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Objective Full Reference Image Quality Assessment Metrics

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Abstract: Digital Images are captured, stored, transmitted and displayed in different formats in various devices. There is a need to maintain quality of an image throughout the processing of an image. The quality of an image can be measured using either objective or subjective image quality assessment methods. However subjective image quality assessment methods are expensive and time consuming. But objective methods can evaluate the quality of image well as compared to subjective methods. This paper aims to present various techniques implemented based on objective methods for assessing the quality of an image.

Keywords: image quality assessment, quality metric, distortions, reference image, original image.

I. INTRODUCTION

Digital images are subject to various types of distortions during storage, compression and storage of image. There is a great need of highly efficient image quality assessment systems in our daily life. The assessing quality of image is highly considered critical in each of image processing applications. There are two types of methods to assess the quality of an image that are used in image processing systems [6].

- Subjective Image Quality Assessment
- Objective Image Quality Assessment

The principle of subjective image quality method is based on the group of observers judge the quality of an image being seen by them. This method is very expensive and difficult to implement in automatic systems [1].

The objective image quality assessment methods based on quantitative measures to predict the quality of an image automatically.

The objective quality metrics can automatically adjust the quality of an image and could include in automatic systems.

Objective image quality metrics are classified according to availability of an original image with which the distorted image would compared that is called Full Reference. In some cases, the reference image is not available, this approach is called No Reference method. In some cases the partial information of an image is available to evaluate the quality of an image, this is called Reduced Reference method [2].

But in this paper, methods based on full reference approach are discussed to assess the quality of an image. Here assuming reference image is available for assessing the quality of an image.

II. TECHNIQUES

There are various objective image quality metrics proposed for assessing the quality of an image based on full reference methods.

The simplest and widely used full reference quality metric is the Mean Squared Error(MSE), computed by averaging the intensities of distorted and reference image pixels. By computing the MSE one can calculate the peak-signal-to nose ratio (PSNR). Another form of PSNR is also described which is Weighted Signal to Noise Ratio (WSNR). WSNR is based on Contrast Sensitivity function (CSF). Firstly the difference of reference and distorted image is computed then the difference is transformed into frequency domain using two dimensional Fast Fourier transform. These metrics are simple to calculate and mathematically easy. But these metrics does not correlate well with perceived image quality.

To overcome the problem of MSE, a new metric has been proposed to evaluate the quality of an image which is Structural Similarity Index (SSIM) [3]. It is based on comparing the structure of original image and distorted image. It also compares the local patterns of pixels that have been normalized for luminance and contrast. But this metric does not work well for scaling, rotation and translation of images. SSIM could not able to evaluate the quality of badly blurred image.

To handle such situations, a new version of SSIM have been proposed which is Complex Wavelet SSIM (CWSSIM)[5]. It is based on the fact that local phase contains more structural information and could tune well for rotation and translation of an images.

Instead of using summation method of finding the distortion in an image another metric is developed that is Universal quality index (UQI) [4]. This metric is based on images being tested, the viewing conditions and the individual observers. It is also applicable to various image processing applications and provide meaningful comparison across different types of image distortions. This work attempts to develop a new index to replace MSE and PSNR roles. MSE is sensitive to energy of errors instead of structural distortions.

Both UQI and SSIM are related to the human visual system, noting that people evaluate image quality based on the structural information rather than pixel intensities themselves. They use the structural information such as the mean, variance, and covariance of intensity values of the reference and distorted image.

Another image quality metric was proposed to evaluate the quality of an original image that is Visual Information

Fidelity(VIF). It is based on modeling of the statistical image source, the image distortion channel and the human visual distortion channel. Image quality assessment is done based on information fidelity where the channel imposes fundamental limits on how much information could flow from the reference image, through the image distortion process to the human observer. The VIF has a distinction over traditional quality assessment methods, a linear contrast enhancement of the reference image that does not add noise to it will result in a VIF value larger than unity, thereby signifying that the enhanced image has a superior visual quality than the reference image and no other quality assessment algorithm has the ability to predict if the visual image quality has been enhanced by a contrast enhancement operation.VIF produces more correlated values as compared to other objective metrics but its cost with respect to time is very high.

To overcome this problem a new quality metric based on full reference approach is proposed that is Contrast Error Distribution (CED) [9]. It provides a new way for defining the quality of an distorted images with a quiet simple form and good stability across various types of degradation of an image.

Another new image quality metric based on Harris Response full reference image quality metric is Harris Response Quality Metric(HRQM) [8]. It uses the gradient information matrix and its eigen values that reflect well the information about the geometric structure of an image pixel. When an image is degraded by image compression, noise, transmission error, the gradient information of the image is changed, causing the Harris response to change. Therefore, the degree of change in the Harris response of the image is related to the quality degradation of the image.

Another image quality metric Visual Signal to Noise Ratio (VSNR) [10]. VSNR is wavelet based image quality assessment method which some low level and mid level properties of human vision such as contrast sensitivity, visual masking and global precedence.

Another image quality metric is Riesz-transform based Feature Similarity metric (RFSIM) [7].It is based on the fact that the human vision system (HVS) perceives an image mainly according to its low-level features. The 1st order and 2nd order Riesz transform coefficients of the image are taken as image features, while a feature mask is defined as the edge locations of the image. The similarity index between the reference and distorted images is measured by comparing the two feature maps at key locations marked by the feature mask. RFSIM is computed by comparing Riesz transform features at key locations between the reference image and a distorted image. Considering the fact that HVS is sensitive to image edges, key locations are marked by a mask formed by the Canny operator with respect the feature extraction, the 1st order and 2nd order Riesz transforms are used because they can extract several types of image low-level features effectively and efficiently

Another image quality based on structural information is Histograms of Oriented Gradients (HOG) [10]. It is based on the distribution of local orientations in one image reflects high order properties of an image. It is robust to various types of image distortions and quiet efficient in terms of computational complexity.

Another Image Quality metric to evaluate the quality of an image is Noise Quality Measure (NQM). It is based on images degraded only by noise injection. It is based on human vision system and could tune to according to the size and resolution of an image. It is also sensitive to masking effects in contrast perception due to local background and viewer CSF.

III. CONCLUSION

In this paper various metrics for assessing the quality of an image based on full reference approach that are implemented .There are so many techniques available but still no such technique is available that can evaluate 100% quality of an image.

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