IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Presenting a Novel Technique for Color Enhancement of JPEG Images by the treatment of Y-Cb-Cr Chromatic Components

Author: Mr. Sumedh A Sonawane, Students, Genba Sopanrao Moze College of Engineering Balewadi, Pune

Abstract: This paper presents a novel method for color enhancement of images in the compressed domain. The proposed technique is simple but more effective than some of the existing techniques. The chromatic components of the images are taken into account for treatment rather than the luminance component. A performance analysis is also made for the previously available techniques such as Alpha Rooting (AR)[2], Multi Contrast Enhancement (MCE)[3], Multi Contrast Enhancement with Dynamic Range Compression (MCDERC) [4], Contrast Enhancement by Scaling (CES) based on the metrics such as JPEG Quality Metric (JPQM) , CEF, Y-WBQM [6](Wang–Bovic-Quality-Metric), Cb-WBQM, Cr-WBQM. Some of the serious limitations encountered in the existing system are possibility of appearance of superfluous edges in the enhanced image boundaries and lack of preservation of colors in the enhanced image. The results of all previous techniques along with that of the proposed one are compared with respect to those obtained by applying a spatial domain color enhancement technique that appears to provide very good enhancement. The proposed novel method is found to be very efficient and effective when compared to the spatial and compression domain based method

Keywords: Chromatic Components, Luminance Component, Color Enhancement, Discrete Cosine Transform (DCT), Quality Metrics, Spatial Domain, Compression Domain

1. Introduction:

1.1 Overview: Image enhancement is required mostly for better visualization or rendering of images to aid our visual perception. There are various reasons, why a raw image data requires processing before display. The dynamic range of the intensity values may be small due to the presence of strong background illumination, as well as due to the insufficient lighting. It may be the other way also. The dynamic range of the original image may be too large to be accommodated by limited number of bit-planes of a display device. The problem gets more complicated when the illumination of the scene widely varies in the space. In that case, in some places the scene appears to be too dark while in some other places it is too bright. In such images it is necessary to improve the local contrast. Image enhancement very often deals with such improvement of image contrast as it is related to the sharpness of the details. These methods are designed on the principle of amplifying the local intensity or color variations within an image to increase the visibility of texture details and other features.

All the existing enhancement techniques are spatial-domain based. However, increasingly images are being represented in the compressed format for efficient storage and transmission. Hence, it has become imperative to investigate compressed domain enhancement techniques to eliminate the computational overheads for carrying out the inverse transform to the spatial domain and back into the compressed domain by forward transform. In particular, processing in the DCT [8] [9]domain has attracted significant attention of researchers due to its adoption in the JPEG and MPEG compression standards.

1.2 Literature Survey: A majority of techniques advanced so far have focused on the enhancement of gray-level images in the spatial domain. These methods include adaptive histogram equalization, unsharp masking, constant variance enhancement, homomorphism filtering, high-pass, and low-pass filtering, etc. These methods have also been adapted for color image enhancement. However, later approaches for enhancing color images have taken into account also the chromatic information as well. In many such algorithms, the R-G-B color coordinates are transformed into a different space such as H-S-V, Y-Cb-Cr, etc., where chromatic components are more uncorrelated from the achromatic component. This allowed the representation of the color in terms of hue, saturation, and intensity in closer agreement with the physiological models which describe the color processing of the human visual system. There are also a few work reported in the R-G-B space. For example, Jobson et al. has used retinex theory leading to excellent quality of the enhanced images. However, their technique is computationally intensive as it requires filtering with multiscale Gaussian kernels and post-processing stages for adjusting colors. There are also techniques reported using equalization of the 3-D histograms in the R-G-B space.
Major Limitations of Existing System are:

- Possibility of appearance of superfluous edges in the enhanced image boundaries.
- Lack of preservation of colors in the enhanced image.

1.3 Objectives of the Proposed System : The display of a color image depends upon three fundamental factors, namely i) its brightness, ii) contrast, and iii) colors. In this work, we have considered all three attributes while designing a simple computationally efficient algorithm.

The simplicity of the proposed algorithm lies in the fact that the computation requires only scaling of the DCT coefficients mostly by a factor which remains constant in a block. the proposed algorithm not only uses the same scale factor for both the DC and AC coefficients, but also scales the chromatic components as well with the same factor (with the exception of their DC coefficients).

The proposed algorithm performs the color image enhancement operation in three steps. First, it adjusts the background illumination. The next step preserves the local contrast of the image and the last one preserves the colors of the image. Moreover, in a block DCT space, the algorithm attempts to exploit the advantage of having localized information from the DCT coefficients. The algorithm is designed in such a way that each block (of size 8×8) for all the components could be handled independently. This makes it more suitable for parallel implementation.

1.4 Project Plan: Project is planned and modularized into the following divisions:

1) **Adjustment of Local Background Illumination:** In adjusting the local background illumination, the DC coefficient of a block is used. The DC value gives the mean of the brightness distribution of the block. This adjustment may be performed by mapping the brightness values to a value in the desired range. This function should be monotonic in the given range. The maximum brightness value of the image is denoted as I_{max}. The DCT coefficients of a 8×8 block of the luminance component (Y) IS denoted by $\{Y(k,l), 0 \le k,l \le 7\}$. Then $Y(0,0)$ is the DC coefficient and the rest are the AC coefficients. The normalized DC and AC coefficients is denoted by $\{\ \bar{y}(k,l) = (Y(k,l)/8), 0 \le k,l \le 7\}$. In adjusting the local brightness, this DC coefficient is mapped to by using a monotonically increasing function $y = \{f(x), 0 \le x,y \le 1\}$ in the interval of [0, 1] as follows:

$$\hat{\tilde{y}}(0,0) = I_{\max}.f\left(\frac{\hat{y}(0,0)}{I_{\max}}\right).$$

2) **Preservation of Local Contrast:** The enhancement factor for a block during adjustment of its luminance is defined as

$$\kappa = \frac{\widetilde{Y}(0,0)}{Y(0,0)}$$

where $\bar{Y}(0,0)$ is the mapped DC coefficient and Y(0,0) is the original DC co efficient.

Since the DCT is a linear transform, multiplying all the coefficients Y of by κ results in the multiplication of the pixel values in the block by the same factor. This also preserves the contrast of the block. However, there is a risk of overflow of some of the pixel values beyond the maximum allowable representation (say B_{max}). This can be controlled by taking into account of the standard deviation (σ) and mean (μ) of the brightness distribution of the block. It is assumed that the brightness values of this distribution lie within $\mu \pm \lambda \cdot \sigma$, where $\lambda > 0$ is a constant. In that case κ should lie within an interval.

3) **Preservation of Colors:** A restricted scaling operation has to be performed for preserving the colors. The chromatic components should be also processed for preserving the colors. Though in the Y-Cb-Cr color space the chrominance components are decor related better than that in the Y color space, the increasing values in the component usually tend to desiderate the colors. Typically one may observe from the conversion matrix for going from the Y-Cb -Cr space to the R-G-B space, for G>R and G>B increasing Y while keeping Cb and Cr unchanged reduces both the (R/G) and (B/G) factors. Hence the chromatic components should be also processed for preserving the colors. In this case, there is also a chance that the enhanced values of the chromatic components may fall outside the range of representation (in the spatial domain) due to the scaling operation.

4) **Suppressing Blocking Artifacts:** The major problem in developing algorithms in the block DCT domain is the blocking artifacts that may be visible as a result of the independent processing of the blocks. We have observed that blocking artifacts are more visible in the regions where brightness values vary significantly, especially near the edges of sharp transitions of luminance values. For suppressing these artifacts, therefore, it would be necessary to keep the variations of the DC coefficients smooth or continuous. Later these values are further smoothed by taking the average of parameter values in the neighboring blocks.

5) **Composition of the Enhanced Image:** We have decomposed the DCT blocks into smaller blocks, if necessary, and performed computations on them. Later these smaller blocks are merged into the original block size. In this case, we have identified the blocks having significant variations by examining their standard deviations (σ). If the σ is beyond a threshold (denoted here as σ_{thresh}), we decompose an 8 × 8 block into four 4 × 4 sub-blocks. Then the same enhancement algorithm is applied to each sub-block. Finally, the four enhanced sub-blocks are combined again to an 8 × 8 block.

2. Functionalities:

2.1 Product Perspectives: The display of a color image depends upon three fundamental factors, namely i) its brightness, ii) contrast, and iii) colors. In this work, we have considered all three attributes while designing a simple computationally efficient algorithm.

The simplicity of the proposed algorithm lies in the fact that the computation requires only scaling of the DCT coefficients mostly by a factor which remains constant in a block. the proposed algorithm not only uses the same scale factor for both the DC and AC coefficients, but also scales the chromatic components as well with the same factor (with the exception of their DC coefficients).

The proposed algorithm performs the color image enhancement operation in three steps. First, it adjusts the background illumination. The next step preserves the local contrast of the image and the last one preserves the colors of the image. Moreover, in a block DCT space, the algorithm attempts to exploit the advantage of having localized information from the DCT coefficients. The algorithm is designed in such a way that each block (of size 8×8) for all the components could be handled independently. This makes it more suitable for parallel implementation.

2.2 Product Functions: The Functions of the project includes

1. Adjustment of Local Background Illumination[12][13]
2. Preservation of Local Contrast
3. Preservation of Colors
4. Suppressing Blocking Artifacts
5. Composition of the Enhanced Image

2.3 Software System Attribute: The system also caters to the following non-functional or quality requirements:

2.3.1Maintainability: The system shall be an easily maintainable one. The system can be enhanced without affecting other parts of the system since we develop the enhancement based on DCT Co-efficient.

2.3.2 Reliability: The system must not produce unexpected errors that may inadvertently crash the computer it is running on. The system must not crash on giving data that do not pertain to the specified constraints.
2.3.3 Security: No explicit security mechanisms are needed

3. System Design

3.1 System Overview: The functionalities of the system is clearly depicted by the Level 0 Context Diagram.

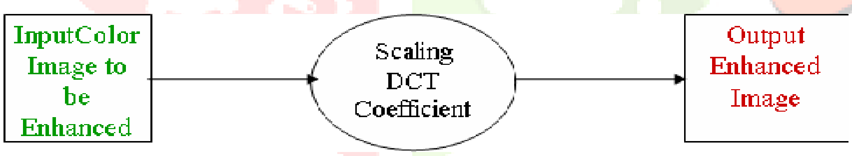


Fig.no.2 Level 0 Context Diagram for Novel Color Enhancement Technique

3.2 Content Diagram:

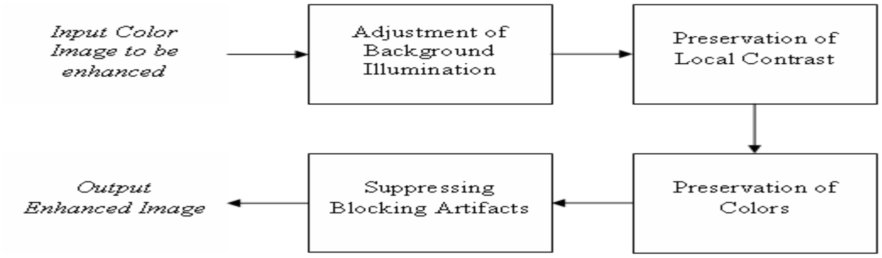


Fig. no 3 Content Diagram for the Novel Color Enhancement Technique

3.3 Data Flow Diagram:

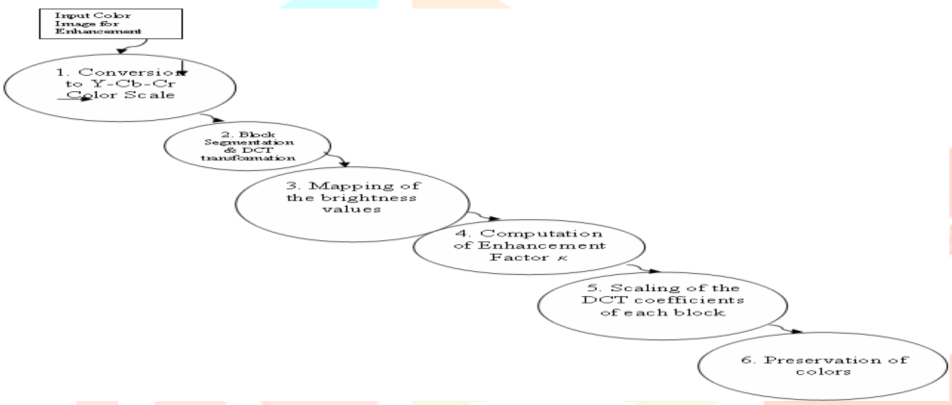


Fig. no 4 DFD Level 1 for the Novel Color Enhancement Technique

3.4 Algorithm Employed:

1. Compute μ and σ using $\mu = \hat{c}(0,0)$. $\sigma = \sqrt{\sum_{k=0}^{N-1}\sum_{l=0}^{N-1} \hat{c}(k,l)^2 - \mu^2}$.

2. If $(\sigma > \sigma_{\text{thresh}})$,

2a. Decompose into $(N/2) \times (N/2)$ DCT sub-blocks,

2b. For each block apply similar computations as described in Steps 3 through 5, and

2c. Combine 4 of these $(N/2) \times (N/2)$ blocks into a single $N \times N$ DCT block and return.

3. Compute the enhancement factor (κ) as follows:

3a. $\kappa = (f(Y(0,0)/N.I_{\max}))/(Y(0,0)/N.I_{\max})$,

3b. $\kappa = \min(\kappa, (B_{\max}/\mu + k\sigma))$, and

3c. $\kappa = \max(\kappa, 1)$,

4. Scale the coefficients:

4a. $\tilde{Y} = \kappa Y$, and

4.b. Apply

$$U'(i,j) = \begin{cases} U(i,j) - 128N, & \text{for } i = j = 0 \\ U(i,j), & \text{otherwise} \end{cases}$$

$$V'(i,j) = \begin{cases} V(i,j) - 128N, & \text{for } i = j = 0 \\ V(i,j), & \text{otherwise.} \end{cases}$$

On U and V for preserving colors

4. Implementation And Results:

4.1 Specific hardware requirements:

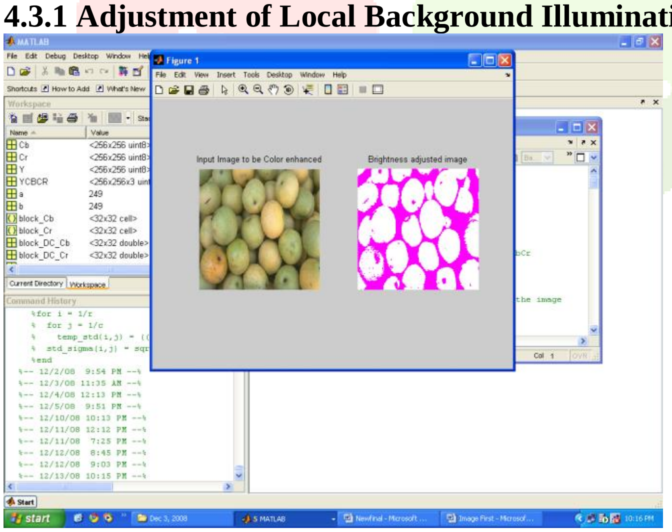
Processor: Intel Processor IV
RAM: 128 MB
Hard disk :20 GB
CD drive: 40 x Samsung
Floppy drive: 1.44 MB
Monitor: 15’ Samtron color
Keyboard 108 mercury keyboard
Mouse: Logitech mouse

4.2 Specific software requirements

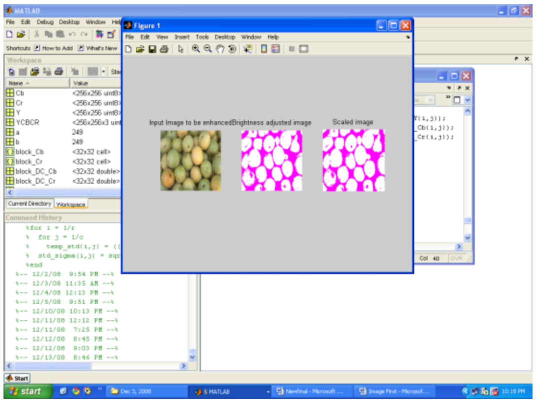
OperatingSystem- Windows XP/2000
Language used - Matlab

4.3 Screen Shots

4.3.1 Adjustment of Local Background Illumination



4.3.2 Preservation of Local Contrast



5. Conclusion And Future Work:

A restricted scaling operation has been performed on the image The previous enhancement algorithms only change the luminance component (Y) and keep the chrominance components (Cb and Cr, respectively) unaltered. Though in the Y-Cb – Cr color space the chrominance components are decor related better than that in the R-G -B color space, the increasing values in the component usually tend to desiderate the colors. Typically one may observe from the conversion matrix for going from the Y - Cb- Cr space to the R-G -B space, for G>R and G>B increasing Y while keeping Cb and Cr unchanged reduces both the (R/G) and (B/G) factors. This is why we believe that the chromatic components should be also processed for preserving the colors. Hence there is a chance that the enhanced values of the chromatic components may fall outside the range of representation (in the spatial domain) due to the scaling operation. Hence as a part of future work considers the preservation of colors and suppression of blocking artifacts.

6. References:

[1] D. J. Jobson, Z. Rahman, and G. A. Woodell, "A multi-scale retinex for bridging the gap between color images and the human observation of scenes," *IEEE Trans. Image Process.*, vol. 6, no. 7, pp. 965–976, Jul. 1997.

[2] D. J. Jobson, Z. Rahman, and G. A. Woodell, "Properties and performance of a center/surround retinex," *IEEE Trans. Image Process.*, vol. 6, no. 3, pp. 451–462, Mar. 1997.

[3] J. S. Lim, *Two-Dimensional Signal and Image Processing*. Englewood Cliffs, NJ: Prentice-Hall, 1990.

[4] R. C. Gonzales and E. Woods, *Digital Image Processing*. Reading, MA: Addison-Wesley, 1992.

[5] *The Colour Image Processing Handbook*, S. J. Sangwine and R. E. N. Horne, Eds. London, U.K.: Chapman & Hall, 1998.

[6] S. Wolf, R. Ginosar, and Y. Zeevi, "Spatio-chromatic image enhancement based on a model of humal visual information system," *J. Vis. Commun. Image Represent.*, vol. 9, no. 1, pp. 25–37, Mar. 1998.

[7] A. F. Lehar and R. J. Stevens, "High-speed manipulation of the color chromaticity of digital images," *IEEE Trans. Comput. Graph. Animation*, pp. 34–39, 1984.

[8] S.-S. Kuo and M. V. Ranganath, "Real time image enhancement for both text and color photo images," in *Proc. Int. Conf. Image Processing*, Washington, DC, Oct. 23–26, 1995, vol. I, pp. 159–162.

[9] I. Bockstein, "Color equalization method and its application to color image processing," *J. Opt. Soc. Amer. A*, vol. 3, no. 5, pp. 735–737, May 1986.

[10] R. N. Strickland, C.-S. Kim, and W. F. McDonnell, "Digital color image enhancement based on the saturation component," *Opt. Eng.*, vol. 26, no. 7, pp. 609–616, July 1987.

[11] B. A. Thomas, R. N. Strickland, and J. J. Rodrigues, “Color image enhancement using spatially adaptive saturation feedback,” in *Proc. Int. Conf. Image Processing*, Santa Barbara, CA, Oct. 26–29, 1997, vol. 3, pp. 30–33.

[12] A. Toet, “Multiscale color image enhancement,” *Pattern Recognit. Lett.*, vol. 13, no. 3, pp. 167–174, Mar. 1992.

[13] I. Pitas and P. Kiniklis, “Multichannel techniques in color image enhancement and modeling,” *IEEE Trans. Image Process.*, vol. 5, no. 1, pp. 168–171, Jan. 1996.

[14] Jayanta Mukherjee and Sanjit K. Mitra, “Enhancement of Color Images by Scaling
the DCT Coefficients” IEEE Transactions on Image Processing, Vol. 17, No 10, pp. 1783- 1794 October 2008