Combined Contrast Enhancement and Noise Removal using Intrinsic Image Decomposition

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Article Received: 27 January 2018  Article Accepted: 23 February 2018  Article Published: 09 April 2018

ABSTRACT

Propose to introduce intrinsic image decomposition priors into the decomposition models for contrast enhancement. At first the input color image is converted in to HSV for reducing the color artifacts and complexity of the process. Then each channel output is displayed using command in the Matlab. The color image is converted in to LAB space for calculating the weight W. The final output is the decomposed Reflectance and illumination layers obtained by intrinsic decomposition of V channel. This method is performed on Matlab. The proposed model is effectively solved by the Split Bregman algorithm. Then, by adjusting the illumination layer, obtain the enhancement result. To avoid potential color artifacts introduced by illumination adjusting and reduce computing complexity, the proposed decomposition model is performed on the value channel in HSV space. Experiment results demonstrate that the proposed method performs well for a wide variety of images, and achieves better or comparable subjective and objective quality compared with state-of-the-art methods. During the contrast enhancement process the flicker noise is added, the noise can be removed using the vertical component analysis in the frequency domain.


1. INTRODUCTION

Decoupling illumination and reflectance from an images is a long-standing problem in computer vision. In order to solve this problem, introduce a framework for decomposing an image into the product of an illumination component and a reflectance component. Due to the nature of the problem, prior information on shading and reflectance is mandatory. The proposed method adopts that pixels in a region with similar chromaticity values have the same reflectance. This assumption was used to minimize the l2 norm of the local per-pixel reflectance gradients to extract the illumination and reflectance components. To obtain smooth chromatic regions, texture was treated in a new style. Texture was removed in the first step of the algorithm and the smooth image was processed for intrinsic decomposition. In the final step, texture details were added to the intrinsic components based on the material of each pixel. In addition, user-assistance was used to further refine the results. The qualitative and quantitative evaluation on the MIT intrinsic dataset indicated that the quality of intrinsic image decomposition was improved in comparison with previous methods. The flicker noise is introduced in the video contrast enhancement. This is removed by nullifying the largest coefficient of the V component in the frequency domain of an image.

2. INTRINSIC IMAGE DECOMPOSITION

Intrinsic image decomposition means, splitting an image in to illumination and reflectance layer. Illumination layer gives an idea about how much light is incident in an image. The Reflectance layer gives the object structure by reflecting the light from the object. Intrinsic image decomposition is performed in the Value channel of an image. At first the image is converted in to HSV. The further processing is performed in the V channel. V channel gives an idea about the degree of white or black mixed with Hue. The Hue channel gives Color information. Enhancement methods can be classified into two categories. Histogram based and
Retinex based Histogram-based methods enhance image contrast by modifying histogram distributions. Retinex-based methods assume that the scene in humans eyes is the product of reflectance and illumination layers. This model is effectively solved by the Split Bregman algorithm.

Enhancement result is obtained by adjusting the illumination layer. Decomposition model is performed on HSV space. Flicker introduced during video enhancement is removed. Too bright and too dark images are removed. Flickering effect is very high in V component. Then nullify the largest coefficients if they are greater than a threshold.

3. CONTRAST ENHANCEMENT BASED ON INTRINSIC DECOMPOSITION

At first Input the image I. Then Convert RGB into HSV representation. V channel image is decomposed into Illumination (L) and Reflectance (R) layer. Then L layer is adjusted by Gamma mapping function 'La'.

La is multiplied by R to get enhanced V channel image Ve. CLAHE is used to further enhance the local contrast of Ve. The enhanced result is denoted as Ve cap. HSV image is transformed to RGB space. Final result is the original color image I.

Fig1: Less contrast image
Fig 2: HSV converted image

After converting in to HSV, then the image is converted in to LAB space. In LAB space chrominance blue, Chrominance red and illumination information is dominant.

Fig 3: LAB image

4. ALGORITHM OF REFLECTANCE LAYER EXTRACTION

1. Read a colour image I
2. Convert colour image in to HSV.
3. Display the images in I, H, S, V.
4. Read the size of the V channel.
5. Convert the V channel image in to 3x3 patches IVK.
6. Convert the color image I in to LAB space to calculate the weight W.
7. Read the size of the LAB image LA.
8. Convert the LAB image LA in to 3x3 patches.
9. Extract the red channel matrix.
10. Extract the Green channel matrix.
11. Extract the Blue channel matrix.
12. Calculate the chromatic normalization L.
13. Read the size of the L.
14. Convert the L in to 3x3 patches, ILK.
15. Calculate the weight function $w_{ij}$.

\[
w_{ij} = \exp\left(-\frac{\|f_i - f_j\|^2}{2\sigma^2}\right),
\]

16. Solution to the reectance layer is obtained by

\[
r^{k+1} = A^{-1}z,  \\
A = \theta I + \lambda M^T M,  \\
z = \theta \left(\frac{v}{l_k}\right) + \lambda M^T (b^k - b^k),
\]

17. Convert the reectance matrix in to 3x3 patches.
18. Map each of the 3x3 patch to the corresponding 3x3 patch of I.
19. Convert HSV to RGB format.

5. ALGORITHM OF ILLUMINATION LAYER EXTRACTION

1. Define dx and dy.
2. Apply FT on dx and dy to get fdx and fdy.
3. Illumination is directly obtained by using the equation

\[
L^{k+1} = \mathcal{F}^{-1}\left(\frac{\mathcal{F}(\theta'[R^{k+1} + \beta L_0])}{\mathcal{F}(\theta + \beta) + \mu(\mathcal{F}^*(d_x) + \mathcal{F}^*(d_y))}\right),
\]

6. ILLUMINATION ADJUSTMENT

It is used to enhance the illumination details. They lighten the dark areas and Compress intensities in bright areas. In Log and Sigmoid functions loss of details in bright areas. So Gamma mapping function is used in illumination adjustment. The equation for Gamma mapping function is given below
\[ L_\alpha = 255 \times (L/255)^{1/\gamma}, \]

Mapping function is used to enhance the global contrast. \( L_\alpha \) is multiplied with \( R \), to get \( V_e \).

![Fig 4: Illumination adjusted image](image)

CLAHE is used to improve the local contrast of \( V_e \). Finally, HSV to RGB conversion is performed inorder to obtain the contrast enhanced output.

![Fig 5: Local contrast enhanced image](image)

After performing illumination adjustment and reflectance and illumination layer extraction the contrast of an input image is enhanced. In image contrast enhanced output is shown in fig 6.
Fig 6: Contrast enhanced image

Fig 7: Low contrast video frame

Fig 8: Contrast enhanced video frame with flicker
During video enhancement, flicker noise is introduced. It is mainly due to contrast difference between the two successive frames.

The flicker noise in a video enhancement is shown in the figure below. During video enhancement, at first input the video. Then read the number of frames in the video.

After enhancing the contrast of a video frame, flicker noise is introduced. Contrast enhanced video frame with flicker noise is shown in the figure 8

7. FLICKER REMOVING ALGORITHM
   1. Select the video input.
   2. Read the number of frames in the video.
   3. Select the first frame.
   4. Resize in to 300 X 300.
   5. Convert the first frame in to RGB.
   6. Read the number of rows, columns and dimension of the first frame.
   7. Check that the number of frames is greater than 1.
   8. Compute the difference between the two frames.
   9. The output of the difference is imDiff
   10. Read the number of rows, columns and dimension of the imDiff.
   11. Too bright and too dark frames are neglected by selecting the cutoff.
   12. The flickering should appears as an strongest periodic signal along the vertical axis of the image.
   13. Flickering can be detected by finding coefficients in the frequency domain.
   14. That represents flickering in the difference
   15. image and nullify them.
   16. Transform back in to Time domain.
   17. Read the size of V(150X150).
   18. Convert V in column vector (150*150 X 1).
   19. Sort the column vector in to an descending order.
   20. Nullify the largest coefficients, if they are greater than threshold
   21. Reshape V in to 150X150.
   22. Convert V in to time domain fdwt.
   23. Compute the difference between fdwt and imDiff.
   24. Add the difference output in to the first frame.
8. FLOWCHART REPRESENTATION OF THE ENTIRE PROPOSED METHOD

9. CONCLUSION
In this paper, propose to enhance images by estimating illumination and reflectance layers through intrinsic image decomposition. On the one hand, we constrain the reflectance layer to be piecewise constant according to the color similarity.
On the other hand, the illumination layer is enforced to be locally smooth. Since the decomposition model is non-convex and non-differential, we adopt the Split Bregman algorithm to iteratively solve this problem. After decomposition, perform Gamma correction on the illumination layer to boost the details globally. Then we adopt CLAHE to further enhance local details. Experimental results demonstrate that our decomposition model outperforms state-of-the-art image decomposition models in terms of image enhancement, and our enhancement method achieves the best subjective and objective quality for a wide variety of images.

For image enhancement, it may introduce flickering artifacts if it is applied directly to video enhancement. This artifacts is also removed using this method.

REFERENCES


