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Rerendering Landscape Photographs

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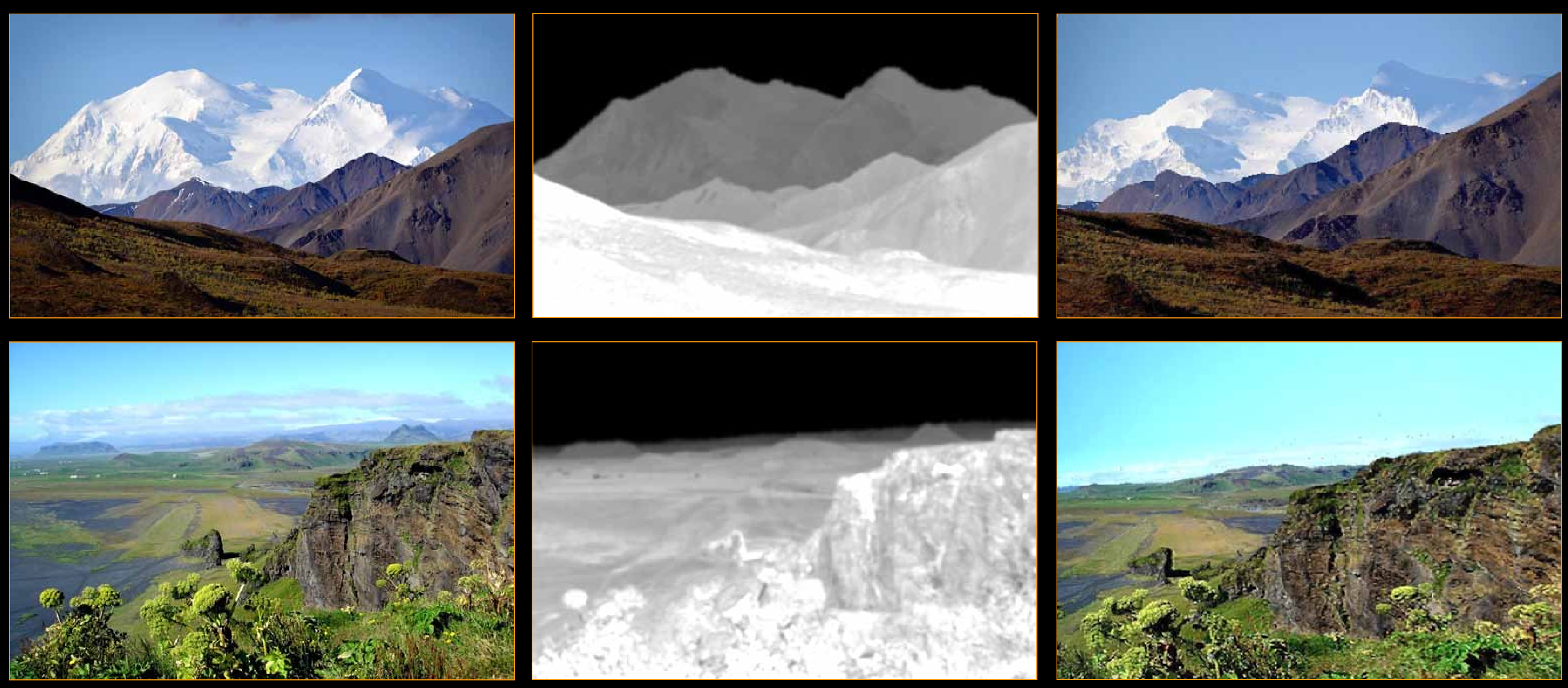

(a) input (b) depth map (c) novel view

FIGURE 1: Rerendering based on estimated depth.

(a) input (b) albedo (c) relit

FIGURE 2: Relighting based on estimated albedo.

ABSTRACT

We present an approach for realistic rerendering of landscape photographs. We first extract a view dependent depth map from single input landscape images by examining global and local pixel color distributions and demonstrate application in novel viewpoint renderings. For relighting, we assume diffuse reflectance and relight landscapes by estimating the irradiance due the sky in the input photograph. Finally, we also take into account specular reflections on water surfaces which are common in landscape photography and demonstrate relighting of scenes with still water.

1. DEPTH ESTIMATION

We propose a simple approach for depth estimation inspired by recent work in single image dehazing [2]. Most landscape images have a little amount of haze in them due to atmospheric scattering. We make the observation that this results in the blue channel of the images to progressively increase in magnitude with depth due to haze accumulation. We call this the blue channel prior for landscapes and estimate depth as 1−log(B) where B is the blue channel contribution in [0,1] (Fig. 1). For scenes without haze however, we cannot rely on the blue channel for depth cues. For such scenes, we estimate depth as inversely proportional to the local contrast around every pixel (Fig. 3). We apply a small amount of post-processing to the obtained depth map including bilateral filtering and depth interoplation across scanlines to handle outliers. Here, we employ additional heuristics about scanline depth ordering to filter initial depth values.

DEPTH FROM LOCAL CONTRAST

(a) input (b) high freq. (c) depth map

FIGURE 3: Estimating depth from local contrast in haze free scenes.

DEHAZING COMPARISON

(a) input (b) He et al. [2] (c) our result

FIGURE 4: Comparison of depth estimation with dark channel prior.

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2. RELIGHTING

Relighting of scenes requires modeling of scene reflectance and incident illumination, typically in the form of a light probe [1]. For relighting of landscape images, we make the assumption of diffuse reflectance of the scene and upwards facing surface normal. Under this assumption, the recorded photograph I is a product of an unknown scene albedo ρ_d and the incident irradiance E due to the sky. Hence, we first estimate the sky irradiance E. This requires segmenting out the sky which can be done either manually using standard image editing tools or even automatically using scene depth estimates (Section 1). We resample the segmented sky into a latitude-longitude format and then compute the following integral over the upper hemisphere $E = \int_\Omega L_i(\omega_i)\cos\theta_i d\omega_i$, to compute the sky irradiance. Thereafter, we estimate the per channel albedo based on the irradiance as $\rho_d = I / E$. Finally, we relight the scene under a different illumination by multiplying ρ_d with the incident irradiance due to a novel illumination environment (Fig. 2, top-row).

Not all landscape scenes are diffuse and scenes with water bodies exhibit specular reflections. We handle still water bodies in this work. First, we assume a horizontal axis of reflection in the image (typical for most landscapes). For surface with slight ripples, we compute a per pixel specular albedo by dividing water pixels by corresponding land/sky pixels above the reflection axis. Next, we relight the diffuse land pixels as before and composite the novel sky. Finally, we relight the water pixels by multiplying the water albedo with the relit reflected land/sky pixels (Fig. 2, bottom-row). For perfectly still surfaces however, we compute an average water albedo that we employ for relighting.

RELIGHTING CROSS-VALIDATION

FIGURE 5: Top-row: original images. Bottom-row: relit images.

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