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# Effect of KMM on JPEG compression

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**Abstract**: Image compression is essential for efficient transmission and storage of images. This paper uses K-Modulus Method which transforms the whole image into multiples of predefined integer. Dividing the whole image by that integer will guarantee that the new image is less in size from the original image. KMM is used along with JPEG to increase the compression ratio and PSNR value.

**Keywords**: Compression, KMM, JPEG, DCT.

## I. INTRODUCTION

JPEG is based on DCT is a lossy compression technique. It is a commonly used compression standard in internet and other applications. In this article, we have focused on increasing the PSNR value and the compression ratio. The organization of the paper is as follows. Following the introduction, the basic concept of K-Modulus method is outlined in section 2.section 3 discusses the JPEG compression. Section 4 describes the proposed approach. Section 5 shows the experimental measurements. Finally in section 6 the conclusion is discussed.

## II. K-MODULUS METHOD

A common characteristic found in many images is correlation between the neighbouring pixels. Hence we should find a method to reduce the correlation between the pixels in an image. Along with redundancy reducing the irrelevancy is very important in compression. The technique used in our paper is spatial transformation. k-Modulus method (k-MM) first appeared as Five Modulus Method (FMM)[1]. Basically, it was initiated as a transformation method for image compression. The essential concept of FMM was to transform the entire image pixels into multiple of five. Lately, the k-Modulus Method (k-MM) was founded as a generalization for the FMM. In fact, the basic idea behind k-MM is to transform the whole image into multiples of k, where k is any integer between 2 to 25[2]. Since the human eye cannot differentiate between the original image and the transformed k-MM image [3] .In KMM the pixels in an image are altered in such a way that all the pixels in an image are divisible by K.

## III. JPEG

Joint Photographic Experts Group (JPEG) is a lossy type of compression technique..In lossy compression we cannot recover every data in an image when it is uncompressed as it permanently removes redundant information in an image. In JPEG we can decide between the image size and the quality. The JPEG images look same as the original images but if we want smaller size then the effect of it is seen in the quality of image. . Humans visual ability is restricted at high frequencies using this as an advantage JPEG eliminates high frequency data in an image while performing compression.. JPEG consists of two main blocks:. The Discrete Cosine Transform (DCT) and the Quantizer

### A. Discrete Cosine Transform

The Discrete Cosine Transform, which expresses the data as sum of cosine is applied to each block of image.DCT's are similar to DFT's but they use only real values.. DCT-II that is 'The DCT" is applied to each block of the image . The value of a frequency reflects the importance and speed of change, while the value of a magnitude corresponds to the difference associated with each color change [4]. Every block of pixels are related to the frequencies in the image.DCT coefficients found are equal to the intensities. The DCT coefficients of p(i,j) which are divided into N × N blocks with value of N=4,8,16 or 32 are found by using the formulae:-

$$X(u,v) = k(u,v) \times \sum_{i=0}^{N-1}\sum_{j=0}^{N-1} p(i,j)\cos\left(\frac{\pi(2i+1)}{2N}\right)\cos\left(\frac{\pi(2j+1)}{2N}\right)$$

$$\text{with} \begin{cases} K(u,v) = \frac{2}{N}C(u)C(v) \\ C(X) = 0 \text{ if } X = 0 \\ C(X) = 1 \text{ if } X \neq 0 \end{cases}$$

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The rate at which the image is compressed and the quality of the image is inversely proportional in JPEG. Better the quality of image less will be the compression and vice versa.

B. Quantization

Over a very large area of image the human eye can anticipate small differences in the brightness but when it comes to high frequencies it cannot distinguish the variation in the brightness strength . Hence we can remove high frequency components. These high frequency components in the image can be removed by dividing each pixels in the frequency domain by a predefined constant which is then rounded to nearest integer. This forms the main part of lossy JPEG compression. In this process the high frequency components becomes zero and remaining components are changed to very small values. Quantization forms an integral part of JPEG compression.8x8 block of DCT coefficients is further quantized [5]. By using a particular quantization matrix we can get different level of image compression and quality. Hence the designer can decide quality level from 1 that is poorest to 100 that is best quality. A common quantization matrix is given below [7]:

$$\begin{bmatrix} 16 & 11 & 10 & 16 & 24 & 40 & 51 & 61 \\ 12 & 12 & 14 & 19 & 26 & 58 & 60 & 55 \\ 14 & 13 & 16 & 24 & 40 & 57 & 69 & 56 \\ 14 & 17 & 22 & 29 & 51 & 87 & 80 & 62 \\ 18 & 22 & 37 & 56 & 68 & 109 & 103 & 77 \\ 24 & 35 & 55 & 64 & 81 & 104 & 113 & 92 \\ 49 & 64 & 78 & 87 & 103 & 121 & 120 & 101 \\ 72 & 92 & 95 & 98 & 112 & 100 & 103 & 99 \end{bmatrix}$$

C. JPEG Algorithm

JPEG algorithm is as follows:-

1. Divide an image into blocks .if image cannot be divided then do zero-padding.
2. For each block find the DCT.
3. After finding the DCT , divide each block by the quantization matrix and round to nearest integer
4. The image that we get is the JPEG compressed image.
5. We take the inverse DCT to get back the data for compressed image.

## IV. PROPOSED APPROACH

The proposed compression and encryption processes are shown in fig.2.

Step 1: Input Image. Divide into 8 by 8 block

Step2: Apply K- modulus

Step3: 1)2-DCT is applied to each block.

2) Then by using Quantization matrix the blocks are compressed.

Step4: Calculate PSNR and compression ratio for different values of KMM

Step 5: Perform the inverse to get back the original Image back.

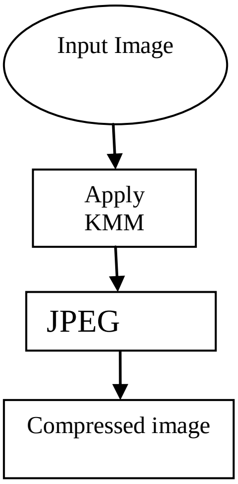


Fig 2: compression and encryption flow diagram

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## V. EXPERIMENTAL MEASUREMENTS

To measure the quality of the reconstructed images compared with the original ones, a standard metric is used. PSNR (peak signal to noise ratio) is most commonly used in lossy compression. let the pixels of the original image be denoted by I(i , j) and the pixels of the reconstructed image by K(i , j). We first define the mean square error (MSE) between the two images.MSE is the cumulative squared error between the compressed and the original image and is given as:

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

The PSNR is defined as the amount of the peak error, given as:

$$\text{PSNR} = 20\,\text{Log}_{10}\,\frac{\max\ |I(i,j)|}{\text{MSE}}$$

Compression ratio, CR is given by

$$\text{Compression Ratio} = \frac{\text{Uncompressed Size}}{\text{Compressed Size}}$$

### A. Experimental Results

In order to support the proposed contribution in this paper, variety of test images have been used, fig 2. The TIFF images are compressed and encrypted for different values of K in KMM. The first and the simplest evaluation measure is the peak-Signal-to-Noise ratio (PSNR). The second measure is the Compression Ratio (CR).Both the performance measures ,PSNR in Table 1 and CR in Table 2 have been computed between the original TIFF and the reconstructed TIFF image with K=2,5,10,15 and 20 in KMM. PSNR value upto 30 is considered to be good .Table 1 shows that we get fairly good PSNR for value of K upto 20.Table 3 gives the PSNR and CR values for only JPEG. It is observed that the PSNR and the CR is improved when KMM is used along with JPEG in compression.

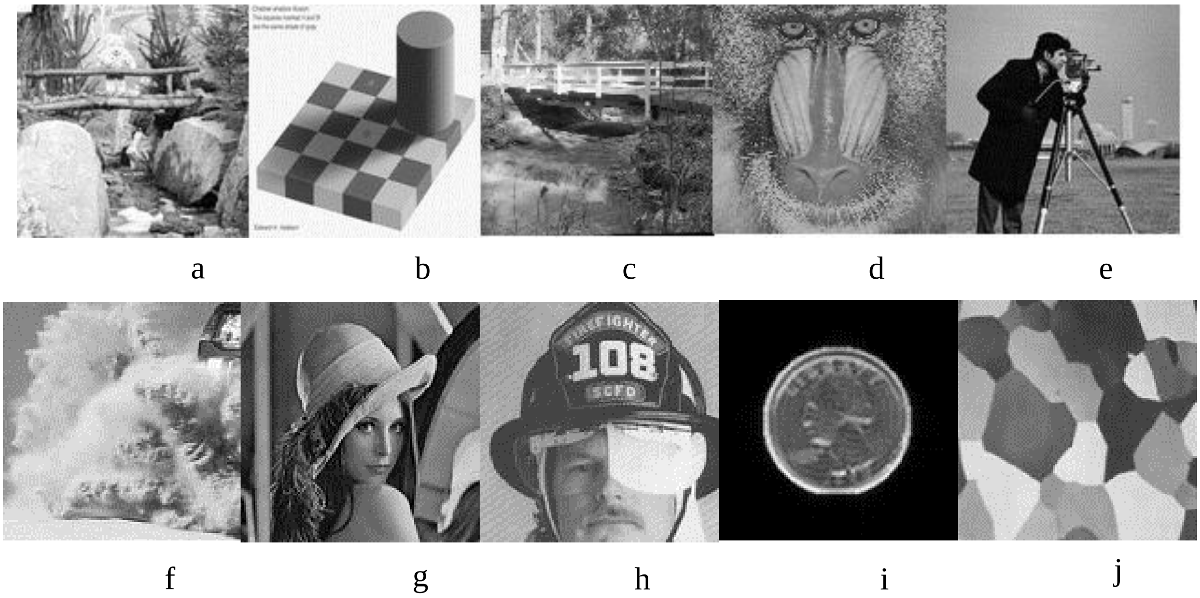


FIG 2: TEST IMAGES

TABLE1: PSNR VALUES OF RECONSTRUCTED IMAGES FOR DIFFERENT K VALUES OF KMM

| K-MM | a | b | c | d | e | f | g | h | i | j |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-MM | 51.15 | 51.43 | 51.13 | 51.17 | 51.19 | 51.12 | 51.06 | 51.07 | 53.63 | 51.08 |
| 5-MM | 45.13 | 46.9 | 45.09 | 45.07 | 45.07 | 45.11 | 45.1 | 45.15 | 43.32 | 45.13 |
| 10-MM | 38.81 | 40.52 | 38.83 | 38.87 | 38.63 | 38.83 | 38.78 | 39.03 | 39.61 | 38.76 |
| 15-MM | 35.46 | 37.43 | 35.34 | 35.45 | 35.35 | 35.29 | 35.45 | 35.65 | 32.6 | 35.49 |
| 20-MM | 32.94 | 36.02 | 32.86 | 32.82 | 32.97 | 32.8 | 32.92 | 33.17 | 31.36 | 32.57 |

TABLE 2: CR VALUES OF RECONSTRUCTED IMAGES FOR DIFFERENT K VALUES OF KMM

| K-MM | a | b | c | d | e | f | g | h | i | j |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-MM | 0.97 | 1.63 | 0.98 | 0.49 | 0.49 | 0.5 | 0.5 | 1 | 1.9 | 1.05 |
| 5-MM | 0.98 | 2.17 | 0.98 | 0.97 | 1.4 | 1.01 | 1.03 | 1.08 | 2.13 | 1.3 |
| 10-MM | 1.02 | 2.38 | 1.01 | 0.99 | 1.61 | 1.12 | 1.12 | 1.27 | 2.5 | 1.72 |
| 15-MM | 1.08 | 2.98 | 1.07 | 1.02 | 1.86 | 1.26 | 1.24 | 1.48 | 2.6 | 2.16 |
| 20-MM | 1.15 | 3.2 | 1.12 | 1.06 | 2.13 | 1.43 | 1.37 | 1.62 | 3.65 | 2.29 |

TABLE 3: PSNR AND CR OF RECONSTRUCTED IMAGES WHEN ONLY JPEG IS APPLIED

| K-MM | a | b | c | d | e | f | g | h | i | j |
|---|---|---|---|---|---|---|---|---|---|---|
| PSNR | 28.38 | 33.25 | 26.39 | 25.26 | 30.68 | 31.65 | 30.26 | 31.15 | 37.75 | 35.44 |
| CR | 0.98 | 1.41 | 0.97 | 0.97 | 1.09 | 1.03 | 0.99 | 1.02 | 2.1 | 1.05 |

## V. CONCLUSION

In this paper, we have combined K-Modulus Method with Jpeg compression .K-Modulus helps in increasing the image compression when used along with JPEG. Better compression ratio is produced for higher K values in the K-modulus method, but the PSNR value produced is lower. Hence Depending on the application, the designer can control the value of K selected Therefore, for low resolution images, higher k (more than 20) could be used.

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