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INTERACTIVE EXAMPLE-BASED COLOUR TRANSFER USING SPEEDED UP ROBUST FEATURE

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Abstract— Example based colour transfer aims at copying the colour appearance from a given example to a target colour image. The presences of corruptive artifacts in example based colour transfer can be suppressed using self learning filtering scheme. Object preservation is the main problem of example based colour transfer. During Colour transfer some objects in the target image will be covered with some unwanted colours .This can affect the natural look of object. This paper presents an interactive example based colour transfer which aims at corruptive artifacts suppression along with objects preservation. In this user can select the object that he wishes to preserve. Using this method we can avoid presences of unwanted colours of object in the target image. The proposed system mainly consist three main stages. Colour transfer stage, segmentation stage, and replacement of the extracted object. In the colour transfer stage, an iterative probabilistic colour mapping with self-learning filtering scheme and multiscale detail manipulation scheme is used. Next, the segmentation stage is based on speed up robust feature (SURF) algorithm. For finding point correspondences between two images of the same scene or object we can use SURF algorithm. In this stage the object that the user wants to preserve gets extracted. Finally, the extracted object will replaced to target image without any colour change. PSNR and SSIM shows that the proposed method will produce better result than the previous methods.

Keywords—Colour transfer, Example based colour transfer ,Segmentation, SURF, Object Preservation, PSNR, SSIM, Self-learning filtering

1. INTRODUCTION

Colour is the one of the most essential feature of an image. Colour manipulation has very large application in film industry. Example-based colour transfer is an automatic method of colour manipulation. Which aims at copying the colour from a given reference image to a target. It has various applications in movie post production, artistic and photo enhancement. A normal colour transfer algorithm should keep the scene of the source image and apply colour to the target. As no colour transfer algorithms are ultimate, most of them produce some unsatisfactory result.

Quick development has been witnessed in the last decade in the field of color transfer. Representative approaches include classical histogram matching, Statistical transfer [2], N-dimensional probability density function transfer [3], Gradient-preserving transfer [4], non-rigid dense correspondence transfer [5] and progressive transfer [6]. Even though these approaches are effective in transferring the color information, they would occasionally produce visual artifacts, due to the big difference in the intensity distribution between the reference and the target, an unsatisfactory transferred result was produced, with remarkable artifacts .Corruptive artifacts suppression for example based color transfer [1] specify the corruptive artifacts suppression in example- based colour transfer using self-learning filtering scheme. Based on the application of colour transfer, we want to develop a new colour transfer algorithm using user interaction.

In this paper, a colour transfer framework is proposed which aims at corruptive artifacts suppression along with object preservation. First using iterative probabilistic colour mapping the colour transfer is performed. Next, the object in the target image which the user wishes to preserve, without any colour transfer effect is extracted. This is done by segmentation using speeded up robust features (SURF). Finally, the extracted object is replaced to the colour transferred image. As a result the object retains its colour even after colour transfer.

2. RELATED WORKS

In this section we have analyzed different techniques for transferring colour among images. We have reviewed various methods for colour transfer between images. And also analyzing some colour transfer method with object preservation is also discussed. And finally summarize their advantages and defects.

The histogram matching [9] is able to specify the shape of the referred histogram that we expect the target image to have. However, histogram matching can only process the color components of the color image independently. Since the relationship of the color components are separated, this approach would produce the unsatisfactory look, e.g. grain effect, color distortion. Reinhard *et al.* [2] firstly proposed a way to match the means and variances between the target and the reference in the low correlated color space. This approach was efficient enough, but the simple means and variances matching were likely to produce slight grain effect and serious color distortion. Abadpour *et al.* [12] proposed the exploited principal component analysis (PCA) and created a low correlated and independent color space to reduce the color correlation. Pitié *et al.* [3],[11] proposed an N-dimensional probability density function transfer approach to reduce the high-dimensional PDF matching problem to the one-dimensional PDF matching by Radon Transform [9]. This operation can reduce the color correlation and keep the color distribution of the transferred result consistent with that of the reference. However, it would lead to the variance of image contents as the pixel intensity changed.

Corruptive artifacts suppression for example-based color transfer [1], discuss the corruptive artifacts suppression in example based color transfer, which suppress the corruptive artifacts like color distortion, grain effect and loss of details. This method is an automatic colour transfer approach. Some applications of example-based colour transfer needs a user interactive example based colour transfer that preserve objects in the target. In this proposed a speeded up robust features (SURF) based colour transfer framework with object preservation, using this user can select the object he likes to get preserved. PSNR and SSIM show that the system has good performance than the previous methods.

3. PROPOSED SYSTEM

The proposed system mainly consists of three main stages. Colour transfer stage, Segmentation stage, Replacement of the extracted object. In the colour transfer stage, transfer the colour of the reference to the target using an iterative probabilistic colour mapping with self- learning filtering scheme and multiscale detail manipulation scheme is used.

In the segmentation stage we extract the object in the target without any colour transfer. For that first we want to create ground truth segments of all objects in the target images and store it as a SURF database .Then after colour transfer user needs to input the object in the target image that he wants to preserve. For segmentation we use speeded up robust feature (SURF) algorithm. The object and target image without colour transfer is passed to the SURF function for extracting the object from the target image. SURF mainly consist three stages. First, the interest point detection: in this stage we extract the feature point of target and the corresponding ground truth segment of the object. Next, the local neighborhood descriptor: in this stage finding feature points in the neighborhood of the point of interest of the target and the ground truth segment. Last, matching: by comparing the descriptors obtained from target and the ground truth segment, matching pair can be found. After all these stages the required objects get extracted. Finally, the extracted object will replaced to the corresponding location of the colour transferred image. In this project we can also preserve multiple objects in the target image based on user needs

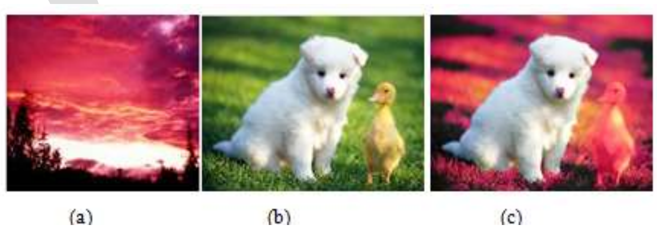

Figure 1. Interactive Example based colour transfer with object preservation (a) Reference. (b) Target. (c) After colour transfer, colour of the puppy is preserved

Figure 2. Interactive Example based colour transfer with multiple object preservation (a) Reference. (b) Target. (c) Boat gets preserved after colour transfer. (d) Boat and sea are preserved after colour transfer

The proposed system mainly consist two methods. First, for colour transfer we use an iterative probabilistic colour mapping with self-learning filtering scheme and multiscale detail manipulation scheme is used. Next, for segmentation we use speeded up robust feature (SUFR) algorithm.

3.1. Colour transfer method

The colour transfer is achieved using three stages: probabilistic colour mapping along with self learning filtering, and multi-scale detail manipulation as in [1]. In probabilistic colour mapping, N-Dimensional colour vector pairs are transformed to 1-Dimensional distribution. This matches colour distribution of target image to that of reference. Correlated property of colour results in colour distortion. So decorrelation can be used to solve this issue using homographic transformation (iterative). Then channel quantization is performed and afterwards 1-Dimensional probability density distribution is calculated. The colour mapping can be calculated through no of equations in various steps [1] as follows: Projection with randomized orthogonal transform is defined as,

$$H = [I|R]^{*} Qn……….. (1)$$

Where I is a 3*3 identity matrix, R is homography coefficient, Qn is randomized orthogonal matrix (n times iteration). Channel quantization

$$G = H^{*}g………………. (2)$$

$$R = H^{*} r………………. (3)$$

$$Smin = \min (G, R)……… (4)$$

$$Smax = \max (G, R)……… (5)$$

$$S = (Smax - Smin)/q…… (6)$$

Where g is a transferred result, r is reference image, q is steps of quantization. 1D probability density distribution:

$$(g) = Hist(S,G)………..(7)$$

$$\rho\ (r) = Hist(S,R)……..(8)$$

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$$\tau = \text{HistMatch}(\rho(g), \rho(r)) \ldots\ldots..(9)$$

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 until 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. In order to solve this we are introducing a filter. 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.

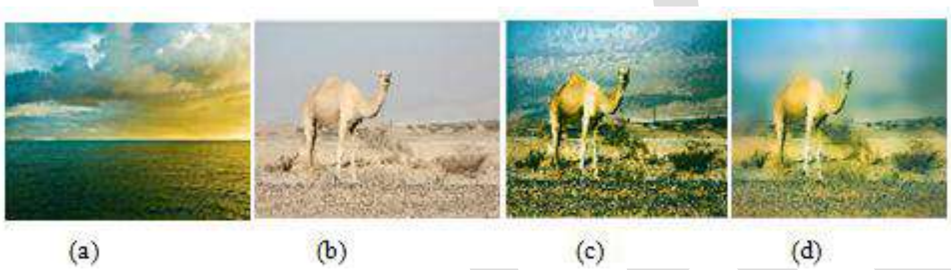

Figure 5. Example based Colour transfer with Self- learning filtering (a) Reference. (b) Target. (c) Colour transferred

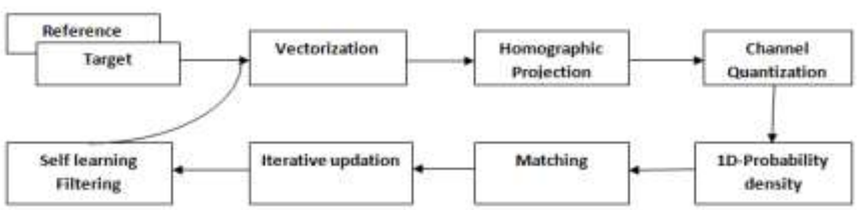

Figure 4. Block diagram for example based colour transfer with corruptive artifacts suppression

3.2 Segmentation method

For segmentation we use speeded up robust feature (SUFR) algorithm [2]. For finding point correspondences between two images of the same scene or object we can use SURF algorithm. The algorithm has three main parts interest point detection, local neighborhood description, and matching.

3.2.1 Interest point detection

SURF uses a blob detector based on the Hessian matrix to find points of interest. The determinant of the Hessian matrix is used as a measure of local change around the point and points are chosen where this determinant is maximal. In contrast to the HessianLaplacian detector by Mikolajczyk and Schmid, SURF also uses the determinant of the Hessian for selecting the scale, as it is done by Lindeberg. Given a point p=(x, y) in an image I, the Hessian matrix H(p, σ) at point p and scale σ, is defined as follows:

$$H(p,\sigma) = \begin{pmatrix} L_{xx}(p,\sigma) & L_{xy}(p,\sigma) \\ L_{xy}(p,\sigma) & L_{yy}(p,\sigma) \end{pmatrix}$$

Where $L_{xx}(p,\sigma)$ etc. are the second order derivatives of the grayscale image.

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3.2.2 Local neighborhood descriptor

The goal of a descriptor is to provide a unique and robust description of an image feature, e.g., by describing the intensity distribution of the pixels within the neighborhood of the point of interest. Most descriptors are thus computed in a local manner; hence a description is obtained for every point of interest identified previously. The first step consists of fixing a reproducible orientation based on information from a circular region around the interest point. .Then we construct a square region aligned to the selected orientation, and extract the SURF descriptor from it.

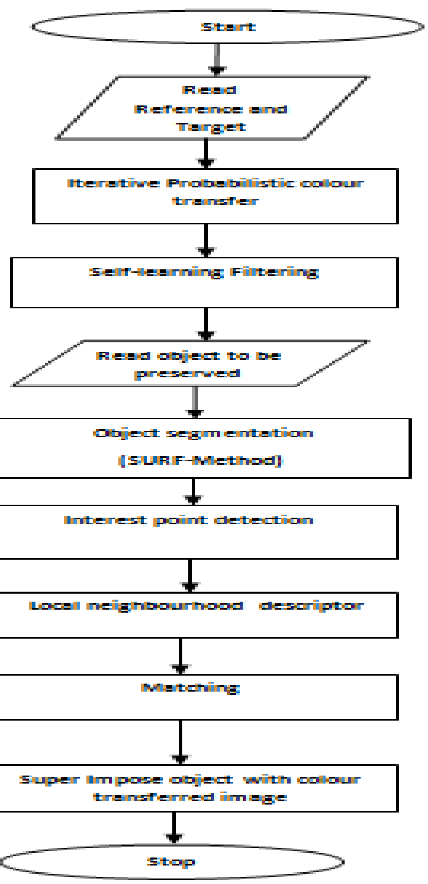

Figure 3. The flow chart of the proposed method

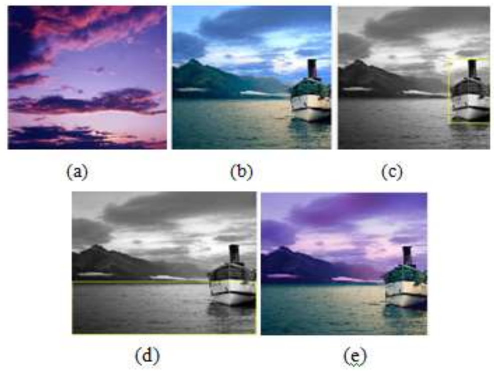

Figure 7. SURF based image segmentation for object preservation colour transfer .(a) Reference (b) Target.(c) Detecting boat in the target using SURF (d) Detecting sea in the target. (e) Boat and Sea get preserved

3.3.3 Matching

By comparing the descriptors obtained from target and ground truth segments, matching pairs can be found.

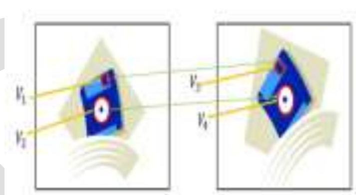

Figure 6.SURF summary

4. RESULTS

In the proposed method, PSNR and SSIM are 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 colour images to verify the effectiveness of the proposed scheme. Several set of images like the white puppy, house, and Camel 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 colour transferred images with structure preservation yielded the higher PSNR value. Higher the PSNR value, lesser will be the noise and the colour atmosphere of structure preserved target image will look more similar to the colour of the target. The proposed system with structure preservation yielded higher PSNR value, thus the structure is more correctly preserved than in colour transfer without structure preservation. 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.

The other parameter for performance evaluation is, Structural Similarity (SSIM).SSIM is used for measuring the similarity between two images. The SSIM index is a full reference metric; in other words, the measurement or prediction of image quality is based on an initial uncompressed or distortion-free image as references. SSIM is designed to improve on traditional methods such as peak signal-to-noise ratio (PSNR) and mean squared error (MSE), which have proven to be inconsistent with human visual perception. As same as that of PSNR performance evaluation using SSIM was conducted on a group of colour images to verify the effectiveness of the proposed scheme. SSIM of without structure preservation and with structure preservation is tested. For both cases the values noted where different. The colour transferred images with structure preservation yielded the higher SSIM value. Higher the SSIM value, structure is more similar to that of target. The proposed system with structure preservation yielded higher SSIM value, thus the structure is more correctly preserved than in colour transfer without structure preservation. The comparison of SSIM values is shown in Table 1.

Figure 8.Performance evaluvation of sample image

Target Image	Reference Image	PSNR		SSIM	
		Without Preservation	With Preservation	Without Preservation	With Preservation
Boat	Sunset	5.117	8.366	0.0090336	3.0075
Camel	Sunset	4.1588	7.0708	0.0069848	3.0068
Puppy	Sunset	5.0176	7.9524	0.0097518	3.0093

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7. CONCLUSION

In this proposed method an interactive example based colour transfer with object preservation is introduced. This framework proposes a speeded up robust features (SURF) based colour transfer framework with object preservation, using this user can select the object he likes to get preserved. The proposed system mainly consist three stages, first an iterative probabilistic colour transfer with self learning filtering and multiscale details manipulation scheme. Next, a SURF based object segmentation, in this stage we extract the object that the user wants to preserve. Finally the extracted object is superimposed on the colour transferred image. Multiple objects can also be preserved in this method. In addition, to evaluate the quality of colour, transfer, propose a series of objective and subjective measurements including PSSNR and SSIM. In this project we can also preserve multiple objects. By the experimental analyses in the objective and subjective data, we found that this framework had better performance than the state-of –the art approaches, especially in dealing with the object preservation. This framework can achieve colour reliability, grain inhibition and also object preservation. An interactive example based colour transfer with object preservation has very large applications in film industry, graphics design and photo enhancement. In the future, we will extend our framework to video editing.

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