Reading a Research Paper Pass 2 Notes

**What is your takeaway message from this paper?**

My takeaway message from this paper is that tools, such as mathematics, modeling, and machine learning, are extremely useful, but to a limited extent. For said tools to be useful, researchers must rigorously define parameters and structure and consider edge cases. The example in the paper that I am referring to is how the researchers reduced the complexities of an image to a simple mathematical equation of the sum of albedo, illumination, and shadow scale factor. This reminds me of how for algorithmic programming problems, the bulk of the problem comes from knowing which algorithm to use and how to properly define it to fit certain constraints.

**What is the motivation for this work (both people and technical problem), and its distillation into a research question? *Why doesn't the problem have a trivial solution? What are the previous solutions and why are they inadequate?***

The motivation for this work stems from the incredible range of practical applications of shadow removal and detection. The paper suggests that shadow removal and detection can increase the performance of various computer vision algorithms (recognition algorithms, shadow matting, etc.), find sources of illumination in images, and reconstruct shadow-free images. I infer that such technology would allow for increasing the quality of images (revolutionizing the camera/image processing industry), improving the efficacy of medical imaging, and increasing realism in Virtual Reality technology. This problem doesn’t have a trivial solution because shadows have the innate property of transparency and nonuniformity. Trying a brute solution and removing the shadow entirely from a picture simply creates a gaping hole and trying to lighten the areas of shadow all at once creates varying degrees of brightness. The previous solutions are having a user select shadows on an image and having an algorithm remove them, creating a gradient boundary on the shadow and lightening the shadow in a gradient-like manner, and using mathematics to predict where the light sources are. They are all inadequate because they either don’t provide a hands-off, automatic approach, work for only a select few number of images, or produce images of low-quality that seem slightly off.

**What is the proposed solution? *Why is it believed it will work? How does it represent an improvement? How is the solution achieved?***

The proposed solution is to first detect the shadows by finding their shadow boundaries automatically. For the shadow removal aspect, researchers model shadows as surfaces with varying “light intensity.” Finally, a shadow-free region enhancement method is performed to increase the quality of the generated image. It is believed that it will work because the entire intensity surface is calculated at the same time. This allows the model to approximate the surface for each pixel and handle nonuniform shadows. This is an improvement because previous algorithms were only able to handle uniform shadows from simple images. The previous algorithms also made significant assumptions about the properties of the shadow and reflectivity of the surface, which are unrealistic.

**What is the author's evaluation of the solution? *What logic, argument, evidence, artifacts (e.g., a proof-of-concept system), or experiments are presented in support of the idea?***

The author’s evaluation of the solution is one of confidence. They firmly believe that their algorithm allows for the removal of shadows from a wide-variety of images and the procurement of high-quality images. Their strongest use of evidence lies in how they show before and after pictures and compare them to the before and after of other methods. In the images that they place in their results section, it is clear to the human eye that their method does result in the procurement of high-quality, shadow-free images.

**What is your analysis of the identified problem, idea and evaluation? *Is this a good idea? What flaws do you perceive in the work? What are the most interesting or controversial ideas? For work that has practical implications, ask whether this will work, who would want it, what it will take to give it to them, and when it might become a reality?***

I believe that the method is smart and well-thought out. Shadows can’t be analyzed pixel by pixel because they adhere to a formula that a light source and an obscuring object produce a singular shadow. Additionally, shadows can’t be analyzed as uniform surfaces because of the properties of shadows. Shadows have varying degrees of illumination in different areas. For example, the umbra can be significantly darker than the penumbra region of the shadow. However, a significant flaw I perceive in this work is the limitation of technology. The images with shadows captured to be used in the method have physical resolution limitations. Additionally, the paper did not provide results on edge cases. I wonder if this model would work on very complex images, images with low resolution, or images with very reflective surfaces. The most interesting ideas are how the paper uses a surface to generalize information about the pixels. This work could have practical applications in security, safety inside of vehicles, or even increasing immersiveness of VR technology. However, I believe that this technology may take many years to see significant applications.

**What are the paper's contributions (author's and your opinion)? *Ideas, methods, software, experimental results, experimental techniques...?***

The main contributions of the paper is a methodology that produces high-quality, shadow-free images at a reliable rate, regardless of the conditions of the input.

* Idea: Uniformity does not hold in the penumbra
* Smooth surfaces can be used to generalize image information on pixels
* Regions outside of a shadow and inside should have similar properties
* Requiring users to plot points manually increases accuracy

**What are the future directions for this research (author's and hours, perhaps driven by shortcomings or other critiques)?**

I believe that this technology relies too heavily on the resolution of the given image. The sharp, high-quality resolution of the image and the necessity of researchers manually plotting points creates significant constraints for everyday users of this technology. I believe that there will eventually be research that automatically finds shadow boundaries and removes shadows.

**What questions are you left with? *What questions would you like to raise in an open discussion of the work (review interesting and controversial points above)? What do you find difficult to understand? List as many as you can.***

How is shadow scale factor defined?

What is shadow intensity?

What are higher-order models of shadow detection and how are they different from lower-order models?

How is the Bayesian Framework implemented and why is it useful?

Does this technology work on edge cases?

Why isn’t there technology that allows for the automatic searching of shadow boundaries?