Development of a Portable Anisotropic Reflectance Measurement System for Modeling and Rendering of Bidirectional Texture Functions

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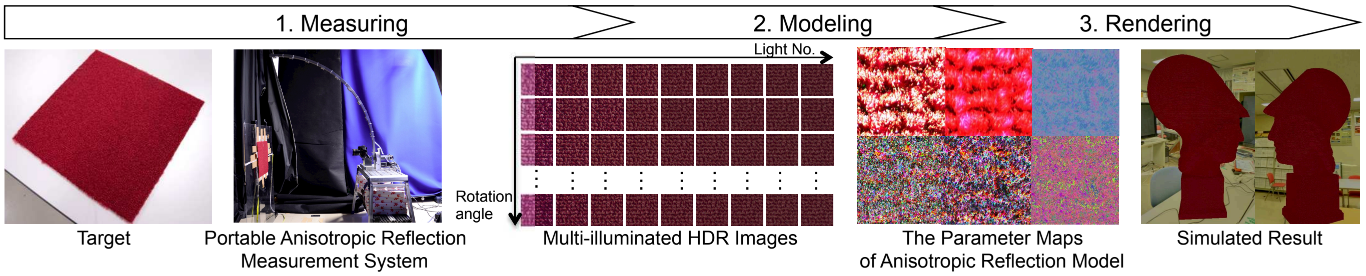

Figure 1: *Our Modeling and Rendering Process of Bidirectional Texture Functions using the PARMS.*

1 Introduction

Recently, Computer Graphics (CG) productions need the novel method to represent realistic CG objects. It is very difficult for their creators to set parameters of the reflection models that express correctly surface reflection of real objects.

Einarsson et al. proposed the image-based relighting method using Light Stage 6 that can render person under variable viewpoint and illumination [Einarsson et al. 2006]. But their system design depends on the size of a target, so the size of measurement system must be in proportion to the size of a target.

In this paper, we propose a Portable Anisotropic Reflectance Measurement System (PARMS) that has no limits to the shape and the size of targets. We also configure a modeling and rendering process of the Bidirectional Texture Function (BTF) described by anisotropic reflection models using the PARMS. We show the result on the reflection simulation using the BTFs that are generated from multi-illuminated High Dynamic Range (HDR) images acquired by the PARMS.

2 Our Approach

Figure 1 shows our modeling and rendering process of BTF using the PARMS. At first, the multi-illuminated HDR images of a target are acquired by the PARMS. Second, we generate the BTF that is described by the anisotropic reflection models generated from multi-illuminated HDR images in each pixel. At last, we implement the image-based lighting method using generated BTF for the reflection simulation of a target.

For measuring, we develop the PARMS that is constructed of a digital camera, a tripod, the arm of semi-circular arc with equally spaced 9 LED lights, a stepping motor, an absolute encoder, the rotation controller board of the arm, and a PC that controls the camera and the board. We can acquire multi-illuminated HDR images by rotating arm, turning on the lights in order, and taking multiple shots at different exposure settings. Since the PARMS is portable system and is able to measure around the center space of the arc, we can measure separately the surface reflection of large objects from any angle. This is the reason that the PARMS has no limits to the shape and the size of targets.

In modeling process, the parameters of anisotropic reflection model are estimated in Levenberg-Marquardt optimization using multi-illuminated HDR images in each pixel. This parameters is the set of specular reflectance, anisotropic variance, diffuse reflectance, normal direction and tangent direction in each pixel.

In rendering process, we adopt the image-based lighting method for BTF rendering of targets. For real-time rendering, the omni directional image is approximated with a finite number of light sources using importance sampling algorithm.

The contributions of our work are the following:

1. Introducing the PARMS that can measure the anisotropic reflection of arbitrary 3D objects because of its portability.
2. Providing modeling and rendering process of BTF using the PARMS.

In our experiment, we set the red carpet as a target. Multi-illuminated HDR images were generated from 684 images acquired by rotating arm in each 10 degrees, turning on 9 lights in order, and taking 4 shots at different exposure settings. The parameters of anisotropic reflection model were automatically determined from multi-illuminated HDR images in each pixel. We simulated the reflection of red carpet using the BTF generated from the anisotropic reflection models in doors.

In conclusion, we proposed the PARMS that has no limits to the shape and the size of targets. We configured the modeling and rendering process of BTF described by the anisotropic reflection models using the PARMS. We showed the result on the reflection simulation using the BTFs that are generated from multi-illuminated HDR images acquired by the PARMS.

In future work, we try to develop the image-based 3D reconstruction algorithm based on the images acquired by the PARMS.

References

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