Enhanced Image Compression System

Pavithra Mohan, Msc, M.Phil
Bhardhidasan University, Kajamalai road, Trichy 620020.

Abstract *— Image compression is defined as the process of Data compression on digital images. The aim of image compression process is to reduce redundancy content of the image data in order to be able to store or transmit data in an efficient form. Image segmentation methods, which are primarily used for a data reduction process in image, can be used for compression. The reduced file created by the image compression process is called as compressed file and is used to reconstruct the image, resulting in the decompressed image. There are many approaches implemented for image compression process. Huffman coding is loss less approach with extra attractive functions in diverse utility inclusive of medical survey and analysis, technical drawing and so on. Huffman coding has higher characteristics of image compression. Proposed work recognize that Huffman coding set of rules is a step by step manner and involves the variable length codes to input characters & it is useful in finding the entropy and probability of the kingdom. The discrete wavelet transform (DWT) refers to wavelet transformation method for which the wavelets are discretely sampled. A remodel which localizes a function both in area and scaling and has some ideal properties compared to the Fourier transform. This paper proposes a Multi Level DWT approach for image compression technique. This approach split the image into multiple matrix and apply DWT for compression. It has been show that the image compression using Multi Level DWT provides better image quality than image compression using Huffman and other DWT compression technique. Moreover, the Multilevel DWT is quite faster compared to existing Image compression techniques.*

Index Terms *— Image Compression, Lossless compression technique, Huffman coding, DWT, Multi Level DWT*

I. INTRODUCTION

Data compression is the method to reduce the redundancies in information illustration for you to lower records garage necessities and consequently conversation fees. Reducing the storage requirement is equivalent to growing the ability of the garage medium and hence verbal exchange bandwidth. Thus the development of green compression techniques will continue to be a design venture for destiny verbal exchange systems and superior multimedia packages. Data is represented as a aggregate of statistics and redundancy. Information is the part of facts that ought to be preserved permanently in its original shape so as to properly interpret the that means or purpose of the records. Redundancy is that portion of statistics that may be eliminated while it isn't always wished or may be reinserted to interpret the statistics whilst wanted. Most often, the redundancy is reinserted in order to generate the unique facts in its original shape. A technique to lessen the redundancy of records is described as Data compression. The redundancy in facts representation is decreased such a way that it could be eventually reinserted to get better the original information, that is known as decompression of the facts. Data compression schemes will be static or dynamic. In static strategies, the mapping from a fixed of messages (statistics or sign) to the corresponding set of compressed codes is continually constant. In dynamic methods, the mapping from the set of messages to the set of compressed codes changes through the years. A dynamic approach is called adaptive if the codes adapt to adjustments in ensemble characteristics over the years.

Image compression is the application of Data compression on virtual snap shots. The goal of picture compression is to reduce redundancy of the photo facts so as to be capable of save or transmit information in an efficient form. Image compression may be lossy or lossless. Lossless compression is from time to time favored for synthetic photographs along with technical drawings, icons or comics. This is because lossy compression methods, particularly when used at low bit quotes, introduce compression artifacts. Lossless compression strategies will also be favored for excessive price content, including medical imagery or photograph scans made for archival functions. Lossy techniques are specially appropriate for herbal photographs along with pics in applications in which minor loss of fidelity is acceptable to gain a large discount in bit charge. Run-duration encoding and entropy encoding are the techniques for lossless photo compression. Transform coding, where a Fourier-related transform inclusive of DCT or the wavelet remodel are applied, followed by using quantization and entropy coding may be stated as a way for lossy photo compression. A compression artifact (or artefact) is the end result of an competitive statistics compression scheme applied to an photo, that discards a few data that can be too complicated to store in the available information-price, or may additionally have been incorrectly determined by using an algorithm to be of little subjective importance, however is in truth objectionable to the viewer. Artifacts are often a end

result of the latent mistakes inherent in lossy information compression.

A statistics compression gadget in particular consists of 3 essential steps – elimination or discount in facts redundancy, discount in entropy and entropy encoding. The redundancy in records may additionally seem in special paperwork. For instance, the neighbouring pixels in a normal picture are very an awful lot spatially correlated to every other. By correlation it way that the pixel values are very similar inside the non-aspect clean regions within the picture. These redundancies in information illustration may be reduced with a purpose to reap capability compression. Removal or reduction in records redundancy is generally completed by way of remodeling the original statistics from one shape or illustration to another. The famous strategies used in the redundancy reduction step are prediction of the records samples.

Wavelet evaluation can be used to divide the facts of an photograph into approximation and detail sub-alerts. The approximation sub-alerts suggests the overall fashion of pixel values and 3 detail sub-alerts show the vertical, horizontal and diagonal information or modifications within the picture. If these details are very small then they may be set to 0 with out drastically changing the photo. The price under which information are taken into consideration small sufficient to be set to zero is known as the brink. The greater the no. Of zeros the more the compression that may be done. The quantity of facts retained via an photograph after compression and decompression is called the „strength retained" and that is proportional to the sum of the squares of the pixel values. Two sorts of compression strategies are gift.

TYPES OF COMPRESSION TECHNIQUE

Lossless compression: A approach in which the compressed photo is reconstructed without any loss of facts is known as lossless compression. Lossless compression ratio offers accurate satisfactory of compressed pictures, but yields best much less compression.

Lossy compression: A approach in which the compressed image is reconstructed with lack of records is known as lossy compression. The lossy compression techniques lead to lack of facts with better compression ratio.

LOSSLESS COMPRESSION

The Lossless compression techniques involve no loss of records. The unique facts can be recovered precisely from the compressed records. It is used for programs that can't tolerate any difference between the original and the reconstructed records. Lossless compressed picture has a larger length in comparison with lossy one. In a strength restrained packages like wireless communication, Lossless compression is not favored because it consumes power, extra time for photograph transfer. In the following sections attention is at the lossless compression techniques as listed underneath.

- Run length encoding
- Huffman encoding
- LZW coding
- Area coding

LOSSY COMPRESSION

The Lossy compression includes a few lack of information. The facts that have been compressed using lossy strategies typically cannot be recovered or reconstructed exactly. It results in better compression ratios at the expense of distortion in reconstruction. The advantage of lossy over lossless is excessive compression ratio, less technique time and occasional energy in case of strength restricted applications. In the subsequent sections consciousness is at the lossy compression techniques as indexed below.

- Transformation coding
- Vector quantization
- Fractal coding
- Block Truncation Coding
- Subband coding

II. RELATED WORK

M. A. El-Dosuky, et.al,.[1] Proposed a virtual era had been evolved for picture compression. Specifically in the fields of photograph acquisition, records storage and bitmap printing. Compressing an picture is considerably unique than compressing raw binary information. Images have sure statistical properties which can be exploited via encoders in particular designed for them so, the end result is less than premier when the use of popular purpose compression applications to compress pics. One of many strategies below photo processing is picture compression. Image compression have many packages and performs an essential role in green transmission and storage of photographs. The photograph compression objectives at lowering redundancy in photograph statistics to keep or transmit simplest a minimal number of samples And from this we can reconstruct an excellent accession of the original picture according with human visual notion. The maximum famous approach for picture compression, over the last several years, was Discrete cosine rework (DCT). Its choice as the standard for JPEG is One of the primary reasons for its reputation. DCT is utilized by many Non-analytical programs such as photograph processing and signal-processing DSP programs along with video conferencing. The DCT is used in transformation for information

compression. DCT is an orthogonal remodel, which has a hard and fast set of foundation function.

Siddhartha Choubey, et.Al,.[2] Proposed a wavelet rework that has won widespread reputation in signal processing and photo compression. Recently the JPEG committee has released its new photograph coding standard, JPEG-2000, which has been primarily based upon DWT. Wavelet rework decomposes a sign into a set of basis capabilities. These basis functions are called wavelets. Wavelets are acquired from a unmarried prototype wavelet referred to as mom wavelet via dilations and transferring. The DWT has been introduced as a exceedingly efficient and flexible approach for sub band decomposition of signals. The 2D-DWT is these days established as a key operation in image processing .It is multi-resolution evaluation and it decomposes pics into wavelet coefficients and scaling feature. In Discrete Wavelet Transform, sign power concentrates to unique wavelet coefficients. This function is beneficial for compressing pictures. Wavelets convert the photo into a sequence of wavelets that can be stored greater effectively than pixel blocks. Wavelets have hard edges, they are able to render pics bette. In DWT, a time-scale representation of the digital sign is obtained using virtual filtering techniques. The signal to be analyzed is handed thru filters with special cut-off frequencies at distinctive scales. It is straightforward to enforce and reduces the computation time and assets required. A 2-D DWT may be visible as a 1-D wavelet scheme which remodel along the rows after which a 1-D wavelet transform along the columns. The 2-D DWT operates in a clear-cut way by way of placing array transposition between the 2 1-D DWT.

Raj Gaurang Tewari, et.Al,.[3] carried out an photo compression approach wherein size of the image is reduced by casting off the unwanted pixels from the photograph. The WDR is the green approach in which the complete photo is divided into small matrix and matrix which has assorted houses are removed from the photo. Discrete Coefficient Transformation (DCT): The DCT approach is the coefficient based totally transformation in which the colored features of the enter picture are been analyzed and processed. In the proposed approach the image indexing is being achieved according to the pixel value of enter image. To apply vector quantization the coefficients of the enter image are calculated which the color depth values are and inside the closing step the matrix of coloration depth values is generated via taking imply of the pixels. Vector Quantization: The vector quantization of the enter cost is generated from the imply matrix that is generated inside the preceding step. In the vector quantization, 3 steps are observed. In step one, the gray scale pixels of the input image are divided to analyze person gray scale pixels. In the second one step, the RGB pixels are divided to research individual a part of the pixel. In the closing step, the DB values of the pixels are generated to generate final compressed photograph. DCT and Image Masking: In the last step, the approach of DCT and picture covering is being applied wherein the pixels which have least significance are eliminated from the image. The importance of the pixels of the image is being analyzed through the DB values generated in the vector quantization. This ends in era of final compressed image which has much less size than the enter image.

Rosziati Ibrahim, et.Al,.[4] Proposed a Medical Image Compression through Using Threshold Predicting Wavelet-Based Algorithm. Medical community additionally boost a excessive intention to supply a low computational value algorithm with excessive velocity compression and decompression to help the existence network bandwidth functionality whilst reducing the picture size to preservation the restrained garage size. As inside the literature, the wavelet coefficient is predicted primarily based on restore region and variables. But, clinical pictures have its very own statistical distribution and feature exceptional properties on extraordinary subbands. So, to get extra particular prediction, the quantity of predictor variable have to be adjust primarily based on the image's residences. The compression manner start with reworking the photo into coefficient where it usually achieved by using Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) or Fast Fourier Transform (FFT).

Chaozheng Yang, et.Al,.[5] Implemented a era is to provide photo compression , is has made tremendous progress in wavelet encoding, resulting from human beings's thorough understanding of the characteristics of wavelet coefficients and powerful enterprise of statistics. In the still photograph coding algorithms of wavelet which includes embedded zerotree wavelet coding (EZW) and set partitioning in hierarchical timber (SPIHT) have absolutely applied the distribution rule, the concept of which that rating by means of importance and hierarchical quantization have been adopted by using many encoding algorithms and that they have extensively utilized highly-green bit-aircraft quantization approach(Shapiro, 1993; Said and Pearlman, 1996). In this way, the coding bitstream not simplest has a better compression ratio, but also has terrific embedability. However, in the current worldwide requirements like JPEG, MPEG, H.261 and H.263, what has been carried out the maximum is the discrete cosine rework (DCT) compression encoding. Through orthogonal transformation, DCT coding can transform the photograph alerts from time area to frequency domain for encoding. This paper first analyzes the principle of discrete cosine rework

encoding and research the regulation of frequency spectrum display.

III. IMPLEMENTATION

HUFFMAN CODING

Huffman code technique is primarily based on the two observations:
a. More often occurred symbols could have shorter code words than less frequently.
B. The two symbols that occur least often will have the equal length. The Huffman code is designed via merging the lowest possibly symbols and this method is repeated till handiest two chances of two compound symbols are left. Thus a code tree is generated and Huffman codes are acquired from labeling of the code tree.
Step 1: Read the photo on the workspace of matlab.
Step 2: Call a characteristic which will locate the symbols (i.E. Pixel fee which is not repeated).
Step three: Call a function in an effort to compute the opportunity of each image.
Step 4: Probability of symbols are arranged in lowering order and lower possibilities are merged. This step is sustained until best chances are left and codes are assigned according to rule that, maximum possibly image will have a shorter duration code.

Step five: Further Huffman encoding is completed i.E. Mapping of code words to the corresponding symbols will result in compressed facts
Step 6: The original picture is reconstructed i.E. Decompression is performed the usage of Huffman deciphering.
Step 7: Match the code words with code dictionary to get the reconstructed image.

DISCRETE WAVELET TRANSFORM

Wavelet transforms are absolutely very important computational equipment. A transform is a acquainted concept to mathematicians. It is a widely used trendy mathematical device that enables with fixing troubles in more than one areas. The essential concept of transforms is changing a mathematical amount (it can be a number, a vector, a function, and so on.) to some other form in which it can be unrecognizable, however could present useful capabilities. This converted quantity is, consequently, used to solve the hassle on hand, or to carry out a few helpful calculation. The end result can then be transformed back to the authentic form. Initially, wavelets were solely in mathematics. Now, the quantity in their usage has reached areas consisting of seismology, photograph processing, quantum mechanics, sign processing, non-desk bound signals particularly, and information compression.

Encoding System
Six steps process for compressing an image with Discrete wavelet rework is proven below.
Step1.First unique photograph should been surpassed thru high pass filter and coffee pass filter out via applying filter out on every row.
Step2.Now output of the both picture l1 and h1 are combine into t1=[l1 h1].
Step3. T1 is down sampled through 2.
Step4. Now, again T1 has been exceeded through high pass filter out and coffee clear out by using making use of on each column.
Step5. Output of the step4 is meant l2 and h2. Then l2 and h2 is integrate into t3.
Step6. Now down sampled t3 with the aid of 2.This is our compressed picture.
Decoding System:
Here interpreting machine's manner is not exact opposite of encoding machine's method. Steps are shown below.
Step1.Extract low skip clear out photo and high pass clear out image from compressed picture clearly by using taking top 1/2 rectangle of matrix is low pass filter photo and down half rectangle is excessive pass filter picture
Step2. Both photographs are up sampled with the aid of 2.
Step3.Now we take the summation of both photographs into one photograph called r1.
Step4. Then once more extract low skip clear out image and excessive skip filter out picture by in reality dividing vertically. First half of is low bypass filtered photo. And second half of is high pass filter photo.
Step5. Take summation of both images that is out reconstructed photo. Though in DWT, we get very high compression ratio, we lose minimal quantity of data. But if we do a couple of level then we get greater compression ratio but the reconstructed photo isn't same to unique photograph.

MULTILEVEL DWT

The wavelet transform is one of the commonly used tech¬niques in picture compression, after development of JPEG 2000 trendy. Multi-wavelet rework is changed ver¬sion of wavelet rework and some additional capabilities are available with it. Wavelets includes simple features named wavelet feature Ψ(t) and scaling characteristic Φ(t). While multilevel wavelet consists of multi scaling and multi wavelet set of features. In multi-wavelet scaling func¬tion set (Φ(t)) can be written as, Φ (t) = [Φ1(t),Φ2(t)…, Φr(t)]T. Similarly, the multi-wavelet characteristic set Ψ(t) for multi-wavelet coding can be written as Ψ(t) = [Ψ1(t), Ψ2(t)…, Ψr(t)]T. In above equation 'r' can have any value, however from literature it's far clear that for multi wavelets r takes fee identical to 2. The scale equations for multi-wavelet may be written as,

$$\emptyset(t) = \sqrt{2} \sum_{k=-\infty}^{\infty} H_k \emptyset(2t-k)$$

$$\varphi(t) = \sqrt{2} \sum_{k=-\infty}^{\infty} G_k \emptyset(2t-k)$$

Where, {Hk} and {Gk} are matrices of wavelet filters of 'r x r'dimensions for specified integer k. The coefficients of these filters offer more degree of freedom as compared to scalar wavelets3. Filter coefficients are also responsible to integrate important properties such as orthogonality, symmetry and higher order approximation into the multi-wavelet filters. For each and every multi filter bank the input and output is a vector3. Figure 1 represents the analysis filters (H and G multi filters) and synthesis filters (Ĥ and Ĝ multi filters for a single level bi-orthogonal multi filter bank.

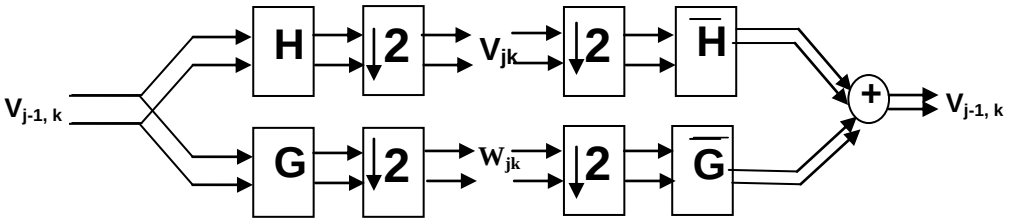

Figure 1 : Image for analysis filters and synthesis filters

Where, Hk and Gk are matrices of wavelet filters of 'r x r'dimensions for specified integer k. The coefficients of those filters provide greater diploma of freedom compared to scalar wavelets3. Filter coefficients are also accountable to integrate essential houses along with orthogonal¬ity, symmetry and higher order approximation into the multi-wavelet filters. For each and every multi filter bank the input and output is a vector3. Figure 1 represents the analysis filters (H and G multi filters) and synthesis fil¬ters (Ĥ and Ĝ multi filters for a unmarried degree bi-orthogonal multi clear out bank.

The fundamental properties of a Multilevel wavelet transform are illustrated as;

The inherent belongings, more degree of freedom in multi-wavelets is the principle property, that is useful to do away with deficiency of scalar clear out. As an example, scalar wavelet can not possess symmetry and orthogonality concurrently. Orthogonality gives the simpler layout and implementation procedure while symmetry is nec-essary for symmetric filters for signal extension. Also, the scalar wavelets are at once linked with the vanishing moments and support period. I.E., to reap higher order approximation, lon¬ger duration filters are necessary. Better localized approximation prefers shorter guide of the respective input function, however higher approxi¬mation is vital to acquire the higher coding advantage.

For any rework to be beneficial in photograph compres¬sion, vital feature required is the quantity of energy compaction. So, a clear out which includes most of energy concentrated in much less range of scaling coefficients can showcase top strength compaction. This becomes massive during the quantization since the quantity of bits required to symbolize the wavelet coefficients might be much less as compared to scaling coefficients. The quanti¬zation noise may be prevented in addition to better overall performance can be performed with the aid of clustering the wavelet coefficient values approximately to 0 with a little variance. Thus, multi-wavelets can provide the better reconstruction.

In multi-wavelet rework single degree of decomposition consequences in 16 subbands, that allows you to be similarly decomposed at some stage in subsequent stage of decomposition and formulate quad-tree representation. So at some point of each itera¬tion count number of subband pass on growing relatively.

For multi stages

1. Read the image
2. Using 2D wavelet decomposition with appreciate to a daubechies wavelet computes the approximation coefficients matrix CA and element coefficient matrixes CH, CV, CD (horizontal, vertical & diagonal respectively) that's obtained by means of wavelet decomposition of the input matrix .

Three. From this, once more using 2D wavelet decomposition with admire to a daubechies wavelet computes the approximation and element coefficients which are acquired by way of wavelet decomposition of the CA matrix. This is considered as level 2.

Four. Again practice the daubechies wavelet remodel from CA matrix which is considered as CA1 for stage 3.

5. Do the same manner for stage 4, degree 5,…
6. Calculate the STD of authentic picture and sets as the threshold value, set all of the approximation coefficients to zero except those whose importance is greater than STD of image.
7. Take inverse rework for degree 1, stage 2, degree three, degree 4 ….. With simplest changed

approximation coefficients and Reconstruct the images for stage 1, level 2, level 3 , level 4…..
Nine. Display the consequences of reconstruction 1, reconstruction 2, reconstruction three, reconstruction 4,…. Ie., degree 1, 2, 3, 4,…. With admire to the authentic photograph.

The results display that the quantitative consequences with stamp image are higher than satellite and scientific photos where stamp photograph yielded higher PSNR values than the opposite snap shots.

IV. EXPERIMENTAL RESULTS

The Mean Squared Error (MSE):

The difference among unique photograph information and compressed photo records is referred to as suggest rectangular blunders (MSE). MSE is inversely proportional to PSNR, as MSE decreases the PSNR will increase. PSNR suggest fine of photograph. Image compression is lossless while MSE is 0. Its higher to have less MSE. F(x,y) is the pixel value of the unique photograph, and f'(x,y)is the pixel price of the decoded image. The MSE calculated through,

$$MSE = \sqrt{\sum_{x=0}^{W-1}\sum_{y=0}^{H-1}[f(x,y) - f'(x,y)]^2}$$

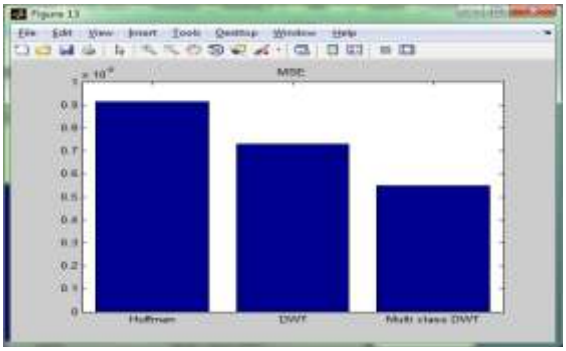

Fig 1: Comparison chart of different compression algorithm using MSE measurements.

Peak Signal to noise Ratio (PSNR):

PSNR is the ratio between most sign powers to noise appear in sign. PSNR is related to excellent of image. For good exceptional of photo the PSNR of photo need to be high. PSNR is relies upon upon the suggest rectangular error (MSE) of picture. When the distinction between the unique photograph and compressed is less the PSNR is excessive so subsequently the nice of image is likewise high.

$$PSNR = 10log\frac{MAX^2}{MSE}$$

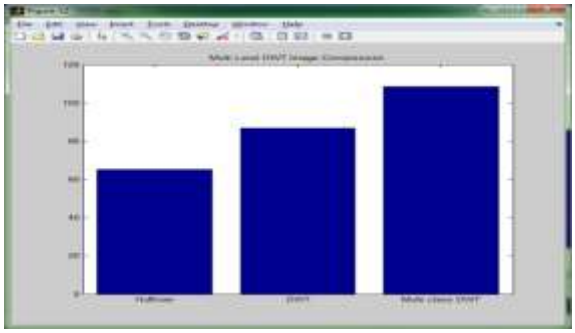

Fig 2: Comparison chart of different compression algorithm using PSNR measurements.

V. CONCLUSION

Image compression is a fast paced and dynamically converting discipline with many different styles of compression methods to be had. Images include big quantity of statistics hidden in them, that is noticeably correlated. A not unusual feature of most photographs is that the neighboring pixels are correlated and therefore contain redundant facts. In this paintings we've got proposed bendy architecture for the implementation of multi-stage decomposition based DWT on this research which presents sufficient high compression ratios without a appreciable degradation of photo first-rate. The effectiveness and robustness of this technique has been justified using a fixed of real photographs. The pictures are keen on a digital digicam. To show the overall performance of the proposed method, a contrast among the proposed approach and other commonplace compression strategies has been discovered. From the experimental consequences it's far glaring that, the proposed compression approach offers higher overall performance compared to different traditional techniques. Wavelets are better acceptable to time-restricted facts and wavelet primarily based compression approach maintains better picture first-rate with the aid of decreasing errors.

REFERENCES

[1] Han, Song, Huizi Mao, and William J. Dally. "Deep compression: Compressing deep neural networks with pruning, trained quantization and huffman coding." arXiv preprint arXiv:1510.00149 (2015).

[2] Raid, A. M., et al. "JPEG image compression using discrete cosine transform-a survey." arXiv preprint arXiv:1405.6147(2014).

[3] Mofreh, Amira, Tamer M. Barakat, and Amr M. Refaat. "A New Lossless Medical Image Compression Technique using Hybrid Prediction Model." Signal Processing: An International Journal (SPIJ) 10.3 (2016): 20.

[4] Sodha, MsNidhi, Daxa V. Vekariya, and MsHiral R. Shah. "IMPLEMENTATION OF IMAGE COMPRESSION USING SET PARTITIONING HIERARCHICAL TREE USING HUFFMAN ENCODING." Development 2.6 (2015).

[5] Tomar, Rime Raj Singh, and Kapil Jain. "Lossless image compression using differential pulse code modulation and its application." Computational Intelligence and Communication Networks (CICN), 2015 International Conference on. IEEE, 2015.

[6] E. C. Larson and D. M. Chandler, "Most apparent distortion: Full-reference image quality assessment and the role of strategy," J. Electron. Imag.,vol. 19, no. 1, pp. 001006:1–001006:21, Jan. 2010.

[7] W. Xue, L. Zhang, X. Mou, and A. Bovik."Gradient magnitude similarity deviation: A highly efficient perceptual image quality index," IEEE Trans. on Image Process., vol. 23, no 2, pp. 684–695, Feb. 2014.

[8] Z. Wang, A. C. Bovik, H. R. Sheikh, and E. P. Simoncelli, "Image quality assessment: From error visibility to structural similarity," IEEE Trans. Image Process., vol. 13, no. 4, pp. 600–612, Apr. 2004.

[9] Z. Wang, E. P. Simoncelli, and A. C. Bovik, "Multiscale structural similarity for image quality assessment," Proc. 37th Asilomar Conf. Signals, Syst., Comput.,Nov. 2003, pp. 1398–1402.

[10] Z. Wang and Q. Li, "Information content weighting for perceptual image quality assessment," IEEE Trans. Image Process., vol. 20, no. 5, pp. 1185–1198, May 2011.