Light Source Estimation for Realistic Shadow using Segmented HDR Images

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***Abstract*— To achieve seamless integration of the real scene with virtual objects, we need to obtain accurate illumination condition of the real scene. Using HDRI (High Dynamic Range Image) we can acquire and control real world illumination information. There are various intensity levels of light sources in a HDRI; some regions are very bright and others are not. Bright regions contain much more lighting information than the other regions. Thus in this paper we propose a light source estimation method by using the ratio of intensity of radiation from segmented HDR images which are divided by characteristics of histogram value.**

This paper describes three mains steps performed in the research. First, we segment an image efficiently; second, we analyze the distribution of intensity of radiation. Finally, we estimate light sources from segmented HDR images by using the ratio of intensity of radiation.

***Index Terms*— High Dynamic Range Image(HDRI), Image Based Lighting(IBR)**

I. Introduction

In various fields such as a movie, advertisement for commercial products, game, VR and AR, seamless integration of virtual objects with a real world scene has been frequently used. To achieve more realistic synthetic results, accurate geometric models, material appearance and real world illumination conditions are required. Among them, accurate geometric models can be obtained by 3D scanners and material appearance can be defined by "Reflectance Distribution Function" such as "BSSRDF" and "BRDF". And real world illumination conditions can be represented by HDRI (High Dynamic Range Image). But to exploit this information, it requires heavy computation time. So, in this paper we propose a method to estimate illumination conditions efficiently for realistic synthetic scene.

To analyze the distribution of real world illumination we exploit the segmented HDRIs which represent real world illumination. Rendering result with virtual objects using the proposed method is closely mimic the objects rendered using IBL method (Image Based Lighting) that is based on global illumination technique. Proposed method can be used some applications where computational time is vital factor, estimating few number of light sources. Also it is possible that use the lighting effect of each segmented image.

II. Related Work

In the last few years, significant progress has been made in the area of estimating the reflectance properties and the illumination conditions of a scene based on images of the real world scene. Initial research in this area started for shape from shading application, which focused on recovering most prominent single light source [1, 2]. However the illuminations of the real world are very complex and cannot be represented using a single light source. Another work that closely relates to our research was to estimate few directional light sources from high dynamic radiance maps [3]. But the major drawback with their approach is that they used an iterative method to optimize the placement of light sources. Their solution has a chance of getting stuck in local minima.

III. Estimation of Lighting Condition

A. Estimation Procedure

Figure1 shows the overall procedure for estimation of lighting condition. For the first we need to segment input HDRI as the intensity of radiation, it can be segmented many regions but in our experiment we segment it into three regions; bright, medium bright and dim region. Using these segmented images, light sources are estimated by using median cut algorithm and the result can be used rendering scene [5].

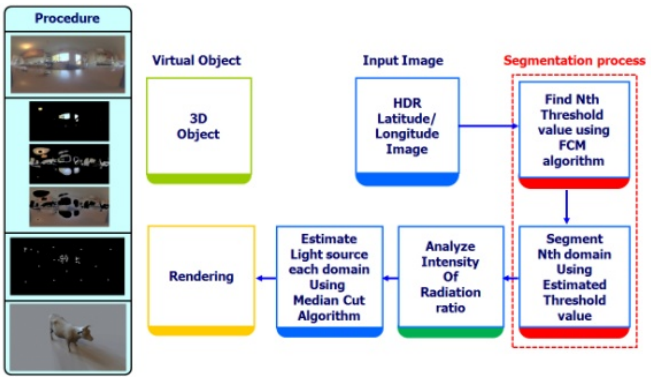

Fig.1. Overall Procedure of Proposed Method

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B. *Segmentation of HDRI*

We use tone-mapped image which has LDR-level range of the HDRI to segment the HDRI using the characteristics of image histogram. We do this since it is hard to classify the distribution of the pixel values due to the wide range of HDRI. In addition, user intervention is required to determine the characteristic value of the histogram. We use Fuzzy-C Means clustering algorithm to automatically find a characteristic value of the histogram without user intervention [5].

Figure 2 shows the procedure of FCM algorithm. The FCM algorithm is operated until the difference of the current and previous set is less than 0.0001. Then the light source information is computed from each segmented HDR image by using the median cut sampling algorithm.

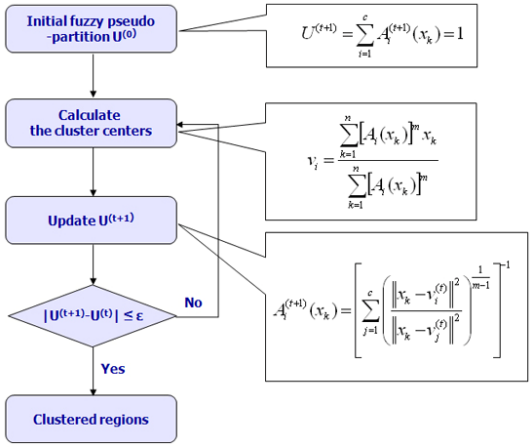

Fig.2. FCM Algorithm

Figure 3 shows the segmented HDR images and the intensity of radiation of each image using proposed algorithm.

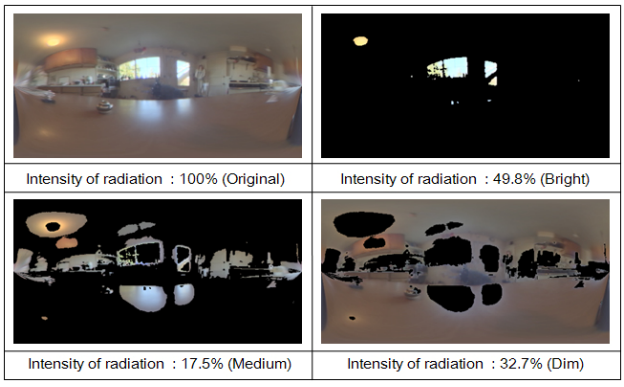

Fig.3. Segmented HDRI

C. *Median Cut algorithm*

We estimate the light sources based on the intensity of radiation by using Median Cut algorithm [4]. Total intensity of radiation is computed by the sum of the total pixel energy in the image; $E = 0.1215R + 0.7154G + 0.0721B$ following ITU-R recommendation BT.709. Radiation of each region is also computed similarly using the pixels within each region. The number of light sources corresponds to the computed ratio of intensity radiation. Median Cut algorithm operates to partition an image into 2^n regions of similar light energy.

IV. Result

Figure 4 shows the estimated result and the rendering result using the proposed method which estimates the parameters of light sources from the segmented HDR images. As shown in Figure 4 the segmented images have different effect on the scene. Bright regions affect more on generating shadows and other regions contribute more on shading and color effect.

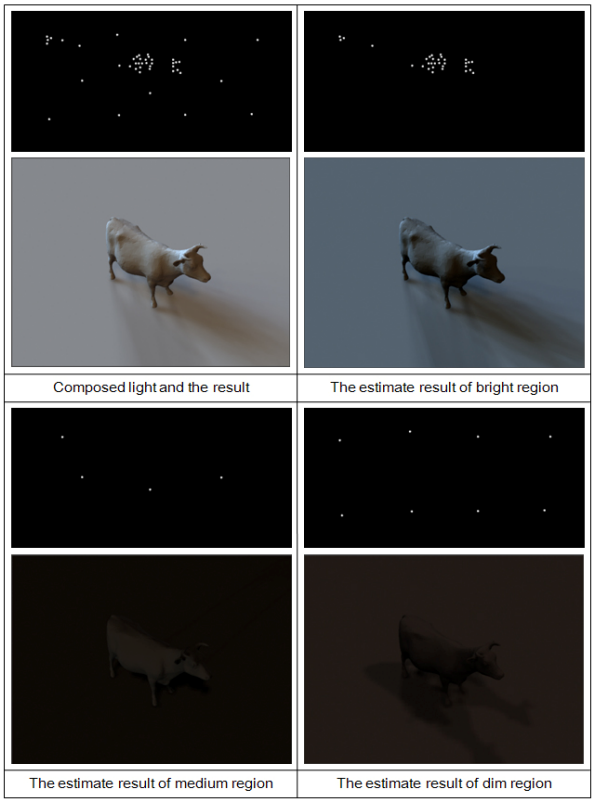

Fig.4. Estimated result and rendering result

V. Conclusion

Using the segmented HDR images, light sources can be estimated more efficiently such as more light sources are estimated in bright regions. Therefore it can generate realistic shadows using the small number of light sources. And it can be efficiently used in AR and interactive applications where realistic shadow is required and rendering time is a vital factor.

Acknowledgment

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