Notes on Shadow Removal Using Intensity Surfaces and Texture Anchor Points

**Abstract**

The purpose of the paper is to recognize the difficulties and obstacles of shadow detection and removal on images and popularize newly discovered techniques. The goal of these techniques is to take any image and remove all shadows while preserving its original quality. The reason behind the difficulty is that the phenomenon of shadows is sourced from many variables, such as lighting and reflectivity of the surface, which can be hard to capture and define.

**INTRODUCTION**

* Goals: To turn an image with shadows into a high-quality replica of the same image, but without shadows
* Albedo: fraction of light that is reflected
* Illumination: level of lighting
* Shadow Scale Factor?
* Image = Albedo + Illumination + Shadow Scale Factor
* Constraints that images have to be placed under: lighting conditions,acquisition device properties, type and behavior of shadowed surfaces, statistics of shadow pixels
* shadowed surface- a part of the surface which is occluded from at least one direct light source in the scene.
* What is the shadow scale factor? What is shadow intensity?
* Uniform shadows are easier to calculate as there is simply one unknown to calculate scale factor
* Non Uniform shadows have varying scale factors

The problem that this paper is addressing is finding a system that turns images with shadows into high-quality replicas of the same images, but without shadows. By reducing and simplifying an image into a mathematical model of three variables: illumination, albedo, and shadow scale factor, researchers can estimate how much of “shadow” is in a specific area and cancel the effects the “shadow” has on that area. However, this is the old, traditional approach that runs into issues of only being applicable to a select, few number of images.

I’m confused about what “shadow scale factor” means. It is a term thrown out and seems to see no other use on the Internet. I’m assuming that it is an arbitrarily defined term that differentiates areas with shadows from areas without using methods discussed later. I’m also confused as to how this paper deals with pixels. The formula that an image is composed of illumination, albedo, and shadow scale factor isn’t intuitive.

**Results:**

The author(s) uses before and after pictures as evidence that their research was successful. Pictures are powerful sources of credibility because they are relevant and appropriate for the research, a computer vision problem. They also include pictures where the proposed method wasn’t completely successful. This makes their research convincing because the researchers are objectively analyzing and critiquing their own data. The six pairs of before and after pictures are all significantly different and have shadows with different properties (testing for edge cases). Some pictures include uniform shadows, while others have shadows that vary greatly in brightness. However, all procured results seem to perform well and remove the shadows from the images.

Background:

In order to successfully remove a shadow, a researcher must first define where the shadow is and where it begins. In regards to this aspect of shadow removal, the researchers of this paper recognize that one of the first approaches was to split a shadow into its interior and gradient edges and nullify them individually. However, this led to unevenness in images. Additionally, this method requires the given image to have uniform shadows. The researchers in this paper recognized the constraint that images had to have uniform shadows and sought to develop a method to remove shadows from all images. In addition, other researchers used the method of using pixel intensities of an image to create an intensity surface to address the issue of curved shadows. Since objects with strange shapes, such as curves would reflect light differently and had shadows with properties difficult to define. This research essentially found shadow scale factors accurately, but assumed that the shadows were uniform.

To the best of your understanding, what is proposed in this paper? The answer to this question should contain as much detail as possible, and should be a few paragraphs long, most likely.

The paper should be analyzed and separated into two portions: the defining and analyzing of problems that computer vision researchers face when attempting to solve the shadow definition and removal problem and the researchers' method to address these issues.

Firstly, the concept of shadows is rooted in physics since shadow is simply the absence of light. While shadows are produced from objects obstructed sources of light, the shadows produced are nonuniform and have varying degrees of brightness. In pictures where there are multiple light sources, it can be difficult to pinpoint where a shadow begins and how it is defined. Additionally, changes in brightness can be small and difficult to detect with digital cameras, which points to the problem of constraint of technology. The shape and orientation of the object obscuring the light source affects shadows in unique ways as well. The boundary of where the shadow starts and where it ends can be especially difficult to determine if there are multiple shadow edges that intersect with reflective edges.

Now that the problems with shadow detection and removal have been addressed, most computer vision researchers follow the convention of separating the problem into shadow detection and image reconstruction. In regards to shadow detection, the researchers used the method of utilizing “pixel intensities to form an intensity surface,” which creates a shadow scale factor for each pixel. Additionally, the entire intensity surface is computed at the same time, which deals with shadows across curved surfaces and preserves the textures on the shadow boundaries. This method results in the successful removal of nonuniform shadows. In addition, the shortcomings of previous approaches to the problem of shadow removal and detection are resolved. This methodology does not constrain input images to specific illumination conditions, is capable of dealing with nonuniform shadows, and is able to handle curved surfaces and analyze the reflectivity of a wide variety of figures that block a light source.

What are the key concepts/terms/ideas that are blocking your more complete understanding of this paper? These should be the things you highlighted as confusions that you feel are most important for you to understand in order to understand this paper.

* Shadow Scale Factor
* Intensity Surface
* Pixel Intensity
* Scale Factor Smoothness
* Smooth surface with minimal curvature = good approximation of shadow-free intensity surface
* SVM
* MRF labeling

Additional comments:

We show that if each image channel is considered as an intensity surface,

approximating the shape of the intensity surface in shadow

regions can aid in obtaining shadow-free images of high

quality, regardless of whether shadows are uniform or

nonuniform, and regardless of intensity surface geometry.

we perform shadow-free

region enhancement, which aims at further improving the

quality of the final shadow-free image, reducing the effects

of noise and image processing transformations which may

introduce artifacts in shadow-free regions.