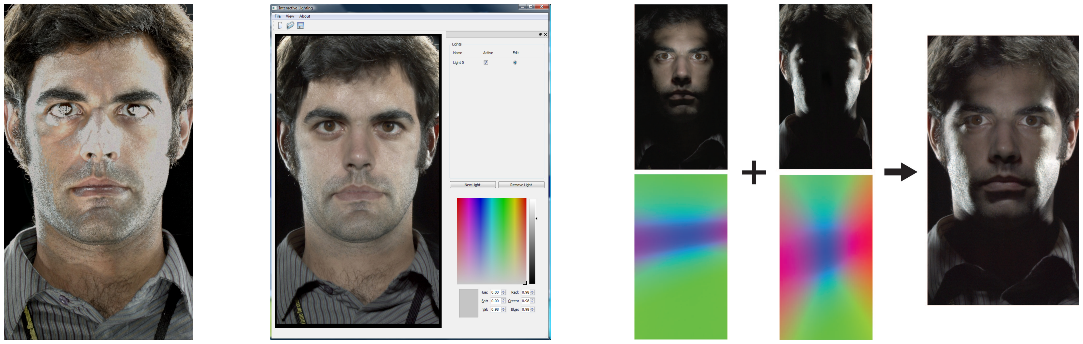
Interactive Lighting Manipulation Application on GPU

Borom Tunwattanapong Paul Debevec
University of Southern California Institute for Creative Technologies



(a) novel lighting (b) interface of application (c) combining result

Figure 1: *(a): The face lit from per pixel view dependence reflection angles. (b): Interface of the application implemented on Qt. (c): Specifying illumination from light direction map and combining the result from several sets of map.*

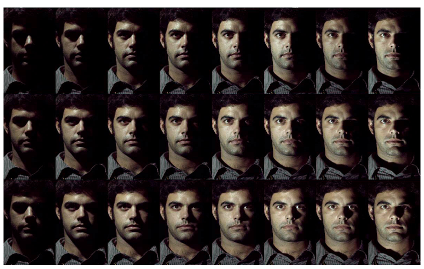


Figure 2: *Illumination data from 480 light directions.*

1 Overview

We present a technique for relighting an image such that different areas of the image are illuminated with different combinations of lighting directions. The approach is to capture a 4D reflectance field using a light stage, calculate the radial basis function interpolation of light constraints specified by users, and render the calculated illumination result in real-time using the GPU. The application can simulate the result of impossible but artistically useful lighting conditions ranging from small cheats of cinematography to non-photorealistic rendering effects as in [Akers et al. 2003]. For example, the user can sculpt a point light (rather than an area light) which illuminates a face from the whole sphere of directions at once, or which lights every pixel simultaneously from a grazing angle (see Fig. 1, a).

2 Capturing illumination data

We use the same apparatus lighting system as in [Hawkins et al. 2004] to capture the reflectance data where the lighting system is synchronized with a stationary high speed camera. By rapidly strobing lights on the subject from 32 longitudinal directions by 15 directions in latitude, we capture 480 lighting directions of the subject (see Fig. 2).

3 Radial basis function interpolation of light constraints

Users manipulate the effect of light by applying light constraints at selected image locations. Each constraint specifies a direction, color and intensity of the light as it illuminates the area and the application uses the GPU to calculate a Gaussian radial basis function interpolation of all the lighting constraints. The use of GPU enhances the calculation of the Gaussian exponenial function. The interpolation coefficients can be visualized interactively as a false-color image of the directions by showing (X,Y,Z) lighting direction vector components as (R,G,B) colors (see Fig. 1, c). Users can add multiple, indpendently constrained lights to create more complicated lighting configurations.

4 Calculating the final result

The interpolated lighting direction constraints specify look-ups into the reflectance field, with sub-pixel accuracy using bilinear interpolation. For each set of lighting constraints, one pixel of the final result corresponds to one direction of light. By having more than one set of lighting constraints, one pixel can be lit from several directions, colors and intensities of lights. Users can enable or disable sets of lighting constraints to see the effect of an individual set. The application can render a 480×270 pixel result in real-time using the GPU. It also employs a multi-thread system that calculates the result at 960×540 resolution in the background taking just a second or two to provide a high-resolution update (see Fig. 1, c). This multi-thread system improves the interaction performance by receiving inputs from users and calculating the result at the same time. For final output, the application can render a high-resolution result at 1920×1080 (loading up to a 3GB reflectance field from disk) within three to four minutes.

References

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HAWKINS, T., WENGER, A., TCHOU, C., GARDNER, A., GÖRANSSON, F., AND DEBEVEC, P. 2004. Animatable facial reflectance fields. In *Rendering Techniques 2004: 15th Eurographics Workshop on Rendering*, 309–320.