International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Survey on Image Quality Assessment Techniques

Sejal Patil[1], Shubha Sheelvant[2]

[1, 2]Electronics and Telecmmunication, GHRCEM College of Engineering and Management, Wagholi, Pune, India

Abstract: ***Biometrics defines the skills that point and examine human body exteriors .Which isused to identify the person on their behavioral andbiological distinguishing (for example key-stroke, fingerprint, face, iris, signature, etc.). Calculating quality of an image is fundamental problem in image and video handling, and various methods have been projected for image quality assessment (IQA). Quality of an image can be dignified in two ways: subjective IQA and objective IQA method. Objective method is friendly than subjective method because most of the time the reference image is not available for the comparison. This paper presents a survey on the current image quality assessment Methods.***

Keywords: Image Quality Assessment (IQA), objective & subjective method, other methods.

1. Introduction

The Biometric system is used to compare records stored in a central or local database or even on a smart card. The origin of term "Biometric" comes from the Greek words bios (life) and metric (measure) Biometrics is the automated recognition of individuals based onperson's behavioral and physiological characteristics. Physiological biometrics includes:

1. Finger-scan
2. Facial Recognition
3. Iris-scan
4. Retina-scan
5. Hand-scan

Behavioral biometrics system (based on measurements and data derived from an action) include:
1. Voice-scan
2. Signature-scan
3. Keystroke-scan

Image quality measurement is very important for various image processing applications such as recognition, retrieval, classification, compression, restoration and similar fields. The images may contain different types of distortions like blur, noise, contrast change etc. So it is essential to rate the image quality appropriately. Traditionally subjective rating methods are used to evaluate the quality of the image, in which humans rated the image quality based on time requirements. This is a costly process and it needs experts for evaluating image quality. Nowadays many image quality assessment algorithms are available for finding the quality of images. These are mainly based on the properties of human visual system

In a typical digital imaging system, the image is captured and transformed into digital signal by the sensor .Reduce the noise of digital raw image and is compressed for storage or transmission. When the image is finally displayed on the screen to the end user, it might not same as original because it has been gone through several different processes.
The sources of distortion could be ranged from motion blurring, Gaussian noise, sensor inadequacy, compression, error during transmission or the combination of many factors.

To improve the performance of visual information acquisition, transmission, processing, and storage systems, it is essential to assess visual qualities of the images; it is necessary to maintain quality of image before storage and transmission. Recently, a number of techniques have been designed to evaluate the quality of images and videos.

Image quality methods can be categorized in two parts subjective and objective. The subjective assessment of image is done on the bases of subjective experiments .While objective image quality assessment methods were mainly based on some mathematical measures.

2. Image Quality Assessment

Image quality is a characteristic of an image that measures the perceived image degradation imaging systems may introduce some amounts of distortion or artifacts in the signal, so the quality assessment is an important problem.

Basically image quality is measured in two ways subjective and objective method. In Subjective image quality assessment the evaluation of quality by humans is obtained by mean opinion score (MOS) method where in objective evaluation of quality is done by algorithms. The diagram for the IQA is shown in fig.1.It concerned with how image is perceived by a viewer and gives his or her opinion on a particular image and judge quality of the multimedia content. The human eyes extract structural information from the viewing field, so the human visual system is highly adapted for this purpose. Therefore, the measurement of structural distortion should be a good approximation of perceived image distortion .So the accurate and more efficient IQA measures will certainly enhance their applicability in real-world applications.

Basically image quality is measured in two ways subjective and objective method. In Subjective image quality assessment the evaluation of quality by humans is obtained by mean opinion score (MOS) method where in objective evaluation of quality is done by algorithms. The diagram for the IQA is shown in fig.1.It concerned with how image is perceived by a viewer and gives his or her opinion on a particular image and judge quality of the multimedia content. The human eyes extract structural information from the viewing field, so the human visual system is highly

adapted for this purpose. Therefore, the measurement of structural distortion should be a good approximation of perceived image distortion .So the accurate and more efficient IQA measures will certainly enhance their applicability in real-world applications.

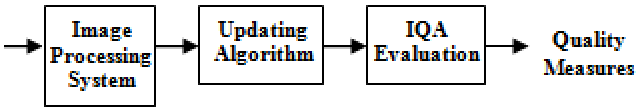

Figure 1: Block diagram of Image Quality Assessment.

3. Image Quality Assessment Techniques

1. Subjective Methods

In subjective quality assessment, images are provided to a number of observers and are asked to compare original images with distorted images in order to evaluate the quality of the distorted images. Based on their evaluation, mean opinion score (MOS) is calculated which is taken as the image quality index. Each image is shown to the observer which is asked to score the image on a scale from 1 to 5.Mean Opinion Score (MOS) scores are given in Table 1. There are three different factor used:luminance, viewing distance from observer to display and display properties are taken into account while conducting the subjective quality test.

A. Double stimulus impairment scale (DSIS)

In this method videos are shown consequently in pairs: first one is the reference, and expert is informed about it, second one is impaired. After their playback, Observers are then asked to vote on the second, keeping first in mind using a scale containing 5 scores: Imperceptible (5), Perceptible but not annoying (4), slightly annoying (3), Annoying (2), and Very annoying (1).

B. Double-Stimulus Continuous Quality-Scale (DSCQS)

This subjective method was developed to measure the quality of service on longer viewing sequences. The method is cyclic which means that the assessor is asked to view a pair of pictures. One is the original video or image without any transmission errors and the other is the same but after alteration by transmission errors. In other words, both images are from the same source, but one passed through radio channel and the other one came directly from the source. The observers assess the quality of both images by direct comparison.

C. Single Stimulus Continuous Quality Scale (SSCQS)

In this technique image sequences without a reference are presented to the observer only once Observers continuously weigh the image sequence along the time on a linear scale by an electronic recording handset associated to a computer and provide a result as “best” or “worst”.

D. Simultaneous Double Stimulus for Continuous Evaluation (SDSCE)

In this technique image sequences are offered in pairs such that original and impaired sequences are presented side by side at same time. Then, the observers are enquired to check the alterations amid the two sequences and to evaluate the fidelity of the image information along the time on a linear scale by an electronic recording handset attached to a computer. The observers are conscious of the original and distorted sequences throughout calculation session. After the calculation session, data is collected from the tests and processed to achieve a level of impairment.

2. Objective Methods

Objective method is a quantitative approach where we are using two images in which intensity of two images, reference and distorted type are used to calculate a number which indicate the image quality. Objective method is classified into three types’ full-reference, reduced-reference and no-reference on basis of availability of reference image.The goal of these models is to automatically estimate the perceptual quality of images, in a way correlated with the human appreciation.

1) *No Reference (NR) models:* In this objective reference IQA method, in general the human visual system does not require of a reference sample to determine the quality level of an image. This method also called “blind models” methods.
2) *Reduced Reference (RR) models:* In this method original reference image from sender side is not completely available at receiver side IQA system. However, some set of features are extracted from the original reference image and they are being utilized by the quality assessment system, which helps assessment system to evaluate the quality of the distorted image and quantify it.
3) *Full Reference (FR) model:* In this objective reference IQA methods, in general the human visual system require of a reference sample to determine the quality level of an image.

4. Full Reference Image Quality Assessment

A. Simple statistics error metrics

MSE:

It stands for the mean squared difference between the original image and distorted image. The mathematical definition for MSE

$$\text{MSE}=1/(M*N)\sum_{I=1}^{M}\sum_{J=1}^{N}(a\,ij-bij)^{\wedge}2$$

Peak Signal to Noise Ratio (PSNR):

PSNR is a classical index defined as the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation

$$\text{PSNR}=10\log_{10}255^{2}/\text{MSE}$$

Where 255 is the maximal possible value the image pixels when pixels are represented using 8 bits per sample.

Maximum Difference (MD):

MD is the maximum of the error signal that is difference between the reference signal and test image.

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

Average Difference (AD):
AD is simply the average of difference between the reference signal and the test image and it is given by the equation.

$$AD=1/MN\sum_{i=1}^{M}\sum_{j=1}^{N}(x(i,j)-y(i,j))$$

Mean Absolute Error (MAE):
MAE is average of absolute difference between the reference signal and test image. It is given by the equation.

$$MAE= 1/MN\sum_{i=1}^{M}\sum_{j=1}^{N}|x(i,j)-y(i,j)|$$

B. Structural Similarity Measures
Although being very convenient and widely used, the aforementioned image quality metrics based on error sensitivity present several problems which are evidenced by their mismatch with subjective human-based quality scoring systems.Among Structural Similarity Index Measure (**SSIM**), has the simplest formulation and has gained widespread popularity in a broad range of practical applications.

In this method measuring the similarity between two images, here we measure image quality based on an initial uncompressed or distortion-free image as reference. It compares two images using information about luminous, contrast and structure. SSIM metric is designed to improve on traditional methods like PSNR and MSE and this is calculated on various windows of an image. The measure between two windows x and y of common size N×N is given as follows:

$$SSIM (x, y) = \{(2\mu_x \mu_y +C_1) (2\sigma_{xy} +C_2)\}/ \{(\mu_x^2 + \mu_y^2 +C_1) (\sigma x2 +\sigma_y^2 +C_2)\}$$

Where μx is average of x, μy is average of y, σx, σy are standard deviation between the original and processed images pixels, respectively.C1, C2 are positive constant chosen empirically to avoid the instability of measure. SSIM is a decimal value between (-1, 1).

C. Information Theoretic Measures
The goal is to relate the visual quality of the test image to the amount of information shared between the test and the reference signals, or more precisely, the mutual information between them. In this measure the Visual Information Fidelity (VIF) is used which is based on the informationtheoretic perspective of IQA

The VIF metric measures the quality fidelity as the ratio between the total informationideally extracted by the brain from the whole distorted image and the total information conveyed within the complete reference image.This metric relies on the assumption that natural images of perfect quality, in the absence of any distortions pass through the human visual system (HVS) of an observer before entering the brain, which extracts cognitive information from it. For distorted images, it is hypothesized that the reference signal has passed through another "distortion channel"before entering the HVS. The VIF measure is derived from the ratio of two mutual information quantities: the mutual information between the input and the output of the HVSchannel when no distortion channel is present (i.e., referenceimage information) and the mutual information between the input of the distortion channel and the output of the HVS channel for the test image. Therefore, to compute the VIF metric, the entire reference image is required as quality is assessed on a global basis.

5. No-Reference Image Quality Assessment

A. Distortion-specific approaches
Thefinal quality measure is computed according to a model trained on clean images and on images affected by this particular distortion. Two of these measures have been included in the biometric protection method.

The JPEG Quality Index (JQI):
This method evaluates the quality in images affected by the usual block artifacts found in many compression algorithms running at lowbit rates such as the JPEG

The High-Low Frequency Index (HLFI):
This method is inspired by previous work which considered local gradients as a blind metric to detect blur and noise. Similarly, the HLFI feature is sensitive to the sharpness of the image by computing the difference between the power in the lower and upper frequencies of the Fourier Spectrum.

B. Training-based approaches
In this approach features are extracted from the image and algorithm is trained to distinguish distorted and undistorted image as used in BLIINDS

Blind Image Quality Index (BIQI) follows a two-stage framework in which the individual measures of different distortion-specific experts are combined to generate one global quality score.

C. Natural Scene Statistic approaches
This approach relies on how the statistics of images change as distortions are introduced to them. It assumes that natural or undistorted images occupy a subspace of the entire space of possible images, and then seeks to find a distance from the distorted image (which supposedly lies outside of that subspace) to the subspace of natural images

This approach is followed by the Natural Image
Quality Evaluator (NIQE):
Completely blind image quality analyzer based on the construction of a quality aware collection of statistical features (derived from a corpus of natural undistorted images) related to a multivariate Gaussiannatural scene statistical model.

6. Reduced Reference (Rr) Models

A RR image quality assessment method based on Roberts cross derivative or wavelet domain model of statistic of natural image is possible. The Roberts cross derivative can be used to extract geometric features of an image, which are applied in HVS perception.

Another method is based on wavelet domain RRIQA using natural image statistics model. This method of RRIQA implements the Kullback-Leibler distance between the marginal PDFs of wavelet coefficients of the original reference and distorted images as an image distortion measure.

7. Conclusion

In this paper we discussed about the various approaches used to evaluate the quality of an image. The experimental results demonstrate that the MSE and PSNR methods are simple and are easy to implement but it does not correlate highly with human awareness. Quality assessment algorithms are desirable to monitor the quality for real time applications. Subjective methods are difficult to implement in real time schemes, so objective approaches are more involved in current years. But correct and effective IQA measures help to improve their applicability in real time applications.

References

[1] Reduced-Reference Image Quality Assessment Using Divisive Normalization-Based Image Representation", Qiang Li and Zhou Wang, IEEE Journal of Selected Topics In Signal Processing, Vol. 3, No. 2, April 2009.
[2] Horé, A., Ziou, D., "Image Quality Metric: PSNR Vs SSIM", IEEE conference on Pattern recognition, pp 2366-2369,2010.
[3] R. Soundararajan and A. C. Bovik, "RRED indices: Reduced reference entropic differencing for image quality assessment," IEEE Trans. ImageProcess., vol. 21, no. 2, pp. 517–526, Feb. 2012.
[4] H. R. Sheikh and A. C. Bovik, "Image information and visual quality,"IEEE Trans. Image Process., vol. 15, no. 2, pp. 430–444, Feb. 2006
[5] Z. Wang, H. R. Sheikh, and A. C. Bovik, "No-reference perceptualquality assessment of JPEG compressed images," in *Proc. IEEE ICIP*, Sep. 2002, pp. 477–480.
[6] X.Zhu andP. Milanfar, "A no-reference sharpness metricsensitive to blur and noise," in *Proc. Int. Workshop Qual. Multimedia Exper.*, 2009, pp. 64–69.
[7] K. Moorthy and A. C. Bovik, "A two-step framework for constructing blind image quality indices," *IEEE Signal Process. Lett.*, vol. 17, no. 5, pp. 513–516, May 2010.