CS448I Project Proposal
Shadow Removal and Contrast Enhancement Based on Light Source Estimation

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1 Motivation

Capturing high-quality images under varying lighting conditions is a common challenge in computational imaging. Shadows, caused by uneven illumination, can degrade image quality by reducing visibility and introducing unwanted artifacts. These artifacts, as well as changes due to local variation in the intensity or color of the illumination also make it more difficult to implement image segmentation, object recognition and other basic tasks for computer vision [1].

This project aims to develop a robust solution for shadow removal and contrast enhancement using light source estimation. By accurately estimating the direction and intensity of light sources, we intend to improve the overall quality and visual effect of the image, and enhance the contrast of the image furthermore.

2 Related Works

Several existing methods address shadow removal and contrast enhancement. Notable approaches include histogram equalization [9], Retinex-based algorithms [7, 2], and deep learning techniques [5].

He-related methods involve applying to each pixel the histogram equalization mapping based on the pixels in a region surrounding that pixel, which is invented by Ketcham et al. [4, 8, 3]. AHE (Adaptive Histogram Equalization) [9] achieves improvement in speed and quality and operates on local regions, making it effective in enhancing details and mitigating the effects of varying illumination conditions across an image.

The Retinex theory posits that the visual system separates the influence of illumination and reflectance when perceiving an image. The illumination change can be modelled as an independent scaling of sensor responses in each channel (a so-called diagonal model of illumination change and consider a single surface which is partially in shadow. A retinex path entirely in shadow or entirely out of shadow gives the same results at each pixel since it is merely calculating ratios within a channel [2].

Many works have been put in shadow detection. Khan et al. [5] propose a framework which automatically learns the most relevant features in a supervised manner using multiple convolutional deep neural networks (ConvNets). Using the detected shadow masks, they propose a Bayesian formulation to accurately extract shadow matte and subsequently remove shadows. Deep learning methods have more adaptability to varied tasks compared with previous pixel-level computation.

3 Project Overview

We intend to develop a robust solution for shadow removal by incorporating light source estimation and use this information to correct shading effects.

3.1 Baseline

We will use Homomorphic Filtering, Dark Channel Prior as baselines.

3.2 Main Pipeline

For light source estimation, we'll directly use the method proposed by Lalonde et al.[6]. Illumination affects different parts of the scene in very different ways. In this approach, information about illumination is captured from three major parts of the image — the sky pixels, the ground pixels, and vertical surface pixels. Using the three parameters, we can compute distributions over these parameters given the sky, the shadows on the ground, and the shading on the vertical surfaces individually and combine these cues to estimate the illumination from the entire image later.

After getting the light source information, we'll try to separate shading from reflectance and correct shading. If time permits, we'll experiment deep learning methods and use original image and light source information as input.

The final goal of this project is to remove the shadows from the original image and enhance its contrast.

4 Timelines and Milestones

- Week 8: Organize literature and implement baselines.
- Week 9: Set up light source estimation and implement main pipelines.
- Week 10: Write report and try to experiment with deep learning methods.

References

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