Color Image Enhancement

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Abstract

The reason for us to opt for this paper is to enhance the vision clarity, to enrich its perceptive view. Direct observation and recorded color images of the same scenes are often strikingly different because human visual perception computes the conscious representation with vivid color and detail in shadows, and with resistance to spectral shifts in the scene illuminant. This paper presents a new technique for color enhancement in the compressed domain. The proposed technique is simple but more effective than some of the existing techniques reported earlier. The novelty lies in this case in its treatment of the chromatic components, while previous techniques treated only the luminance component. This is simplified with the usage luminance component because it adjusts the brightness alone. Thus 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 technique, computationally more efficient than the spatial domain based method, is found to provide better enhancement compared to other compressed domain based approaches.

Keyword

Color Image Processing, Discrete Cosine Transform, Image Enhancement, Primary and secondary color, Luminance Component, Video Compression

I. Introduction

An image becomes digital when it is sampled and quantized into a form which can be understood by a computer. It is tured into a long string of on/off signals. The smallest element of a conventional photograph is a piece of grain. The equivalent digital picture is a pixel. The pix part of this word is from picture, the el from element. Join them together and ou have pixel. Digitizing an image is like overlaying a very fine wire netting over a scene, analyzing the color and brightness seen through each part of the mesh, and then noting down the values in correct order in a huge list [1,3]. The image is very clear when the number of pixels is high. An important concept is that while monitor screen picture element or pixel does have a physical size, an image pixel does not. The monitor screen's pixel size is fixed forever when the screen is manufactured at the factory- just as its counterpart, the grain is silver halide photography is fixed in size when the film is manufactured. On the other hand, a digital image pixel has no physical size until you give it one. A pixel is simply a mathematical definition inside the computer. Its size can be changed to suit our need. Color image processing is divided into two major areas: full-color and pseudo color processing. In the first category, the images in question typically are acquired with a full-color sensor, such as a color TV camera or color scanner. In the second category, the problem is one of assigning a color to particular monochrome intensity or range of intensities. Until relatively recently, most digital color image processing was done at the pseudo color level. The use of color in image processing is motivated by two principal factors. First, color is a powerful descriptor that often simplifies object identification and extraction from a scene. Second, humans can discern thousands of color shades and intensities, compared to about only two dozen shades of gray. This second factor is particularly important in manual (i.e., when performed by humans) image analysis.

There are two types of colors they are:
1. Primary Colors
2. Secondary colors

II. Proposed Algorithm

Every image is on the bases of color, contrast and brightness, these three primary elements are altered in order to obtain enhanced image. Thus direct observation and recorded color images of the same scenes are often strikingly different because human visual perception computes the conscious representation with vivid color and detail in shadows, and with resistance to spectral shifts in the scene illuminant [2, 4].
1. Read the Image.
2. Resize that image for applying DCT Compression.
3. Convert into ycbcr color space
4. Convert luminance part of the input image into vector.
5. Calculate the scaling coefficient from this image.
6. Apply DCT for all three color spaces.
7. Convert image into vector for this compressed images.
8. Apply the scaling coefficient into compressed image in all three color spaces.
• For brightness→Scale Only DC Coefficients.
• For contrast→Scale DC and AC Coefficients.
• Color→Scale DC and AC Coefficients using Function
(use all three colors Information)
9. Convert vector into image.
10. Apply inverse DCT.
11. Convert into RGB color space.

A. Resizing of the Image

The most popular image and video compression methods such as JPEG, MPEG use transform domain techniques and in particular the Discrete Cosine Transform (DCT). One application for such images or video sequences is resizing. Resizing is extensively used to meet the requirements of a specific system, to satisfy user's interests, or to correct spatial distortions [3]. However, a major difficulty encountered when resizing such media is the high computational complexity and the loss of quality caused by the decompression and compression.

B. Properties of Resizing
• Real (unlike DFT)
• Separable
• Efficiently calculated –O(n*log)
• The (0,0) element (top-left) is the DC component
Used in JPEG and MPEG. DCT has a strong "energy compaction" property: most of the signal information tends to be concentrated in a few low-frequency components

C. YCbCr

YCbCr or Y'CbCr is a family of color space used as a part of the color image pipeline in video and digital photography systems. Y' is the luma component and CB and CR are the blue-difference and red-difference chroma components. Y' (with prime) is distinguished from Y which is luminance; meaning that light intensity is non-linearly encoded using gamma .Y image is essentially a greyscale copy of the main image. Y'CbCr is not an absolute color space; it is a way of encoding RGB information. The actual color displayed depends on the actual RGB colorants used to display the signal. Therefore a value expressed as Y'CbCr is only predictable if standard RGB colorants. YCbCr and Y'CbCr are a practical approximation to color processing and perceptual uniformity, where the primary colours corresponding roughly to Red, Green and Blue are processed into perceptually meaningful information[4,9]. By doing this, subsequent image/video processing, transmission and storage can do operations and introduce errors in perceptually meaningful ways. Y'CbCr is used to separate out a luma signal (Y') that can be stored with high resolution or transmitted at high bandwidth, and two chroma components (CB and CR) that can be bandwidth-reduced, subsampled, compressed, or otherwise treated separately for improved system efficiency.

D. Discrete Cosine Transforms (DCT)

DCT and DST is the fastest transform in the existing transforms. But DCT is more commonly used in image compression algorithms compared to DST. Because it reduces the number of computational complexity. The 2-D image of the DCT equation is given by $\{x(m,n), 0 \le m \ge N-1, 0 \le n \le N-1\}$ The coefficient $C(0,0)$ is the DC coefficient and the remaining are the AC coefficients for the block.

E. Inverse Discrete Cosine Transforms (IDCT)

The 2-D image of the IDCT equation is given by $\{c(k,l), 0 \le k \ge N-1, 0 \le l \le N-1\}$ Here also the coefficient $X(0,0)$ is the DC coefficient and the remaining are the AC coefficients for the block. Generation of Many image and video compression schemes perform the discrete cosine transform (DCT) to represent image data in frequency space. An analysis of a broad suite of images confirms previous finding that a Laplacian distribution can be used to model the luminance AC coefficients [7]. This model is expanded and applied to color space (Cr/Cb) coefficients. In MPEG, the DCT is used to code interframe prediction error terms. The distribution of these coefficients is explored. Finally, the distribution model is applied to improve dynamic. Many digital image and video compression schemes use a block-based Discrete Cosine Transform (DCT) as the transform coding. In particular JPEG and MPEG use the DCT to concentrate image information. Image compression systems often divide each image into multiple planes, one for luminance (brightness) and two for color (for example chrominance-red and chrominance-blue). The images are also spatially divided into blocks, usually 8x8 pixels. The DCT is applied to each block in each plane and the results are quantized and run-length encoded (with additional Huffman or arithmetic coding).

III. Adjustment of Local Background Brightness

Brightness is a subjective descriptor that is practically impossible to measure it embodies de achromatic notion of intensity and it is one of the key factors in describing color sensation. 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 [5-6].
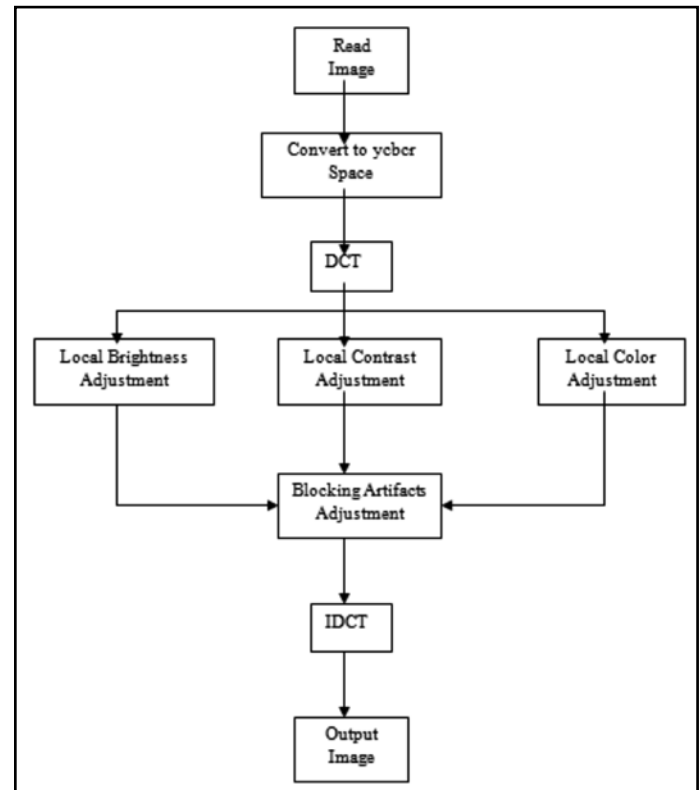

Fig. 1: Encoding and Decoding RGB information Process

Let us denote the maximum brightness value of the image as Imax (which may be available from the header of the compressed stream). Their functional forms are given below, shown at the bottom of the next page. The reasons for choosing these functions are as follows: i) they have been employed earlier in developing image enhancement algorithms, and ii) there is no single function which has been found to provide the best performance for every image. Our objective here is to observe the performances of our proposed algorithm with different choices of these mapping functions. There are also other advantages for using each of the above functions.

A. Preservation of local contrast Contrast, which we define as the difference in intensity between the highest and the lowest intensity levels in an image. The concept of contrast simultaneous is related entirely to the perceived brightness does not depend simply on its intensity; they appear to the eye to become darker as the background gets lighter [6-8]. The basic idea of our algorithm is to filter the image by manipulating the DCT coefficients according to the contrast measure defined. The proposed algorithm has the following advantages:

* The algorithm does not affect the compressibility of the original image
* Given a majority of zero-valued DCT coefficients (after quantization), the algorithm expense is relatively low
* The proposed image enhancement algorithm is applicable to any DCT-based image compression standard, such as JPEG, MPEG.

B. Preservation of Color

Preservation of color
By extensive analysis with several video sequences, Input

Parameters: f(x) (the mapping function) , I max
thresh, N(Block size).max
• Compute σ and μ.
• If (σ > σ
thresh
• Decompose into (N/2) x (N/2) DCT sub-blocks,
• For each block apply similar computations as described in
  Steps 3 through 5, and
• Combine 4 of these (N/2) x (N/2) blocks into a single
NxN DCT block and return.
3. Compute the enhancement factor (κ) as follows:
3a. κ = (f(Y(0,0)/N.I
max
)) /(Y(0,0)/N.I
max

we observed that the statistical distribution of the color is in typical
applications is closer to the enhancement. These techniques 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 decorrelated better than that in the R - G - B
color space, the increasing values in the Y component usually
tend to desaturate 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[3,4]. This is why we believe that the chromatic components
should be also processed for preserving the colors.

C. Algorithm for color enhancement by scaling (CES)

Input : Y , U , V : DCTs of three components of a block.
IV. Comparison of Results with the Previous Approach We have
compared the performance of the proposed approach with that of
three existing DCT domain color enhancement techniques, namely
alpha-rooting, multicontrast enhancement technique, multicontrast
enhancement coupled with dynamic range compression and
contrast enhanced by scaling [5 - 7].

A. Alpha Rooting (Ar)

The computation according to Alpha rooting it requires 1
multiplication and 1 exponentiation operation. Hence, the
computational complexity can be expressed as 1M + 1E per
pixel.
B. Multicontrast Enhancement (MCE)
Computation of the cumulative energies for both enhanced and
original blocks requires 126 additions (ignoring the cost of absolute
operations). For computing Hn , $1 \le n \le 14$, 14 divisions are
required and finally the scaling of the AC coefficients requires
two multiplications each. The total number of operations for each
block is thus 140 multiplications and 126 additions. Hence, the
number of operation per pixel becomes 2.19M + 1.97A.
C. Multicontrast Enhancement with Dynamic Range Compression
(MCEDR
3b. κ = min(κ, (B
3c. κ = max(κ,1)
/ μ + k σ) and
In this case, the number of operations is 128 Multiplications and
126 Additions [7]. In addition, the dynamic range compression
requires the computation of the function (x) with 2exponentiation
and 2 addition operations. Considering all other factors similar
to the previous one, the per pixel operation can be expressed as
0.03E + 3.97M + 2A.

Table 1: List of Techniques Considered for Comparative Study

TECHNIQUES	SHORT NAMES	PARAMETER SET
Proposed approach using t(x) without blocking artifact removal	TW-CES	B =255,k=1.0
Proposed approach using n(x) without blocking artifact removal	DRC-CES	$\Lambda = 1.95$, $B_{max} = 255.k = 1.0$
Proposed approach using ψ(x) without blocking artifact removal	SF-CES	$B_{max} = 255.k = 1.0$ m=n = 0.5, p1 = 1.8, p2 = 0.8
Proposed approach using t(x) with blocking artifact removal	TW-CES-BLK	$B_{max} = 255.k = 1.0$ $\sigma_{thresh} = 14$
Proposed approach using n(x) with blocking artifact removal	DRC-CES-BLK	$\Lambda = 1.95$, $B_{max} = 255.k = 1.0$ $\sigma_{thresh} = 15$
Proposed approach using ψ (x) with blocking artifact removal	SF-CES-BLK	$B_{max} = 255.k = 1.0$ m=n = 0.5, p1 = 1.8, p2 = 0.8 $\sigma_{thresh} = 15$

this case, the number of operations is 128 Multiplications and
126 Additions [7]. In addition, the dynamic range compression
requires the computation of the function (x) with 2exponentiation
and 2 addition operations. Considering all other factors similar
to the previous one, the per pixel operation can be expressed as
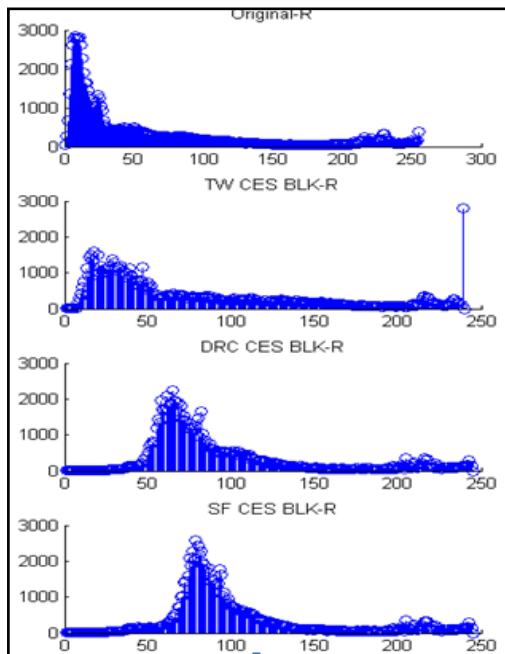0.03E + 3.97M + 2A.

D. Contrast Enhancement by Scaling (CES)

In this algorithm, the scaling of the coefficients by a constant
for each component is the major computational task. This would
require 192 multiplications and four additions. The additions
are necessary for translating (and retranslating back) the DC
coefficients of the Cb and Cr components [9]. Computation of the
scaling factor depends on the type of functions used. In addition,
there is an overhead of computing the standard deviation (σ) and
the mean (μ) of the block, which requires 63 multiplications, 62
additions and one exponential operation (square root).

V. Simulations and Results

Fig. 2: Representing the Input Image

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VI. Conclision

In this paper, we have presented a simple approach for enhancing color images in the block DCT domain by scaling the transform coefficients. The unique feature of this algorithm is that it also treats chromatic components in addition to the processing of the luminance component improving the visual quality of the images to a great extent. A comparative study with different other schemes has been carried out on the basis of different performance criteria. It has been found that proposed schemes outperform the existing schemes in most cases.

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