Light Shower: A Poor Man's Light Stage Built with an Off-the-shelf Umbrella and Projector

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1 Introduction

Compositing an actor or real-world object into a virtual background is a powerful and widely used tool in movie and TV production. To create a natural composite, it is necessary to maintain photometric consistency between the foreground object and the background environment. Various light stage systems have been developed to achieve this goal. Debevec et al. [Debevec et al. 2002] illuminated the actor by an array of inward-pointing RGB light-emitting diodes, and Mitsumine et al. [Mitsumine et al. 2005] surrounded the actor with back-projection screens and projected virtual images onto these screens. One problem with both of these strategies is that the systems involved are very expensive and time-consuming to build. We propose an inexpensive light stage system, *Light Shower*, which consists of an off-the-shelf projector and a white umbrella. The projector projects an image onto the white umbrella, which creates environment light for a human face or a real object inside the umbrella (see Figure 1).

The main novelty of our system is its low cost. It is possible to build the system with materials most people already own, so the cost is negligible. We demonstrate that it has the necessary and sufficient capability to make a convincing composite picture of a real-world object in a virtual scene by making several interesting composites, including a movie sequence with a highly specular object, i.e., a pair of sunglasses. The proposed system is of sufficient quality for low-cost production, and is an ideal platform for students to learn the basic principles of digital lighting and composition.

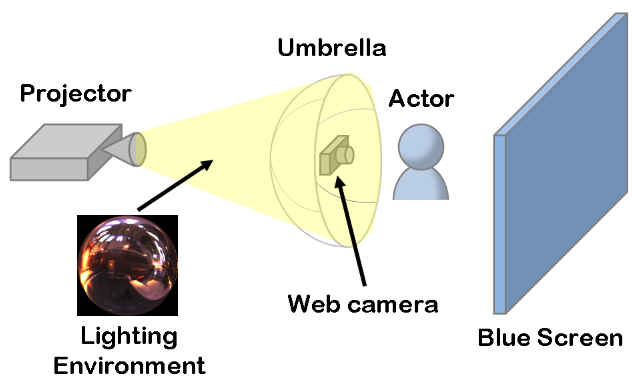

Figure 1: *Light Shower System*

2 Method

Light Shower consists of four main elements: a projector, white umbrella (as a screen), web camera, and blue sheet (see Figure 1). The projector is a TOSHIBA TLP-T700 LCD (2000 lumens). The umbrella, which is made of white plastic and can be purchased from a drugstore for $4 (USD), is suspended from the ceiling with ropes. The web camera (640 x 480 resolution) is fixed inside the umbrella with tape, and points toward a blue sheet for creating matte images. For the lighting environment, we used a high-dynamic range (HDR) mirror ball image of environmental light. We adjusted the tone-mapping parameter manually to obtain an appropriate low-dynamic range (LDR) mirror ball image for the projector output. The region of the mirror ball image projected onto the surface of the umbrella was used for the composite.

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3 Results

Figure 2 shows a composite of an actor in the Galileo's Tomb lighting environment, where the environmental light rotates around the actor (Figure 2, left). Light effects on the actor's face are also rotating simultaneously (Figure 2, right three images). We created this composite using Adobe Premiere Pro. We applied the blue screen key effect for creating a matte image and manually adjusted the tone curves of RGB to adjust the appearance.

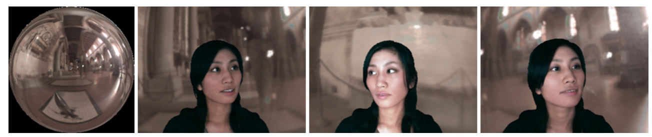

Figure 2: *Composite of an actor*

One of the strengths of using a projector over a diode array is that a highly specular object can be used for a composite. Figure 3 shows a composite of an actor wearing sunglasses in the Grace Cathedral lighting environment. The sunglasses reflect the environmental light.

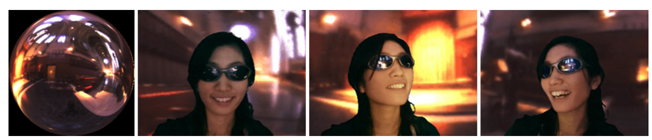

Figure 3: *Composite of an actor wearing sunglasses*

4 Limitations and Future Work

The main limiting factor of our system is the size of the umbrella, which only covers an area about the size of a human face and, therefore, cannot be applied to larger objects or full-body motion. In addition, it cannot reproduce lighting from the sides or behind the subject. We are currently investigating inexpensive methods for creating an enclosed light environment. Other limitations include the natural geometry of an umbrella, which is not a complete sphere; weak lighting intensity; and the lack of an automatic method to adjust colors, as our current post-process is manual and depends on the designerfs skill. To address these problems, we plan to develop various calibration technologies for detecting the shape of the umbrella, morphing the projected image based on the detected shape, and automatically adjusting intensity and color.

References

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