NR), reduced-reference (RR) and full-reference (FR)* depend on the present of the original image. that may be guess image quality mechanically [1].

2.2.1 No-Reference Image Quality Assessment (NR-IQA)

It is first class of IQA techniques which evaluate quality for an image without noticing lacking necessities for an original image of the matching scenery [5].

NR-IQA are of essential importance as they can be set in in actual applications [5].

NR-IQA is an effective subject to study for issues in image processing, this technique the most interesting among approaches of IQA. Thither several methods for NR-IQA. Methods statistical of features that provide acquaintance around the quality of visual images are take-out, they are calculated score of an image quality by these attributes [5].

2.2.2 Reduced-Reference Image Quality Assessment (RR-IQA)

RR-IQA approaches assist as a compare between NR and FR techniques. RR- IQA approaches give a solution for statuses in that the original image is not fully available [6]. These procedures need limited information by original image find at the formula of characteristics. some information is transmitted to receiver region over an auxiliary path [7]. Styles of this kind mostly work by extracting a minimal set of factors (parameters) from the original image, factors which are future used with the damaged image to evaluation quality [6], framework for RR- IQA as shown in figure (1).

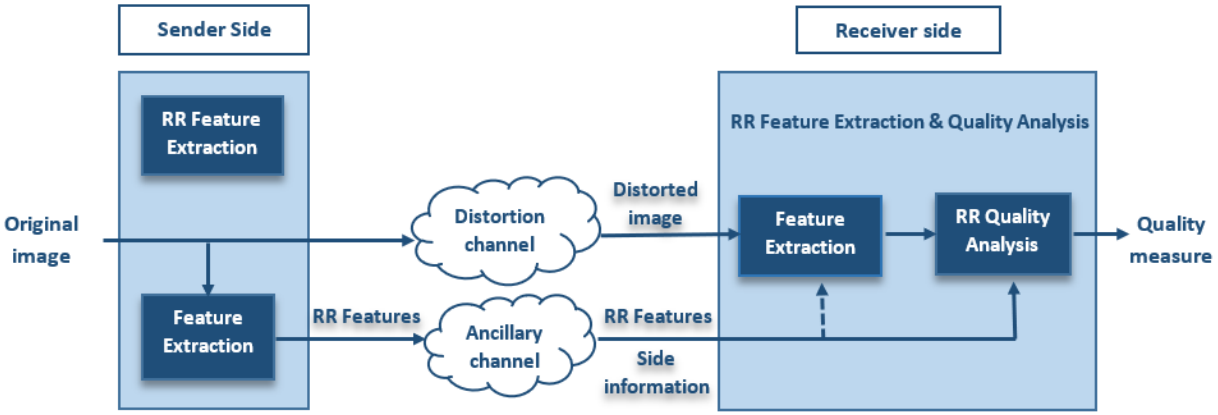

Figure 1. RR-IQA Framework [8]

2.2.3 Full-Reference Image Quality Assessment (FR-IQA)

At this point, damaged image has been matched with the undistorted image(original), that is usually taken using a high-quality machine. figure (2) indicates the schema that illustrates FR-IQA Framework [9].

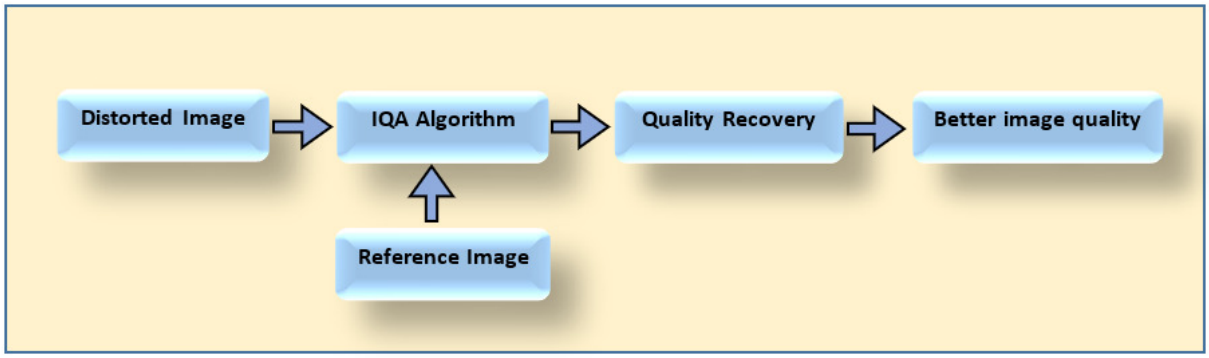

Figure 2. Full Reference Image Quality Assessment Framework [9]

FR-IQA methods offered at most papers can be separated by major sets: First; its dependent the HVS, Second; its dependent arbitrary signal fidelity criteria [10].

2.2.3.1 Human Visual System Based Measures (HVS)

Combination for a basic HVS pattern into objective measures, it is said manages to a best connection with the subjective evaluations. Consign HVS is displayed such as a band pass filter, by an activation function at polar coordinates [11].

$$H(\rho)=\begin{cases}0.05e^{\rho^{0.554}} & \rho<7\\ e^{-9\left|\log_{10}\rho-\log_{10}9\right|^{2.3}} & \rho\geq 7\end{cases}$$

Wherever, (ρ = (u2 + v2)1/ 2, u and v) be the *spatial frequencies*. Both the source and coded images are pre-processed by this filter to mimic the (HVS) result. The image process of multiplying the (DCT) of the image by the *spectral mask* above, and reverse (DCT) transforming is indicated by the (U {·}) operator. in (H1-H3).

Approximately achievable measures for the multispectral images are offered (H1, H2 and H3). The multiscale model (H4) is also described to be explained but it contains channels, which explanation for perceptual phenomena for instance, orientation selectivity, contrast, color and color-contrast. Starting these channels, extraction of features and afterward an aggregate criterion of similarity using a weighted linear mixture of the feature changes is formed [11].

Human Visual System Based (HVS) Measures **can be classed into sets:**

1-Structural Similarity Index (SSIM)

SSIM is a perceptual measure that quantifies image quality damaged produced by operating as by wasted in data transmission or compression of data. It is FR measure that needs two images from the same image capture: an original image and a treated image. The processed image is usually compressed. It may, for instance, be gotten by keeping an original image such as a JPEG then reading it again. SSIM is better accepted in the video industry but has robust uses for still photography. The SSIM is defined as [12]:

$$SSIM(f,g) = l(f,g)c(f,g)s(f,g)$$

Where:

$$\begin{cases} l(f,g) = \dfrac{2\mu_f\mu_g + C_1}{\mu_f^2 + \mu_g^2 + C_1} \\ c(f,g) = \dfrac{2\sigma_f\sigma_g + C_2}{\sigma_f^2 + \sigma_g^2 + C_2} \\ s(f,g) = \dfrac{\sigma_{fg} + C_3}{\sigma_f\sigma_g + C_3} \end{cases}$$

SSIM is too computed in the Imatest Image processing section, which has several abilities not exist in the SSIM. For instance, it can use public degradations (blur, noise, and flare) to images afterward use signal processing methods mostly used to improve images such as bilateral filtering, tone mapping, and unsharp mask [4].

2- DSSIM: Structural Dissimilarity Metric / Differential SSIM

It is comparison images and award a similarity score, which is near for human decision. It's based on the SSIM procedure but develops it by addition multi-scale processing and assist for alpha channels and color.

Structural dissimilarity (DSSIM) possibly be derived from SSIM, however it does not establish a distance measure such as the triangle inequality is not essential satisfied. It is defined as [13]:

$$DSSIM(x, y) = 1/ (1-SSIM(x, y))$$

3- Mean Structural Similarity Index Metric (MSSIM)

It is mean of SSIM and it is defined as [13]:

$$MSSIM(X,Y) = \frac{1}{M}\sum_{l=1}^{M} SSIM(xl,yl)$$

All images of different quality that have approximately same *mean square error* (MSE), with regarding the original image. MSSIM performs a much best indication of image quality.

2.2.3.2 Simple Statistics Error Metrics

1- MSE (Mean Square Error)

It is the very commonly apply and the simplest form for full reference measure which is computed through squared intensity variation of pixels for damaged and original image, mean them by peak signal to noise ratio of the associated quantity [14].

MSE is the most popular destined of IQA. It is FR measure and the values nearest to zero are the better. It is the second instant of the error. The variance of the destined and its bias are both combined with mean squared error. The MSE is the variance of the destined in case of impartial estimator. It has the equal elements of measurement such as the square of the quantity being computed as variance. The MSE presents the *Root Mean Square Deviation* (RMSD) or *Root Mean Square Error* (RMSE) and often denoted to as *standard deviation* of the variance [14].

The MSE can too be tell the *Mean Squared Deviation* (MSD) of an estimator. Estimator is denoted as the action for metric an invisible quantity of image. The MSD or MSE metric the mean of the square of the errors. The error is the margin between the estimator and estimated results. It is a function of risk, considering the predictable value of the squared error loss or squared loss [14].

MSE between two images for example g (x, y) and gˆ (x, y) is identified as [14]:

$$\mathrm{MSE} = \frac{1}{MN}\sum_{n=0}^{M}\sum_{m=1}^{N}\left[\hat{g}(n,m) - g(n,m)\right]^2$$

From Equation, we can understand that MSE is an acting of absolute error [14].

2- Peak Signal to Noise Ratio (PSNR)

This idiom is appearance to rate between a signal that it is highest probable power and power of damaged noise which touches quality of its statement. Since several signals have a very extensive dynamic array, (ratio between the large and small achievable values of a variable quantity) the PSNR is mostly show by logarithmic decibel scale. PSNR represented by mathematical form as follows [1]:

$$\mathrm{PSNR}=20\log_{10}\left(\frac{\mathrm{MAX_f}}{\sqrt{\mathrm{MSE}}}\right)$$

MAXf: The utmost signal value that occurs at original image

3- Peak Mean Square Error (PMSE)

PSNR and MSE are Simple form and maximum used in FR-IQA. Benefit of them are that they are very rapid and relaxed to implement. the other side, they easily and accurately compute the error signal. By PSNR, larger values denote larger image similarity, but by MSE larger values denote lesser image similarity. it is given as [13]:

$$\text{PMSE} = \frac{1}{\text{MN}} \times \frac{\sum_{i=1}^{M} \sum_{j=1}^{N} (x(i,j) - y(i,j))^2}{(\text{MAX}(x(i,j))^2}$$

4- Maximum Difference (MD)

It is known greatest of the error value that is variation among original and test signal [3]. it is given as:

$$\text{MD}=\text{MAX}|x(i,j)-y(i,j)|$$

5- Average Difference (AD)

It gives average for adjustment concerning treated and original image. it is given as [15]:

$$AD = \frac{1}{mn} \sum_{i=1}^{m} \sum_{i=1}^{n} [A(i,j) - B(i,j)]$$

III. CONCLUSION

There are several *objective image quality* compute fashions in the works. The *Mean Squared Error* and the *Peak Signal-to-Noise Ratio* are the two best public objective valuation styles. The MSE, SNR and PSNR are calculated rapidly. Nevertheless, these valuation procedures are not forever the optimal option, particularly if an assessment will be achieved beside the human view of the image excellence. SSIM is extra accurate and reliable than MSE and PSNR in spite of that amount more. De-noising operations are quantitatively calculated by the MSE, PSNR, and RMSE.

ACKNOWLEDGMENT

The authors would like to acknowledge AL-Mustansiriyah University (www. uomustansiriyah.edu.iq) Baghdad-Iraq for its support to present this work.

REFERENCES

[1] Boztoprak, H. (2016), “An Alternative Image Quality Assessment Method for Blurred Images”, Balkan Journal Of Electrical & Computer Engineering, vol. 4(1), pp. 46_ 50, DOI: 10.17694/bajece.24838.

[2] Sonawane, S. and Deshpande, A. M. (2014), "Image Quality Assessment Techniques: An Overview", International Journal of Engineering Research & Technology (IJERT), vol. 3(4), pp. 2013-2017.

[3] Patil, S. and Sheelvant, S. (2015), "Survey on Image Quality Assessment Techniques", International Journal of Science and Research (IJSR), vol. 4(7), pp. 1756_ 1759.

[4] Wang, Z. et al. (2004), "Image Quality Assessment: from Error Visibility to Structural Similarity", IEEE Transactions on Image Processing, vol. 13(4), pp. 600_ 612.

[5] DE, K. and V., A. (2018), "No-Reference Image Quality Measure for Images with Multiple Distortions using Multi-Method Fusion", Image Anal Stereol, vol. 37, pp. 105_ 117, DOI: 10.5566/ias.1534.

[6] Chandler, D. and Sheelvant, S. (2013), "Seven Challenges in Image Quality Assessment: Past, Present, and Future Research", Hindawi Publishing Corporation, vol. 2013, pp. 1_ 53. http://dx.doi.org/10.1155/2013/905685.

[7] Al Madeed, N., Awan, Z. and Al Madeed, S. (2018), "Image Quality Assessment- A Survey of Recent Approaches", Natarajan Meghanathan et al. (Eds): CCSEA, NCOM, AIFU, DKMP, EMSA, SIPRO, SEA - 2018, Computer Science & Information Technology (CS & IT), pp. 143– 156, DOI : 10.5121/csit.2018.80312.

[8] Qiang, Li. and Awan, Z. (2009), "Reduced-Reference Image Quality Assessment Using Divisive Normalization-Based Image Representation", IEEE Journal of Selected Topics in Signal Processing, vol. 3(2), pp. 202– 211.

[9] Yogita, H. and Patil, H. (2015), "A Survey on Image Quality Assessment Techniques, Challenges and Databases", IJCA Proceedings on National Conference on Advances in Computing NCAC 2015(7), pp. 34 – 38.

[10] Sheikh, H.R., Bovik, A.C. and Veciana, G. de (2005), "An Information Fidelity Criterion for Image Quality Assessment using Natural Scene Statistics", IEEE Transactions on Image Processing, vol. 14(12), pp. 2117 – 2128, DOI: 10.1109/TIP.2005.859389.

[11] Avcıbas, İ., Sankur, B. and Sayood, K. (2002), "Statistical Analysis of Image Quality Measures", Journal of Electronic Imaging, vol. 11(2), pp. 206 – 223.

[12] Horé, A. and Ziou, D. (2010), "Image Quality Metrics: PSNR vs. SSIM", 20th International Conference on Pattern Recognition, ICPR 2010, Istanbul, Turkey, pp. 2358_ 23671, DOI: 10.1109/ICPR.2010.579.

[13] Nisha and Kumar, S. (2013), "Image Quality Assessment Techniques", International Journal of Advanced Research in Computer Science and Software Engineering, vol. 3(7), pp. 636_ 640.

[14] Sara, M., Akter, M. and Uddin, M. (2019), "Image Quality Assessment through FSIM, SSIM, MSE and PSNR-A Comparative Study", Journal of Computer and Communications, vol. 7(3), pp. 8_ 1759, DOI: 10.4236/jcc.2019.73002.

[15] Memon, F., Aliunar, M. and Memon, S. (2015), "Image Quality Assessment for Performance Evaluation of Focus Measure Operators", Mehran University Research Journal of Engineering & Technology, vol. 34(4), pp. 379_ 386.