Colour Space Based DCT Compression Algorithm on Acne Face Images

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Abstract- At some or the other time during their life Acne affects almost 85% of adolescents. Dermatologists use manual methods such as direct visual assessment but now a day they keep the patients details along with their photographs to assess the acne. It also provides helps in the mod-ern method of e-treatment. The compression of such acne images needs to be done in order to save the storage space. Analysis of conventional compression method based on Discrete Cosine Trans-form (DCT) is done. The analysis of image compression for various quality factors
(Q) is seen as variations in terms of Compression Ratio (CR), Peak Signal to Noise Ratio (PSNR) and Structural Similarity Index (SSIM). Also image representation can be done in various formats as RGB, YCbCr, and L*a*b* formats all of which have special applications. Here study is done to find that which format would give best results in terms of compromise between Q and CR. The objective of this research is to find a compression method that gives best results in terms of image quality indices (PSNR, CR and SSIM). The suitable quality factor for acne images is 50% for a block size of 8x8 as obtained from the results. The best image compression format for acne images is found to be L*a*b.

Keywords: DCT, YCbCr, L*a*b*, SSIM, PSNR, CR, medical Image compression, Image Com-pression, Acne Face Images.

I. Introduction

Acne is the biggest trouble to a youth in adolescence as it hits human for a certain time. The acne can be defined as pustules, nodules, papules, blackheads and whiteheads, cysts, pimples etc. With e-treatment the dermatologists get acne face or skin images from all around the world. This leads a very huge data for a doctor to access and store. Hence a compression method that would maintain a relation between the image qualities along with the bandwidth econ-omy should be found. This paper computes the image qual- ity parameter variation for various quality factors. Further a colour image can be decomposed into various formats such as RGB (R stands for red G stands for Green and B stands or Blue), YCbCr (luminance and chrominance) [1] and L*a*b*. Many methods for compression based on RGB [2] and luminance [3] are already given in literature. The format for image compression should give very good compromise between PSNR, SSIM and CR [4]. Acne are classified into various types but here this property of DCT [7] image compression can be achieved. Also DCT standard is used as lossy image com-pression in JPEG (Joint Photographic Experts Group). DCT can be applied on any block size of 4x4, 8x8, 16x16etc
Here is applied block size of 8x8 of an image to compute the DCT matrix. DCT is widely used in JPEG [8,9] (Joint Photo-graphic Expert group) for image compression.

considered only the images of acnevulgaris which affects almost 99% of the acne sufferers. Various types of images gives different results for different methods such as natural images can tolerate higher distor-tions such that even a lossy compression method would also give satisfactory results of the recovered image for such im-ages. But the same is not true for the medical images as higher compression would lead to looses in the details of the image that are important for a diagnosis purpose[5]. Hence while applying an image compression methodology on an acne image it must replicate considerably to the original im-age along with sufficient compression. All the techniques are based on DCT [6] details for which are given in next section.

II. DCT Overview

Discrete Cosine Transform presents an image in terms of sum of sinusoids. DCT has assets of energy compaction due to which almost all visually considerable information about an image is intense in just a few coefficients of the DCT.

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The general equation of 2D-DCT is defined as follows:

$$F(u,v) = \left(\frac{2}{N}\right)^{\frac{1}{2}} \left(\frac{2}{M}\right)^{\frac{1}{2}} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} \Lambda(i).\Lambda(j).cos\left[\frac{\pi.u}{2.N}(2i+1)\right] cos\left[\frac{\pi.v}{2.M}(2j+1)\right].f(i,j) \qquad (1)$$

Where M xN is the size of the image and Λ( ) is given as follows:

$$\Lambda(\xi) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for} \xi = 0 \\ 1 & \text{otherwise} \end{cases} \qquad (2)$$

and the *inverse* 2D DCT transform is simply $F^{-1}(u,v)$.

The DCT concentrates the energy of the altered signal in low frequency. Mentioning the visual fact that human eyes are not as much sensitive to the low frequency component as to high frequency, centre of attention is the low frequency component for DCT based image compression.

III. Color Space

3.1 RGB space

RGB component has derived its name from three color ma - trices known as Red (R), Green (G) and Blue (B) matrices
[10]. In such type of representation a colour image can be decomposed into 3 matrices which are grey in colour as R, G and B matrices. Every colour can be made from the com-bination of these three matrices and hence a set of 256x256x256 colours are possible using this format ranging from (0 0 0) as black to (255, 255 255) as white.

3.2 YCbCr space

minance and Cb, Cr are commonly known as the chromi-nance. Luminance gives the arrived brightness of the light comparative to entirety energy in the visible band. Chromi - nance (Cb and Cr) accompanies details of the colour tone. In certain amount of applications, advantageous to depict a colour in terms of its luminance and chrominance contented separately in order to facilitate more resourceful processing and transmission of colour signals.

3.3 L*a*b* space

The 'L*' layer is for brightness from black (0) to white (100) for color images which is same as luminance in the YCbCr
[12] coordinate. The colour information is given by colour channels, a* and b* layers. Chromaticity-layer 'a*' is repre-sentative where color falls along the red-green axis such that green is in the negative direction and red in the positive di-rection and chromaticity-layer 'b*' demonstrating where the color falls along the blue-yellow axis such that blue is in the negative direction and yellow in the positive direction.

IV. Result and Discussion

Previous section gave details of various colour image repre-sentation methods. In this section the analysis done on a set of 5 Acne Face images is given on the basis of these image components. Figure 1 shows the 5 test images. These are acne images and all the images have tribulations on the face in terms of pimples or marks. These tribulations contain necessary information for a dermatologist regarding the type of problem, the treatment that needs to be provided and the volume of affected area. Hence the retrieval of such im-ages should be such that mandatory information should be pertained within the image along with the necessary com-pression.

(a) Test image 1 (b) Test image 2

The Y, Cb, and Cr components of colour image are defined in YUV [11]colour coordinate, where Y is recognized as lu-

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(c) Test image 3 (d) Test image 4

(e) Test image 5

Fig.1. Acne face images.

The quality of an image can be controlled by varying the quantization matrix also known as quality factor (Q) while using DCT based compression. Hence the quality factor is varied from 0 to 100 and the variations are seen in the image quality of the retrieved images in terms of PSNR, CR and SSIM. It is well experimented that PSNR and SSIM increases as the Q of an image is increased.

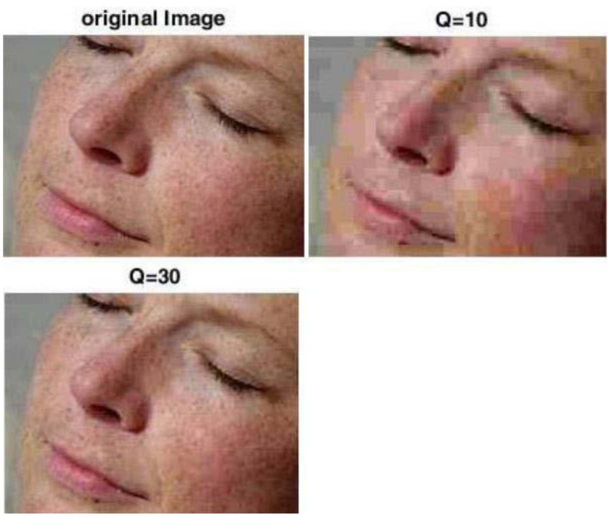

Fig.2. The Retrieved Images For Various Quality Factor Values For Test Image 1.

At the same time the value of CR decreases as the quality factor increases. It is such that to preserve a convinced ex-cellence, some of the coefficients remain non zero due to which compression becomes fewer but the image quality at the time of image retrieval is better. Figure 2 shows the im-ages retrieved for Q values at 10, 30, 50, 70 and 90. Hence with the visible analysis it can be certain that the image vis-ible similarity increases as Q increases.

Figure 3 enlightens the variations of PSNR, of the set of 5 acne images with respect to quality factor (Q). PSNR grad-ually increases as the value of Q increases as the number of non zero coefficients are graded as the value of Q increases which helps in better image retrieval. The above statement is true for all type of images can be better understood from figure 3 where curve for each image is gradually increasing.

Another plot to show the variations of SSIM with respect to quality factor is illustrated in figure 4. From figure 4 it can be noticeably seen that with the increase in the quality factor the value of SSIM increases. It also states that both PSNR and SSIM follow same proportional relation with quality factor for all acne images.

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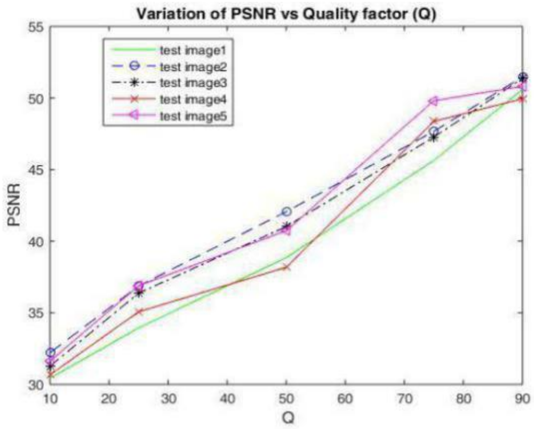

Fig.3. Variation of PSNR versus quality factor (Q).

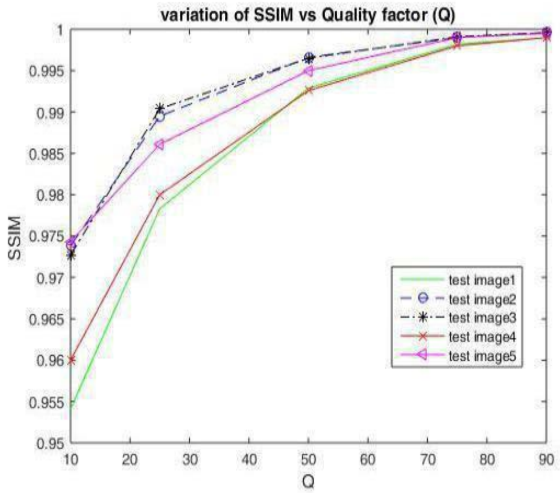

Fig.4. Variation of SSIM versus Quality factor (Q).

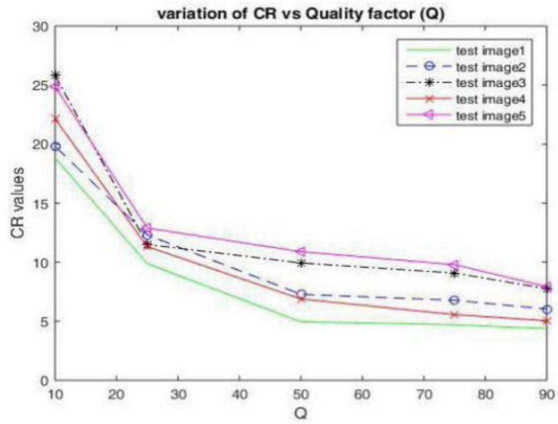

Fig.5. Variation of Compression Ratio (CR) versus Quality factor (Q).

Also figure 5 gives the variations of CR with the quality factor (Q). It can be clearly seen that the compression ratio de-creases with the increase of Q value because less number of zeros in the block leads to less overall compression. The inverse relation between CR and quality factor is true for all the 5 test images.

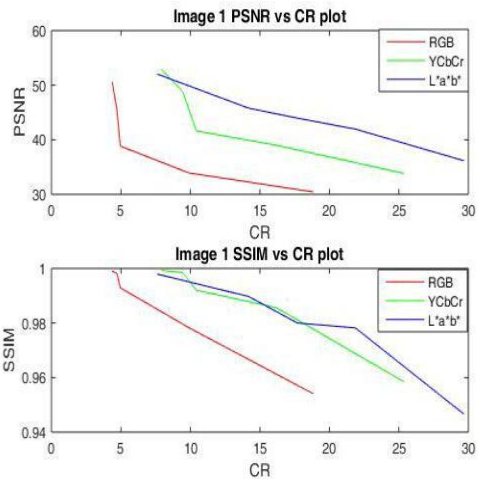

Fig.6. Variation of PSNR and SSIM vs. CR for different approaches of compression for test image 1.

Further remarks were made by studying the effects of implementing the compression on a range of components of a colour image such as explained in the previous section. The plot of PSNR vs. CR and SSIM vs. CR is given in figure 6 for the test image 1. Three curves shows the PSNR's, CR's and SSIM's obtained for the three different approaches of compression of a colour image components as RGB, YCbCr and L*a*b*. Superior curves of PSNR and SSIM are obtained for L*a*b* components.

This can be evidently seen from the given plot that the PSNR obtained at any quality factor or Q is maximum for L*a*b* approach and compression ratio obtained is also maximum for L*a*b* approach. Least compression is ob-tained from the RGB components compression and hence it is not fit for image compression. Now since a Q value of 50 has been adopted as it provides best compromise between image quality and image compression.

Hence below in figure 7 are given the various image quality parameters for the retrieved images of test image 1 at same Q value of 50 but for different compression approaches. Clearly best results are obtained using L*a*b* based compression as well as PSNR values i.e. 17.69 and 43.97 respectively. SSIM ac-quired is less for this method but still is in the satisfactory span for the availed increased compression.

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(a) Test image 1
(b) RGB based compression
(c) YCbCr based compression
(d) L*a*b* based compression

Fig.7. PSNR and CR for different approaches of compression for test image 1.

Below table 1 includes the values of compression ratio, PSNR and SSIM for all the acne images applied different approaches of compressions based on DCT. All the values are obtained at a Q value of 50. And this is clearly observed that best PSNR and CR are offered by L*a*b* method. PSNR values are measured in db and it gives the difference in pixels between a reference image and the retrieved image. Better PSNR enables better performance of the method and as well better visual similarity between 2 images. CR noti-fies how less storage space has been taken by the com-pressed image compared to the actual image. SSIM is a sim-ilarity parameter that gives the visual structural similarity between the two images.

Table 1: Below are the size (in bytes), compression ratio, PSNR (in dB) and respective MSE of the test images.

Method		Image 1	Image 2	Image 3	Image 4	Image 5
RGB	PSNR	38.85	42.06	41.02	38.18	40.73
	SSIM	0.9929	0.9966	0.9965	0.9926	0.9950
	CR	4.95	7.28	9.95	6.89	10.89
YCbCr	PSNR	41.61	44.37	44.84	42.12	44.32
	SSIM	0.9920	0.9966	0.9972	.9965	0.9984
	CR	10.43	12.61	18.05	15.22	18.65
L*a*b*	PSNR	43.97	45.12	44.92	44.41	46.05
	SSIM	0.9830	0.9950	0.9954	0.9961	0.9985
	CR	17.69	18.21	22.11	19.01	21.18

V. Conclusion

The examination is performed to obtain the best compression format for acne images since any information loss in terms of image quality cannot be tolerated for such images. For acne images also the value of compression ratio decreases with increase in the value of Q factor. Also PSNR and SSIM increases with the increase in the value of quality factor. The universal value chosen for Q = 50 gives satisfac- tory compromises here also for acne mages. Various for-mats are existing for representing a colour image such as RGB, YCbCr, XYZ, L*a*b* etc. and these are used widely for different applications. At a Q value of 50 the various approaches are compared for compression and it was found that for acne images the best method or approach for com-pression would be using compression based on L*a*b* method. Enhanced results are obtained in terms of PSNR and CR using this approach.

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