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[POSTER] Retrieving Lights Positions Using Plane Segmentation with Diffuse Illumination Reinforced with Specular Component

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Abstract

We present a novel method to retrieve multiple positions of point lights in real indoor scenes based on a 3D reconstruction. This method takes advantage of illumination over planes detected using a segmentation of the reconstructed mesh of the scene. We can also provide an estimation without suffering from the presence of specular highlights but rather use this component to refine the final estimation. This allows consistent relighting throughout the entire scene for aumented reality purposes.

1 Introduction

Many methods has been proposed to retrieve illumination information in indoor environments. Some of them use light probes [1] or other way to capture light field [2]. The inherent issue with these methods is that they only deal with the illumination at a local scale.

On the other hand, explicit light sources detection allows to relighting in a more consistent fashion. This last method is particularly suitable when synthetic objects must operate in an indoor environment, when the distant illumination assumption is no longer a good approximation. Hara et al. proposed in [3] to use an iterative scheme to retrieve the light source position but requires to know the geometry of the real scene. In [4] , Boom et al. proposed a optimization method to retrieve the light position. However, it does not take into account the specular component and is limited to a single light point light retrieval.

In this article, we propose a way to retrieve multiple point lights positions that take advantages of both diffuse and specular components. Thanks to a 3D reconstruction, provided by the Kinect Fusion algorithm, we proved it is possible to use plane segmentation to exploit large diffuse illumination information. We also show it is possible to use specular component within the same framework to estimate the positions of the lights.

2 Description of the Framework

In this section we will explain the overall framework that has been used to retrieve multiple point lights positions. It is shown in Figure 1. It contains mostly three different steps. First, we split the diffuse and specular components as explained in section 2.1. Then, we estimate a set of possible lines where the light sources could be located. This step is performed separately for diffuse and specular components as shown in section 2.2 and 2.3. Finally, based on the estimated lines, we retrieve the final positions of the lights in section 2.4. The whole framework is executed off-line. Indeed, once the light sources positions are retrieved, we can easily relight synthetic objects using any rendering method.

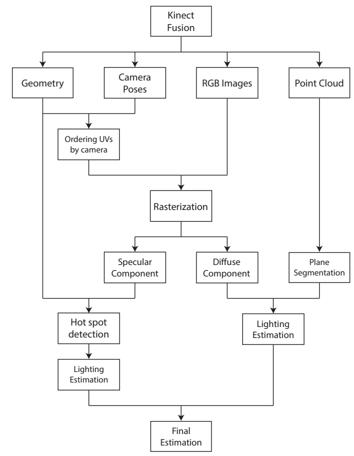

Figure 1: Framework of this method.

2.1 Separation of illumination components

Thanks to the camera poses estimated during the 3D reconstruction, we have multiple values of the illumination for a given point in the reconstructed mesh. As proposed by Nishino et al. in [5], we can split the diffuse and specular components using a rasterization process. For each triangle in the mesh, we simply compare the texture tile associated with each camera and consider the lowest pixel value as the diffuse component.

2.2 Estimation based on diffuse component

We detect the relevant planes using the Random Sample Consensus algorithm (RANSAC). It is then possible to project the diffuse texture onto these planes. The hot spots of the illumination can be located using a local maxima detection algorithm. The result of this process is shown with red points for the computer graphics scene in Figure 2.

Figure 2: View of the scene (left), result of the estimation (right)

With these locations, we can estimate that the point lights sources are located on the lines going from the maxima locations in the direction of plane normal. We keep these estimations for a later step of the framework explained in the subsection 2.4.

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2.3 Estimation based on specular component

We then propose to use the specular component of the illumination to obtain more information about the light source location. To do so, we first subtract the input camera image with the diffuse image computed in subsection 2.1 in order to retrieve the specular component. As in subsection 2.2, we use a local maxima detection algorithm to retrieve hot spots of illumination. Contrary to the diffuse method, we estimate the light sources directions using the mirror's direction at the point where the hot spots were located. Therefore, we obtain another set of lines where the light sources are located as shown in Figure 3.

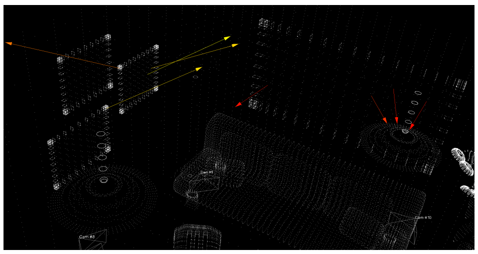

Figure 3: Lines estimated based on specular component

2.4 Final Estimation

In order to retrieve an unknown number of point light sources based on the lines estimated in subsection 2.2 and 2.3, we first need to create temporary points. We consider, for this, the middle of the shortest segment linking each pair of lines. This process allows us to transform a set of lines into a point cloud.

Based on this point cloud, we need to retrieve an unknown number of clusters that correspond to our light sources while eliminating aberrant points. We propose to use a Density-Based Spatial Clustering of Application with Noise (DBSCAN) to compute this final estimation. However, its parameters significantly depend on the scene scale and can be difficult to estimate.

3 Results

This framework has been tested on two different scenes: a CG scene and a practical scene reconstruction. The number of camera poses are 10 and 4 and the number of lights is 3 and 1 respectively.

As we can see with the CG scene in Figure 4, the framework fails in retrieving one of the light source. This is due to the lack of illumination coming from this light source. However, the error made on the estimation is 13.8 centimeters in average (relative to the room height set to 200 centimeters). For the practical case as shown in Figure 5 with its step by step results, we successfully retrieve the position of the light source with a error of 9.8 centimeters.

Figure 4: Estimation result for the computer graphics scene

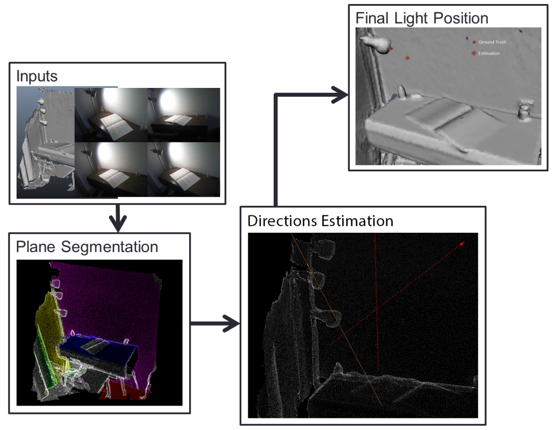

Figure 5: Estimation result for a practical case

Figure 6: Compositing capabilities

Finally, the Figure 6 shows the relighting capabilities resulting of our method. Notice that the shadow of the virtual red sphere matches the environment thanks to our method which successfully estimate the position of the light source.

4 Conclusion & Future Work

We show with this method, it is possible to achieve a multiple point light sources detection with a real scene capture for indoor environments. However, our method does not estimate the light intensity because of the saturation resulting from the Kinect sensor. We believe it is possible to compute this approximation knowing the position of the light (as proposed with this method) and unsaturated pixels of the diffuse image. We further think, it is possible to extend this method for detecting area-lights and their shape properties by extending the local maxima detection algorithm.

Acknowledgements

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