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# Survey of Techniques for Improving the Quality of Image Obtained Using Jpeg Compression Algorithm

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**ABSTRACT**
JPEG compression algorithm which is based on discrete cosine transform is the compression techniques which are used widely in image processing due to bandwidth and data transmission constraints. In this paper various techniques for improving the quality of image in JPEG is reviewed so that effective algorithm can be developed which gives better quality image.

***Keywords:-*** JPEG, DCT (Discreet cosine transform) , DWT (Discreet wavelet transform), CR (compression ratio), MSE (Mean square error) , PSNR (Peak signal to noise ratio), MAE (Mean Absolute Error) , SSIM (Structural Similarity index)

## I. INTRODUCTION

1992, was the year when JPEG ( Joint Photographic Expert Group) compression was developed by **ISO/CCITT** committee as the first international standard of compression for Gray & colored image 25 years have passed but still the search of more optimized and more efficient compression technique is in process. In this paper the various techniques used to improve JPEG compression is studied and reviewed. So that further advancement can be done in the field of image compression.

In JPEG compression technique two types of methods were proposed:

- DCT based Baseline method of JPEG compression for lossy compression.
- Predictive method of JPEG Compression for lossless compression.

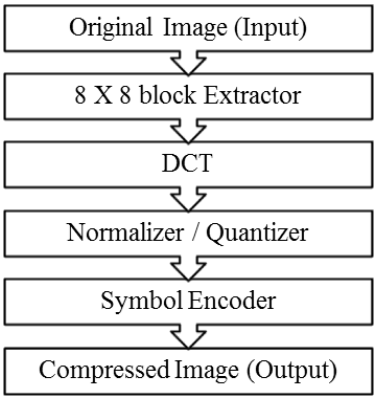
In JPEG compression tradeoff between compression ratio and quality is observed

- Sequential encoding: each image component is encoded in a single left-to-right, top-to-bottomscan;
- Progressive encoding: the image is encoded in multiple scans for applications in which transmission time is long, and the viewer prefers to watch the image build up in multiple coarse-to-clear passes;
- Lossless encoding: the image is encoded to guarantee exact recovery of every source image sample value (even though the result is low compression compared to the lossy modes):
- Hierarchical encoding: the image is encoded at multiple resolutions so that lower-resolution versions may be accessed without first having to decompress the image at its full resolution.[7]

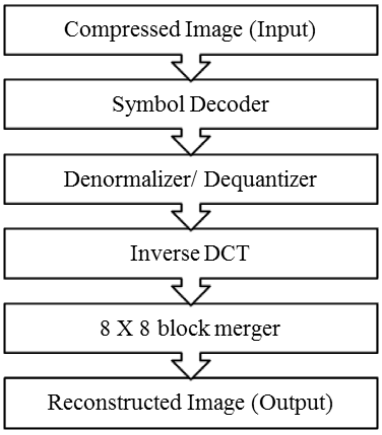
This paper is arranged in four sections, section I is intoduction to JPEG compression, section II briefly gives the steps of JPEG compression , decompression & drawbacks of JPEG compression technique , section III deals with the various techniques used for quality improvement , section IV presents the comparative chart of all the techniques discussed.

## II. JPEG COMPRESSION TECHNIQUE

### *A. JPEG compression process consist of following steps-*




### *B. JPEG decompression process consist of following steps-*



### *C. Drawback of JPEG compression*

i) Image quality by truncation errors from quantizing the DCT coefficients.
ii) Another problem is the damage on the extracted watermarks from JPEG compression for the spatial-domain watermarks.
iii) Artifacts such as blocking effects and Gibbs' phenomenon.

Since quality of image (PSNR, MSE etc.) & compression ratio are important parameters considered during reconstruction of image. Many algorithms are suggested by the researchers to obtain better quality image.

## III. VARIOUS TECHNIQUES USED FOR QUALITY IMPROVEMENT.

### *A. DCT based spectral similarity strategy method.[1]*

In this method spectral similarity is used to obtain better quality image.
Process consist of two steps-
**Step1 Use of translation function**
**Step 2 Band Similarities for Further Bit-Rate Reduction**

Initially a buffer is used to store dct coefficients obtained after DCT transform and then a translation function collects the same frequency components from all individual spectrums, and reorganizes the spectrum. A multi resolution spectrum image is obtained by gathering all the same frequency using translation function.

The complexity after translation has been reduced. Most of the bands in high-frequency domain are low-amplitude coefficients, which can be regarded as insignificant bands. Those high-frequency bands contain only zero after quantization and thereby compression ratio will be raised compared to conventional block-based transform coding schemes. In addition, it can be observed that the other significant bands are highly correlated with each other.

Band Similarity for Further Bit-Rate Reduction: For further bit reduction we find insignificant bands using insignificance discarding algorithm. A matching band is found against each significant band which provides efficient correlation reduction. The best match is obtained when the sum of absolute value of error between the two bands is minimum.

### *B. Adjustments block method [2].*

In this method the quality of reconstructed image is improved by finely tuning DCT coefficients. This method is used to handle the rounding or truncations error due to the DCT coefficients quantization.

The DCT coefficients obtained are adjusted to improve the quality of reconstructed image during inverse quantization stage. Process consist of two steps-

**Step 1 Bit map adjustment**
**Step2 Coefficient adjustment block**

In **Adjustment Bit Map** the variance of a block is computed to check whether the block is smooth. Since, a smooth block is unnecessary to adjust

In **Coefficient adjustment block** three conditions are possible-

**Condition 1** Coefficient is either divided with no remainder or a too small remainder with in the threshold range.
**Adjustment** – Not required

**Condition 2** Quantized coefficients that have been rounded off.
**Adjustment**- A suitable adjustment value is subtracted depending on the quantization value, when the coefficient is recomputed.

**Condition 3** Quantized coefficient being truncated.
**Adjustment -A** suitable adjustment value is added depending on the quantization value, when the coefficient is recomputed.

### *C. Multi-objective evolutionary method [3]*

Multi-Objective evolutionary algorithm approach is used to have a family of solutions. Each solution represents a different Quantization Table.

### *D. Hybrid Transform Coding method [4]*

In hybrid transform technique both DWT & DCT is applied. Initially the DWT is applied to obtain LL, HH, HL, LH components. DCT is applied on LH, HL component to neglect the low value components. LL & HH are quantized to the maximum value. To obtain better PSNR , MSE for same compression ratio. The Y Cb Cr component can be decomposed to Level 1and Level 2 depending on the restriction to PSNR & MSE value.

### *E. Kernel Regression and Probabilistic Self-Organizing Maps method [5]*

This method combines transformed domain and spatial domain. Adaptive kernel regression is used for 2D function approximation, and for control probabilistic self-organizing maps are used.

Process consist of three steps-

Step 1 DCT domain restoration
Step 2 Smoothing
Step 3 Spatial domain restoration

**DCT domain restoration** is based on the fact that maximum information loss during reconstruction takes place in inverse DCT coefficient quantization stage. So each of the quantized DCT coefficients can be regarded as an image to be restored and second order 2D steering kernel regression can be used to enhance each DCT quantization coefficient separately considering the narrow quantization constraint. This process leads to an enhanced version of the input image. Then the DCT coefficients are shifted half block (4 pixels) in each of the four main directions (up, down, left and right). This restoration mechanism is applied to all the five versions of the image (four shifted and one unshifted), and then undo the shifts. The output is obtained by averaging these five images.

**Smoothing** generate an over smoothed image by applying a standard Gaussian low-pass filter with a window size of 9 × 9 pixels and a standard deviation of 10 pixels (Experimentally optimized).For each block line segment which connects the result of the previous subsystem with the quantized DCT coefficients of the over smoothed image is considered.

**Spatial domain restoration** is obtained by repeated application of a second order 2D steering kernel regression on the spatial domain. Probabilistic Principal Components Analysis Self-Organizing Map is used to remove problem of developing a principled criterion to stop the iteration

### *F. Perceptually Optimized Coding method of Colour Images for Band-Limited Information [6]*

A perceptually-based model for the Rate-Distortion function of color subband coders has been introduced

Process consist of two steps-
Step1 Pre-processing stage using a CCT,
Step2 Transform, quantization, encoding stage.

In this method the WMSE distortion of an image in a given color space, such as YCbCr is approximated. This distortion is then minimized to achieve perceptual optimization of the compression. When the weights in the WMSE calculation are taken based on the CSF curves of the human visual system, better correspondence to image quality assessment by the human eye is achieved.
The algorithms are optimized with regard to the color component transform in the pre-processing stage of the compression as well as the quantization tables used in the coding stage, both with respect to WMSE.

## IV. COMPARATIVE CHART

The comparative chart of various techniques used for improving quality of image is as shown below-

| Parameter | DCT spectral similarity strategy method | Adjustment block method | Multi-Objective evolutionary approach | Hybrid Transform Coding method | Kernel Regression and Probabilistic Self-Organizing Maps method | Perceptually Optimized Coding method |
|---|---|---|---|---|---|---|
| Year of Publication | 2001 | 2005 | 2010 | 2011 | 2011 | 2013 |
| Transform Used | DCT | DCT | DCT | DCT & DWT | DCT | DCT/DWT |
| Number of Stages involved | 2 | 2 | 1 | 1 | 3 | 2 |
| Stages Description | Use of translation function<br><br>Band Similarities for Further Bit-Rate Reduction | Bit map adjustment Block<br><br>Coefficient adjustment block | Optimal Quantization table | Hybrid transform stage DWT followed by DCT | DCT domain restoration<br><br>Smoothing<br><br>Spatial domain restoration | Pre-processing stage using a CCT<br><br>Transform , quantization ,encoding stage |
| Modification at which step (SENDER) | On DCT coefficient obtained | Quantizer with coefficient adjustment block | Optimal Quantization Table generation | Earlier DWT followed by DCT | On DCT quantization coefficient | Algorithm Optimized with regard to the color component transform and quantization tables used in the coding stage, both with respect to WMSE. |

| | | | | | | |
|---|---|---|---|---|---|---|
| Modification at which step (RECEIVER) | ------- | Dequantizer with coefficient adjustment block | Optimal Dequantization Table | Earlier DCT followed by DWT | Restoration mechanism is applied to all the five versions of the image (four shifted and one unshifted) | ------- |
| Parameters for study | PSNR<br>Bit rate | PSNR<br>MSE | MSE | PSNR<br>CR | PSNR<br>MAE<br>SSIM | PSNR<br>CR |

## V. CONCLUSIONS

The various techniques of improving the JPEG quality is reviewed so that better compression ratio can be achieved, at the same time not compromising the quality of image.

The techniques can be selected on the basis of application for which it is to be used. The two techniques can be mixed together to obtain a new technique with better image quality. The quality improvement in images can be extended to videos as future prospects.

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