Estimation of Low Dynamic Range Images from a Single Image for High Dynamic Range Imaging Based on Exposure Look-up Table

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Abstract

HDR (high dynamic range) imaging supports wider dynamic range than normal images captured from general still camera. However, this technique usually needs several shots to obtain LDR (low dynamic range) images as merging purpose, causing artifacts such as ghosting. This paper suggests a method to estimated necessary LDR images from a single image using exposure LUT (look-up table) constructed by simple measurement. We first construct exposure LUT for each RGB channel. Then, from an image captured by auto mode in camera, LDR images which have each target average luminance are be estimated using constructed LUT. All procedures are performed with RGGB Bayer image. Also, saturated area is compensated by considering channel dependency. In experimental comparison, high PSNR values are obtained between estimated and captured images.

1. Introduction

HDR imaging is one of main issue in Digital camera industry to overcome current low dynamic range. Many researchers have developed lots of algorithms including Devebec. However, they open needed several shots to obtain necessary luminance images, causing unwanted artifact for moving objects. Accordingly, this paper proposes novel method to estimate target LDR images using LUTs for each channel.

2. Estimation LDR images

In this paper, LDR images refer as RGGB Bayer images because Bayer images are directly obtained from sensor supporting 14bit for each channel. That is, Bayer images have plentiful gray level to utilize LDR image estimation. For our procedure, Cannon Mark is prepared with custom white balance using white patch under D65 illuminant.

1. Construction of exposure LUTs for each channel

Exposure LUT has average luminance values relating between input scene and output digital value for each exposure step. In a camera, input scene can be scaled as range of output value. In this case, 14bit value is used. LUT data is easily obtained by capturing gray patches in Macbeth chart for each exposure step under D65 illuminant. Also, LUTs are constructed for each channel because sensitivity for each channel is not the same, informing different relationship between input scene and output digital values. Figure 1 shows G channel LUT. Other LUTs for R and B channel have similar shape of this LUT.

2. Estimation of LDR images

In HDR imaging, several LDR images are needed for proper exposure steps having proper luminance values. In our case, any LDR images for target luminance can be estimated. We have two procedure; estimation of exposure for target luminance, and estimation of LDR images for all pixels.

Figure 1 also explains the procedure of exposure estimation for higher and lower LDR images. Before the estimation, we assume that at auto mode, average luminance of input scene is the same. Also, scene can be presented as gray scaled value in a camera since for...
exposure control only average of scene is the only factor to show scene characteristics. Therefore, every scene has \( Y_{auto} \) as average luminance. Then, from the current exposure and \( Y_{auto} \) with LUT for G channel, current input scene is estimated, resulting in \( P_1 \). Also, by using LUT, the exposure steps corresponding to each higher and lower target luminance (\( Y_{hi} \) and \( Y_{lo} \)) which show the average luminance for target images can be estimated.

At figure 2, estimation of LDR images for each target luminance are shown. For black dot which is one of pixel value in the input scene, the higher and lower luminance can be obtained using LUT with above exposure steps. This procedure is done for all pixel values in the input scene for each channel, resulting higher and lower LDR images.

3. Compensation of saturated images by considering channel dependency

However these procedure cause wrong estimation for saturated areas in estimation of lower LDR images because these areas recognized as figure 3. To solve this problem, we adopt LUT for R in the estimation of G values since Sensitivity of R has weak than G and B channel. Therefore, to estimate current image for high light area in lower LDR image estimation, R LUT is used for G and B channel. This procedure increase PSNR as

3. Results and discussion

Figure 4 shows comparison results between estimated and captured images from the original image which are captured by auto mode.

This paper proposed estimation method of LDR images for HDR imaging from a single captured images. Exposure LUTs are used for estimation of each channel. At the results, results images from proposed methods are enough similar with captured images by real still camera.

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5. References


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**Fig. 2. Estimation of higher and lower values for each pixel to obtain each target LDR images.**

**Fig. 3. Control of saturated area.**

**Fig. 4. Resulting images. (a)original, (b) and (d) as higher luminance, and (c) and (e) as lower luminance for capture and estimated images.**