A Review Paper on Image Quality Assessment Metrics

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***Abstract*— Image quality assessment plays very important role in different image processing applications such as image enhancement, image compression, image restoration, image acquisition and other fields. Image quality assessment is necessary because images may contain different types of noise like blur, noise, contrast change, etc. Image quality assessment researchers face many problems when designing a model of Human Visual System which can deal with natural images. In this paper we have reviewed some papers based on IQA metrics. We have tried to find some advantages of them by studying it.**

***Index Terms*— SSIM; Image quality assessment (IQA); ESSIM; FSIM; MSSIM; Human Visual system.**

I. INTRODUCTION

WHAT IS QUALITY?

Quality is defined as the measure of excellence. Quality word is used in our daily life like image quality, picture quality, video quality, color quality, etc.

What is image quality?

ISO defined the image quality as a overall merit or excellence of an image as a perceived by the observers. Image quality is defined by the yendrikhovskji as a compromise between color realism and color discrimination.

What is image quality assessment?

Image quality assessment can be defined as to assess or to measure the quality of an image in accordance or in reference to the original image. For example, in image compression, if the captured image contains distortions then it would not match with the original image that is stored in the dataset. So finding the quality of the image in those areas is very necessary. Usually subjective rating methods are used for calculating the quality of the image. In this subjective rating, Observers rated the image quality. The images are given to the experts. Based on the time requirements available, they give scores to the image. Subjective results can provide accurate results, but it is time consuming and also a costly process. This is the reason for the development of objective image quality assessment algorithms (IQA) that will predict the quality of the image automatically. According to the availability of the original reference image, the objective methods are classified into full reference, reduced reference and no reference.

Applications:

1. Image enhancement
2. Image compression
3. Image acquisition
4. Image restoration

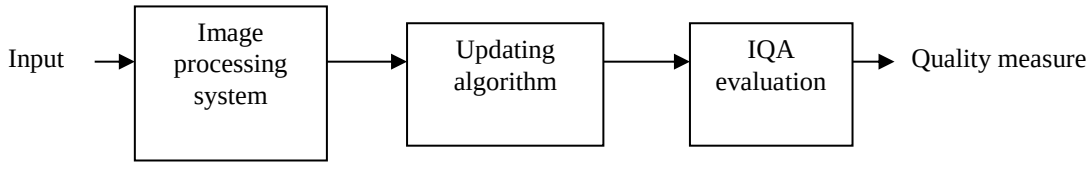

Fig.1 Diagram for IQA[1]

II.LITERATURE REVIEW

Image Quality Assessment Metrics:

1. SSIM: To measure the similarity between two images the method used is the structural similarity index. The SSIM metrics is a full reference metric, or one can also say the measuring of image quality based on an original reference or noise-free image as reference and noisy image as a distorted one. It compares two images using information about luminous, contrast and structure. General tendency in the earlier days, image quality assessment is done on the philosophy that prediction about the error visibility,

while new method is to account for the structural distortion present in the image. This new method is more accurate. The three similarity functions as discussed earlier are then combined into the general form of the SSIM index:

$$SSIM(X; Y) = [l(X; Y)] \cdot c(X; Y)] \cdot [s(X; Y)] \quad (1)$$

2. ESSIM: The Structural Similarity index(SSIM) is proposed, by hypothesis that human nature is that it will extract structural information from a scene or from any image which he has seen. Also simulation results have proved that human visual system structural features are better than PSNR (or MSE). By deeply studying on the SSIM, people searched that it fails in measuring for the badly blurred images. So, based on this, a researcher has developed an improved method which is called Edge-based Structural Similarity (ESSIM).The newer and improvised version of SSIM is E-SSIM. Edge-based structural similarity (ESSIM), can be defined as the comparing quantity metrics which compares the edge information between the distorted image block and the original one, and replace the structure comparison by the edge-based structure comparison. There are a many ways to get the edge information one of them is the the simple edge detection algorithm and second is the local gradients.

Fig.2 (a) [4]

Fig.2 (b) [4]

Fig.2(c) [4]

Fig.2 (a) Original image
Fig.2 (b) ESSIM= 0.2510
Fig.2 (c) ESSIM= 0.1340

3. MS-SSIM: The more flexible method than the other single scale methods is multi scale structural similarity measure. The active SSIM algorithm is a single scale method. This multi scale method image details with different resolutions can be included. Low-pass filtering and down sampling are the two main operations used in this multi scale structure similarity method. The original and the distorted or noisy images are iteratively low-pass filtered and then down sampling will be done on that by factor of 2. For this multi scale operation, the original image is taken as scale1. The highest scale is for example scale M so a total of M-1iterations are taken place. In the SSIM method, three comparisons have been done i.e., contrast comparison, luminance comparison and the structure comparison, similar to that multi scale structure similarity also has three comparisons. The one comparison is performed on scale M is luminance comparison. Other two comparisons are performed on the intermediate scale and after all these the final quality measurement metrics is the combination of these three comparisons.so one can say that this is a more convenient image quality metric than the other single scale methods.

Fig.3 (a)[5]

Fig.3(b)[5]

Fig.3(c)[5]

Fig.3(d)[5]

Fig.3(e)[5]

In the above shown Figure 3 (a) to (e) MS-SSIM is decreasing order and MSE in the (a) is 1while (b) to (e) 225s

4. FSIM: Image quality assessment (IQA), main goal is to use computational models to measure the images quality which gives consistency with subjective evaluations as we all know the structural-similarity (SSIM) index brings IQA from pixel-based stage to structure-based stage. A research work on feature-similarity (FSIM) index for full reference IQA is proposed based on the fact that human visual system (HVS) understands an image mainly according to its low-level features instead of high level features. And here there are two features in the detail can be viewed of the FSIM (feature similarity index).These two are: Phase congruency and Gradient magnitude. First is the phase congruency (PC), which is a dimensionless quantity of the significance of a local structure map and it is used as the primary feature or function in FSIM. Considering that PC is contrast invariant but no effect of contrast information the contrast information on Human visual system perception of image quality, Second feature is the image gradient magnitude (GM) is employed as the s feature in FSIM. PC and GM are complementary of each other in characterizing the image local quality.

Gradient operators can be expressed by different convolution masks. The commonly used gradient operators are prewitt operators, sobel operators, scharr operators. Scharr operator could achieve far better performance as compared to prewitt and sobel operators. The computation of FSIM index is consisting of two stages and There are: local similarity map calculation and then in the second stage is pooling the similarity map into a single similarity score. So, for calculating gradient magnitude of FSIM and FSIMc where FSIMc is chrominance component of FSIM.

III. SUMMARY

Sr.No.	SSIM	MS-SSIM	ESSIM	FSIM
1	SSIM gives IQA from pixel based stage to a structure based stage	MS-SSIM is novel Synthesis based Approach to Calibrate the Parameters that Weight the relative Importance between Different scales.	ESSIM gives Better performance than SSIM and gives Edge and contour information of the image which is human tendency.	FSIM index is used to understand images mainly according to low level features.
2	SSIM is not useful for badly blurred images.	MS-SSIM is also not useful for badly blurred images.	ESSIM is useful for badly blurred or noisy images specifically for Gaussian noise.	FSIM is useful and works well on all datasets.
3	SSIM is having good prediction capability.	Good prediction capability and robust Compares between different scales.	Good prediction capability, efficiency is high.	FSIM gives good prediction capability, higher accuracy and robust.

IV. Future Work

After studying all the metrics related to image quality assessment developed recently, we can conclude that PSNR and MSE are useful but not as much accurate as all the above. And we can use it on the related applications.so,we will check for image enhancement by discrete wavelet transform and see what are the changes in its features. At the final stage comparison between Original and enhanced version of image.

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