Coloring Gray Scale Digital Images using Kekre’s Fast Code Book Generation Algorithm

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ABSTRACT

This Paper presents the novel colorization method for coloring gray scale digital image. The paper introduces the use of Kekre’s Fast code book generation (KFCG) algorithm to generate codebook in Kekre’s LUV Color space and generate color palette. It is observed that the proposed method gives good acceptable results. This algorithm needs a similar color image of same class for coloring gray scale image. The color palettes are prepared by using the color image through KFCG algorithm and then transferred them to gray scale image.

Categories and Subject Descriptors

1.4 Image Processing and Computer Vision
1.4.2 Compression (Coding):- Approximate methods

General Terms

Algorithms, Performance

Keywords

Vector Quantization, Encoding, KFCG, Kekre’s LUV Color space, Color palettes.

1. INTRODUCTION

Colors in the images always provide more clear details than gray scale digital images. These details can be utilized for analysis and Study of the particular image in the applications like medical tomography, information security, Image segmentation etc. Coloring of old black and white movies or rare images of monuments, celebrities is one of the best applications which gives the good feel and understanding. Colorization is the term which means to color any gray scale image. The task of coloring an image is ambiguous since there is no exact definite solution available[1][2][3]. Since the coloring of gray scale image requires the one to many mapping of gray shades to RGB colors. Because of these reasons one needs to have human interaction. This could be in the form of providing the color pallets, providing the reference image of same pattern, style of the input image to be colored or scribbling the image areas with the colors of choice. The color fundamental process followed by the human brain in perceiving color is a psycho visual phenomenon that is not yet fully understood, the physical nature of color can be expressed on a formal basis supported by experimental and theoretical results. Basically, the colors we perceive in an object are determined by the nature of the light reflected from the object. Due to the structure of human eye, all colors are seen as variable combinations of the three so-called Primary colors Red, Green and Blue (RGB)[4][5][6][13]. The characteristics generally used to distinguish one color from another are brightness, hue and saturation. Brightness refers to intensity. Hue is an attribute associated with the dominant wavelength in a mixture of light waves. Saturation refers to relative purity or the amount of white light mixed with a hue. The Hue and saturation taken together are called chromaticity, and the major difficulty lies in the fact that it is an expensive and time-consuming process. For example in order to colorize a still image an artist typically begins by segmenting the image into regions and then proceeds to assign color to each region. Unfortunately, automatic segmentation algorithms often fail to correctly identify fuzzy or complex region boundaries. The colorization using optimization method requires artist only to annotate the image with a few color scribbles’ and the indicated color are automatically propagated in both space and time to produce a fully colorized image or sequence. Some of the authors had published their work in which the one dimensional distribution of luminance values between the images is matched and then transferred to the other components from the source image to target image [7][8]. Another method [9] analyzes color in the spectral domain and presents a spectral color-picking and colorization technique for surface color coating proposes to pick a set of new Colors from the real full-spectral image, to use a multidimensional technique for reducing the image dimensionality to a first principal component, and to colorize the gray-level image, which replaces the .first principal component [10]. Another method, which is, based on Grow Cut image segmentation algorithm [11]. In this approach a user just marks some pixels with desired colors, and the algorithm propagates these colors to the remainder of the image. After the initial colorization is computed, the user can interactively adjust and refine the colors of the image. In this paper new technique of Exhaustive search and Kekre’s Fast Code Book Generation Algorithm is used to search the matching Luminance values of Input gray scale image with the reference image chosen with the same pattern. Depending on the less
Euclidean distance of these L components the corresponding color components are accepted from the reference image to color the input image. The paper provides the innovative method of generating the color pallets using these techniques on reference image.

1.1 Vector Quantization

Vector Quantization (VQ) [16-19] is an efficient and lossy technique for compression of data and has been successfully used in various applications like as index compression [19][20]. VQ has been very popular in a variety of research fields such as speech recognition and face detection [21]. VQ is also used in real time applications such as real time video-based event detection [22] and anomaly intrusion detection systems [23], speech data compression [24], and image segmentation [25][26][27][28], Face Recognition[29], Content Based Image Retrieval CBIR[30][31].

VQ can be defined as a function that maps k-dimensional vector space to a finite set $\mathbf{CB} = \{ C_1, C_2, C_3, ..., C_N \}$. The set CB is called codebook consisting of N number of code vectors and each code vector $C_i = \{ c_{i1}, c_{i2}, c_{i3}, ..., c_{ik} \}$ is of dimension k. The key to VQ is the good codebook. There are various codebook generation algorithms available in literature [33-40].

In Encoding phase image is divided into non overlapping blocks and each block is then converted to the training vector $X_i = (x_{i1}, x_{i2}, ..., x_{ik})$. The codebook is searched for the nearest codevector $C_{min}$ by computing squared Euclidean distance which is Minkowaski distance for $r=2$ as given by equation (1) between vector $X_i$ and all the codewectors of the codebook $\mathbf{CB}$.

$$d(X_i, C_{min}) = \min_{j \in \mathbf{CB}} \{ d(X_i, C_j) \}$$

where

$$d(X_i, C_j) = \sum_{p=1}^{k} (x_{ip} - c_{jp})^2$$

(1)

It is obvious that if the codebook size is increased to reduce the distortion the searching time will also increase.

2. VQ Codebook Generation Algorithm

In this section we discuss VQ codebook generation algorithm KFCG briefly.

2.1 Kekre’s Fast codebook generation algorithm (KFCG)

Here the Kekre’s Fast Codebook Generation algorithm proposed in [36][37] for image data compression is used. This algorithm reduces the time of code book generation. Initially we have one cluster with the entire training vectors and the code vector $C_1$ which is centroid.

In the first iteration of the algorithm, the clusters are formed by comparing first element of training vector with first element of code vector $C_1$. The vector $X_i$ is grouped into the cluster 1 if $x_{i1} < c_{11}$ otherwise vector $X_i$ is grouped into cluster2 as shown in Fig. 2a. where code vector dimension space is 2. In second iteration, the cluster 1 is split into two by comparing second element $x_{i2}$ of vector $X_i$ belonging to cluster 1 with that of the second element of the code vector. Cluster 2 is split into two by comparing the second element $x_{i2}$ of vector $X_i$ belonging to cluster 2 with that of the second element of the code vector as shown in Fig. 2b.

This procedure is repeated till the codebook size is reached to the size specified by user. It is observed that this algorithm gives less error as compared to LBG and requires less time to generate codebook as compared to other algorithms [32][33][34], as it does not require any computation of Euclidean distance. The algorithm shown in Fig.2a. and Fig.2b. for two dimensional case it is easily extended to higher dimensions.
This LUV matrix is a special case of Kekre’s transforms [41].

After the image is converted in LUV space the image is divided in blocks of 2x2 pixels. Hence 12 dimensional training vector set corresponding to L, U and V component of each pixel is obtained. On this set Kekre’s Fast codebook generation (KFCG) algorithm is applied and codebook of size 256x12 is obtained.

Phase two: Generation of Training Vectors for the input gray scale image and Encoding.

Divide the input gray image in 2x2 blocks of pixels and then convert each 2x2 gray block to the vector of dimension 4 and generate the training vector set.

The codebook obtained from the reference image in LUV space is then exhaustively searched for the nearest codevector for each image training vector of the gray image. While searching the training vectors is compared with only the L components of the codevectors.

Once the nearest codevector is obtained the image training vector of dimension 4 is replaced by the entire 12 dimensional codevector and then image in LUV domain is generated.

The final colored image in LUV domain is then converted to RGB using conversion matrix given in equation 3.

\[
\begin{align*}
R & = 1 & -2 & 0 & L / 3 \\
G & = 1 & 1 & -1 & U / 6 \\
B & = 1 & 1 & 1 & V / 2
\end{align*}
\] 

(3)

4. RESULTS AND DISCUSSION

The algorithms are implemented on Intel processor 1.66 GHz, 1GB RAM machine to obtain results. We have tried the algorithm on various classes of images to color them. Out of which results of four classes are presented here the referenced color image used is of size 128x128x3 and the input gray image is of size 128x128.

Fig. 3 to Fig. 6 shows the results four class Puppy, Sunset, Micky and Barbie respectively.

Fig. 5 (a) Color version of input gray Image (b) Input Gray Image (c) Reference Image (d) Colored Image with MSE of 519.6

Fig. 6 (a) Color version of input gray Image (b) Input Gray Image (c) Reference Image (d) Colored Image with MSE of 438.2

The Fig. 3 gives the result of coloring with less MSE value compared to other classes. The sunset class result shown in figure 4 gives the good coloring effect at the output with MSE of 452.6 a bit higher than the previous. The Barbie class and cartoon class gives the good result of coloring as shown in Fig. 5 and Fig. 6.

5. CONCLUSION

Here in this paper we have presented the new innovative idea of coloring gray scale digital images using the vector quantization approach. To obtain codebook we have used Kekre’s Fast code book generation (KFCG) Algorithm. In general the original color image may not be available. However to test the performance of the algorithm we have selected color image and converted it into gray scale image. This image was colored using similar reference image. If we use original color image as a reference image then MSE is very low. The result of the algorithm presented gives very good performance.

REFERENCES

[9]. H.B.Kekre and Dhireendra Mishra, “Colorization of gray scale digital image using Kekre’s LUV Color space”, proceedings of International
conference on managing next generation of computer applications December05 & 06,2008 held at Karunya University, Tamilnadu,
[34]. Ming Yang, “Still image colorization”, ECE Department journals.com.