Volume 5, Issue 9, September 2015 ISSN: 2277 128X
International Journal of Advanced Research in
Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Structure Preservation in Example-Based Color Transfer

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Abstract— Color transfer is an efficient method to change the appearance of a target image according to the color characteristics of a reference image. Example-based color transfer is a part of image editing but easily suffers from some corruptive artifacts. A color transfer framework is proposed which aims at corruptive artifacts suppression along with structure preservation. The framework achieves grain suppression, color fidelity and detail enhancement. During color transfer from a reference image to target image, the whole color appearance will be distributed to the latter. As a result some of the objects will also be covered with unwanted colors. This can affect the natural look of object or structure. If the user is provided with an option to select images he wishes to preserve as such, this drawback will be vanished. A new method to preserve different structures in target image without any change in their color is proposed. The user can select the structure he likes to get preserved. The performance evaluation also show that the method can achieve the desired results than previous methods.

Keywords— Color transfer,target image,corruptive artifacts,segmentation,structure preservation

I. INTRODUCTION

Color is one of the most powerful element in an image, and various color processing methods have been proposed in the field of image processing. Color transfer is a method to change the appearance of a source image according to the color pattern of a target image. It has various applications in movie fields, graphics design and photo enhancement. An ideal image color transfer algorithm should keep the scene of the source image and apply all the dominant color styles of the target. As no color transfer algorithms are ideal, most of them suffers from corruptive artifacts. In Fig 1, it can be seen that the white color of house in the image is not preserved and it has a yellow tint after the color transfer.

In this paper, a color transfer framework is proposed which aims at corruptive artifacts suppression along with structure preservation. The central to color transfer approach is to incorporate a self-learning filtering method into the iterative probabilistic color mapping. First, the structure in the target image which the user wishes to preserve, without any color transfer effects is extracted. This is done by segmentation using region merging method. Next, the color transfer is performed. In this method, probabilistic mapping is iteratively applied to generate color mapping and self-learning filtering is embedded into the procedure of color mapping. The k-levels details is extracted to attain detail preservation. Finally, the extracted structure is replaced to the color transferred image. As a result the structure retains its color even after color transfer.

Fig. 1 Color transfer without Structure Preservation

II. STATE OF THE ART

The different artifacts that are produced are: Color distortion, Grain Effect and Loss of Details. Also different structures in target image are not preserved as such in color transfer. They also get affected with the color characteristics of reference image. The main objective is to suppress the corruptive artifacts that occurs during example based color transfer. Another aim is to preserve structures in target images as such without any color changes, where the user decides which structure is to be preserved.

Representative approaches for color transfer includes fast local color transfer via dominant colors mapping as in [3], distribution-aware image color transfer as in [4], non-rigid dense correspondence transfer as in [7], color distribution transfer for mixed-reality applications as in [11], to list a few. There are different color spaces for color tansfer[5]. Example-based color transfer as in [1], aims at suppressing such artifacts. The segmentation method using region merging as in [2], shows different methods through which different structures are extracted. The idea for user interaction to select structures is obtained from color transfer for gradient meshes as in [12]. The corruptive artifacts were studied through example based image manipulation as in [8]. The different ways of detail preservation are provided in smoothed local histogram filters as in [6], local laplacian filters as in [9] and edge preserving decompositions as in [10].

III. SYSTEM ARCHITECTURE

The proposed system consists of three main stages. First, the segmentation stage, next the color transfer stage and last, replacement of the extracted structure. The segmentation is based on maximal similarity based region merging. The user is provided the option to select which structure is to be preserved, so after segmentation the required structure will get extracted. A new region merging based interactive image segmentation method is presented. The users only need to roughly indicate the location and region of the object and background by using strokes, which are called markers. For color transfer with corruptive artifacts suppression, an iterative probabilistic color mapping with self-learning filtering scheme and multiscale detail manipulation scheme is used. First, an probabilistic color mapping is applied to construct the mapping relationship between the reference and target images. Then, a self-learning filtering scheme is applied into the transfer process to prevent from artifacts and extract details. Thus grain suppression, color fidelity and detail preservation is attained. Finally, the extracted structure will replaced to target image without any color change. Fig. 2 and Fig. 3 shows a comparison of color transfer without and with structure preservation. Multiple structures can also be preserved(both houses preserved as white color as in target image) using the proposed scheme as in Fig. 3.

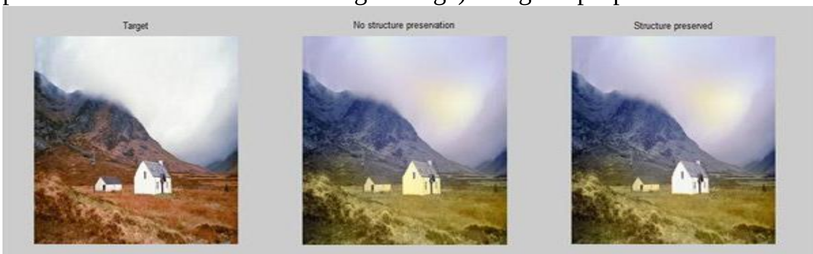

Fig. 2 Comparison of color transfer without and with structure preservation

Fig 3: Multiple structure preservation

The major modules of the proposed system are :

A. Segmentation

A region merging method as in [2] which is based on maximal-similarity is used to assist the merging process with the help of different markers. A region is merged with the next region if the former has the highest similarity with latter among all the adjacent regions. The method merges the regions that are initially segmented by watershed segmentation, and then extracts the object by labeling all the non-marker regions as either background or object.The process is repeated untill no new merging occurs. The markers can be the simple strokes, object marked with green and background with blue (e.g. the green and blue lines in Fig.4). Fig.4 shows the user interface for selecting structures for extraction.

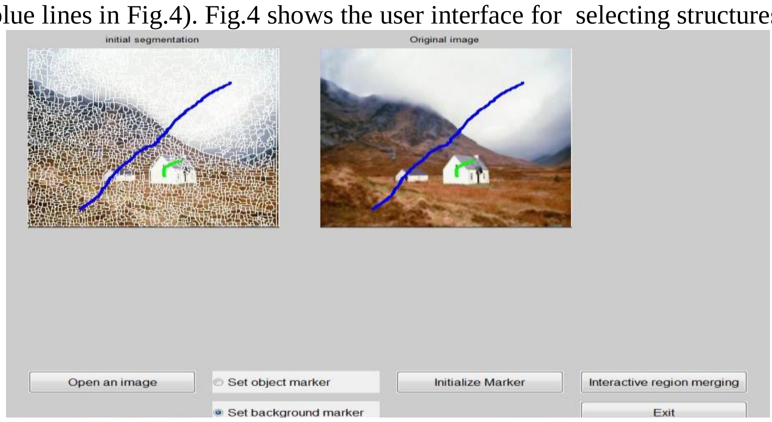

Fig. 4 User Interface for structure extraction

B. Color Transfer

The color transfer is achieved using two stages: probabilistic color mapping along with self learning filtering, and multi-scale detail manipulation as in [1].

In probabilistic color mapping, N-Dimensional color vector pairs are transformed to 1-Dimensional distribution. This matches color distribution of target image to that of reference. Correlated property of color results in color distortion. So decorrelation can be used to solve this issue using homography transformation (iterative). Then channel quantization is performed and afterwards 1-Dimensional probability density distribution is calculated. The color mapping can be calculated through different equations in various steps (as provided in [1]) as follows:

Projection with randomized orthogonal transform :

$$H = [I|R] * Qn$$

where I - 3*3 identity matrix, R - homography coefficient, Qn - randomized orthogonal matrix (n times iteration).

Channel quantization:

$$G = H*g$$
$$R = H* r$$
$$Smin = min(G,R)$$
$$Smax = max(G,R)$$
$$S = (Smax - Smin)/q$$

where g - transferred result, r - reference image, q - steps of quantization.

1D probability density distribution:

$$\rho(g) = Hist(S,G)$$
$$\rho (r) = Hist(S,R)$$
$$\tau = HistMatch(\rho(g), \rho(r))$$

Where Hist is the function for histogram generation. Then the histogram of target is matched with reference using the HistMatch function. The color mapping is iteratively updated untill the target color atmosphere gets closely matched to that of reference.

In self-learning filtering, an edge-preserving smoothing operation is done with reference image. It is incorporated it into the probabilistic color mapping. Output from color mapping produces grain effects. So guided filter is used to solve this. It is an edge preserving filter. Based on mean and variance linear coefficients are calculated.

In Multiscale Detail Manipulation, details in the original target should be preserved after the transfer. Since the self-learning filtering scheme is added into the color mapping, its property of edge-preserving decomposition to extract the details while preserving or enhancing them in the transferred output can be exploited.

C. Replacement of Extracted Structure

The extracted structure needs to be placed back so that it will not be affected with color changes during color transfer. The pasted image is an added combination of mask image and new image(Fig. 5).

The extracted image is replaced as:

Pasted Image = Mask Image + New Image

Fig. 5 Replacement of extracted structure(house)

Algorithm Steps

1. Select the target and reference images
2. Segmentation
   (a) Target image is segmented initially by watershed segmentation
   (b) Users mark regions as object (green) and background (blue)
   (c) Similar regions are merged using maximal similarity based region merging

3. Color Transfer
   (a) Projection with randomized orthogonal transform
   (b) Channel quantization
   (c) 1D probability density distribution
   (d) Iterative updation
   (e) K level details are obtained by applying Self Learning Filtering iteratively

4. Combine extracted object with color transferred target image

Pasted Image = Mask Image + New Image

IV. PERFORMANCE EVALUATION

In the proposed method, PSNR is used as a parameter to compare the system with existing methods. The peak signal-to-noise ratio or PSNR is the ratio between the maximum value of a signal and the power of disturbing noise. Performance evaluation using PSNR was conducted on a group of color images to verify the effectiveness of the proposed scheme. All experiments were implemented on a computer with a 2.30 GHz intel core processor with 4.00 GB memory, and Windows 7 operating system. The programming environment used was Matlab 2010. Several set of images like the white puppy, orange leaves, house, plain etc. where chosen as test images. Two conditions was checked, one without structure preservation and the other with structure preservation. For both cases the values noted where different. The color transferred images with structure preservation yielded the higher PSNR value. Higher the PSNR value, lesser will be the noise and the color atmosphere of structure preserved target image will look more similar to color atmosphere of reference image.

The proposed system with structure preservation yielded higher PSNR value, thus the structure is more correctly preserved than in color transfer without structure preservation. The PSNR results for the image1 is shown in Fig. 6, image2 in Fig. 7 and image 3 in Fig. 8. The reference and target images where randomly chosen by the user. And the results from images proved that the proposed system has a better result compared the existed systems and yielded the higher PSNR value. The comparison of PSNR values is shown in Table 1.

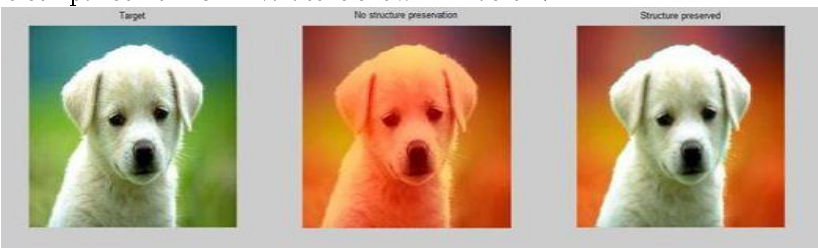

Fig. 6 Performance evaluation for a sample image 1

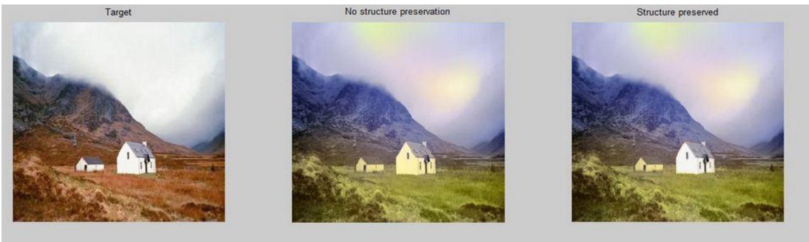

Fig. 7 Performance evaluation for a sample image 2

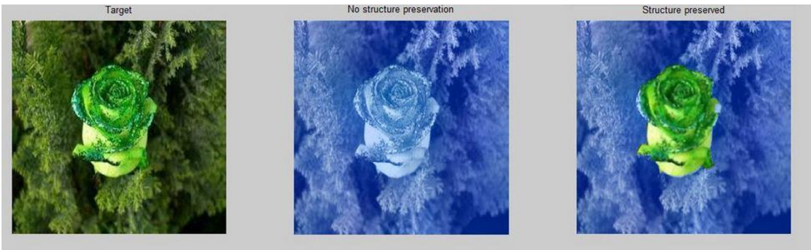

Fig. 8 Performance evaluation for a sample image 3

TABLE I COMPARISON OF PSNR FOR DIFFERENT IMAGES

Image	**Target Image**	**Reference Image**	**PSNR Without Structure Preservation**	**PSNR With Structure Preservation**
1	white puppy	orange colored leaves	13.4354	36.372
2	house	plain	34.6729	43.0137
3	green rose	blue sky	17.0435	34.7663

V. CONCLUSIONS

The proposed system preserves any user desired structure in the image while guaranteeing corruptive artifacts suppression during color transfer. Several structures will be present in the target image. The method preserves the structure as such thus by removing bad tints that occurs during transfer. User can decide which structure to be preserved. During color transfer from a reference image, the whole color will be distributed to target image. As a result some of the objects will also be covered with unwanted colors. So this can affect the natural look of object or structure. So, if the user is provided with an option to select images he wishes to preserve as such, the drawback will be vanished. The drawback of color transfer is overcome using segmentation of the required structure. Then color transfer is performed and the desired structure is replaced. As a result the structure retains its color even after color transfer.

ACKNOWLEDGMENT

The authors express their sincere thanks to HOD, group tutor and staff in Computer Science department, Viswajyothi College of Engineering and Technology for many fruitful discussions and constructive suggestions during the implementation of this paper.

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