

Rerendering Landscape Photographs

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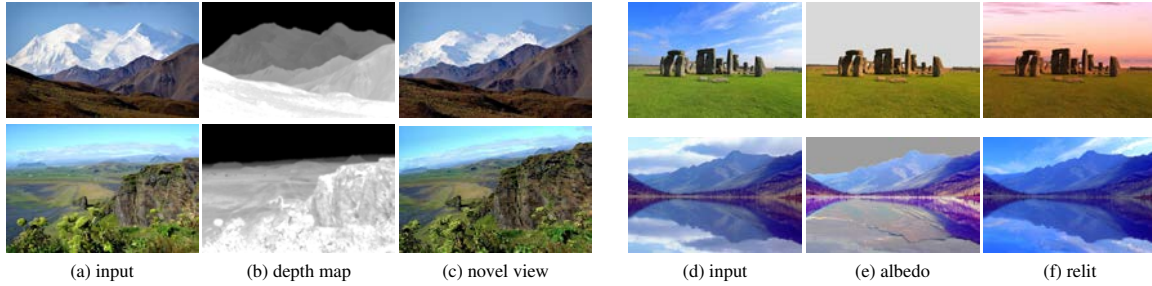


Figure 1: Rerendering landscape photographs. (a - c) Novel views based on estimated depth. (d - f) Relighting based on estimated albedo.

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 [He et al. 2009]. 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 a - c). However, for scenes without haze we estimate depth as inversely proportional to the local contrast around every pixel. We apply a small amount of post-processing to the obtained depth map including bilateral filtering and depth interpolation across scanlines to handle outliers. Here, we employ additional heuristics about scanline depth ordering to filter initial depth values.

2 Relighting

Relighting of scenes requires modeling of scene reflectance and incident illumination, typically in the form of a light probe [Debevec 1998]. For landscape images, we make the assumption of diffuse reflectance of the scene and upwards facing surface normal. Under this assumption, the recorded photograph is a product of an unknown scene albedo ρ_d and the incident sky irradiance L_i . 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. Once E has been estimated, we divide the input image pixels by the per channel E to obtain the per channel albedo ρ_d . Finally, we relight the scene under a different illumination by multiplying ρ_d with the incident irradiance due to a novel illumination environment (Fig. 1, d - f: 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) and divide the segmented water pixels by the corresponding land/sky pixels above the reflection axis to obtain the water albedo. Next, we relight the diffuse land pixels as before. Finally, we relight the water pixels by multiplying the water albedo with the relit reflected land/sky pixels (Fig. 1, bottom-right).

3 Results

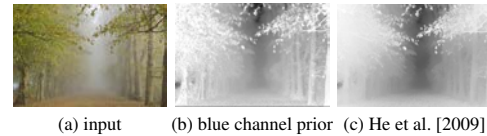


Figure 2: Depth estimation from blue channel prior compared to dark channel prior.

Fig. 2 presents comparison of depth estimation using our proposed blue channel prior with that produced using recent state of the art dehazing algorithms of He et al. [2009]. As can be see, our approach produces very comparable depth map for the scene with a much simpler algorithm that is easily implementable.

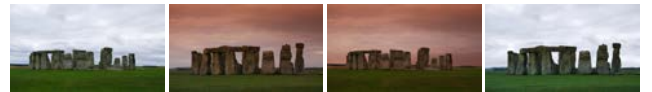


Figure 3: Relighting cross-validation.

Fig. 3 presents evaluation of our proposed relighting strategy for landscape photographs through cross validation. The first two columns shows two original photographs of Stonehenge at different times of day. The last two columns presents relit result of each image lit with the sky of the other image for comparison. Our approach can be easily applied for digital set extensions and editing of natural backgrounds in visual effects pipelines.

References

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- HE, K., SUN, J., AND TANG, X. 2009. Single image haze removal using dark channel prior. In *CVPR*, 5.

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