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Shadow Removal from Images Using the Concept of Chromaticity

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Abstract: A shadow basically is a sort of image produced when light is blocked. A shadow generally takes up most of the space behind an opaque item with light right in front of it. Shadows often introduce errors in the performance of computer vision algorithms, such as object detection and tracking. For better performance, there is need to remove it to get shadow free image. This paper proposes a simple method to remove shadow from images. In this work, in order to objective evaluate the performance of shadow removal system, the statistical parameters were compared using information mean and average gradient. Average gradient can express the ability of small details and can be used to evaluate the clarity of the image, the greater its value, the more clear that the image. In addition, to some extent, the mean can be used to evaluate the image contrast.

Keywords: Shadow removal, Chromaticity, Mean, Average gradient, Statistical Parameters.

I. INTRODUCTION

Shadows in images create lots of problems on image analysis. There is no need of shadow in an image i.e. shadow is unwanted part in images. Shadow affects the images because of the shadow lots of data and information is lost from images. The presence of shadows has been responsible for reducing the reliability of many computer vision algorithms, including segmentation, object detection, scene analysis, stereo, tracking, etc. Therefore, shadow removal is an important pre-processing for improving performance of such vision tasks. Decomposition of a single image into a shadow image and a shadow-free image is a difficult problem, due to complex interactions of geometry, albedo and illumination. Many techniques have been proposed over the years, but shadow removal still remains an extremely challenging problem, particularly from a single image. Most research is focused on modeling the differences in color, intensity, and texture of neighboring pixels or regions. To determine if a region is in shadow, we must compare the region to others that have the same material and orientation. For this reason, most research focuses on modeling the differences in color, intensity, and texture of neighbouring pixels or regions.

1.1 Chromaticity:

Suppose an observer is presented with two spots of light. One spot, the test light, is fixed. The second spot, the matching light, contains light that is a variable mixture of several light sources of different colors. The observer's task is to adjust the intensity of each of the component sources in the matching light until the color appearance of the matching light equals that of the test light. Normal human observers are able to match any test light with a matching light made up of only three sources. This tri dimensionality of color matching has a great advantage for both basic and applied color work: If we define three standard primary sources for the matching light and define a standard observer's color matching behavior, then any test light can be described by just three numbers, the intensities of the primaries that produce a color match for the standard observer. The 1931 CIE XYZ system implements this scheme. The CIE standard observer's color matching was defined by averaging color matching data from several real human observers in several research laboratories, using three real light sources for the matching light. To simplify the logic and computation in applications, the committee decided to mathematically transform the data in such a way that the red, green, and blue real light sources used in the laboratory measurements were replaced by three theoretical light sources. In this system, then, any test light is characterized by three numbers X, Y, and Z, which are the amounts of each of the three primaries needed by the standard observer to match the test light. Y, for example, was defined to be mathematically identical to the luminance of the test light.

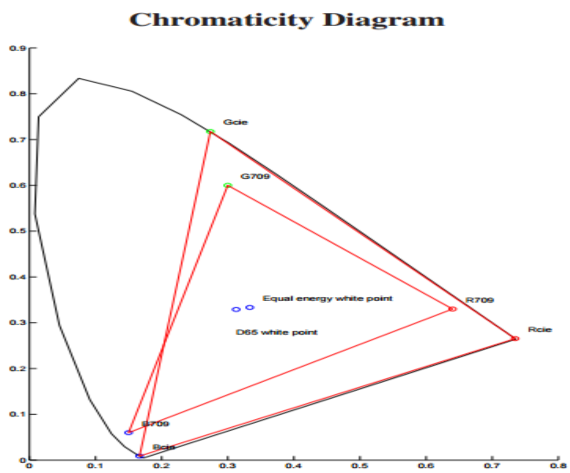

Figure 1.1: Horse shoe shape results from XYZ color matching functions

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For convenience in plotting colors graphically, the chromatic variables are characterized by a two-dimensional derivative statistic (the "chromaticity coordinates") which are derived from X, Y, and Z by normalizing each to their sum:

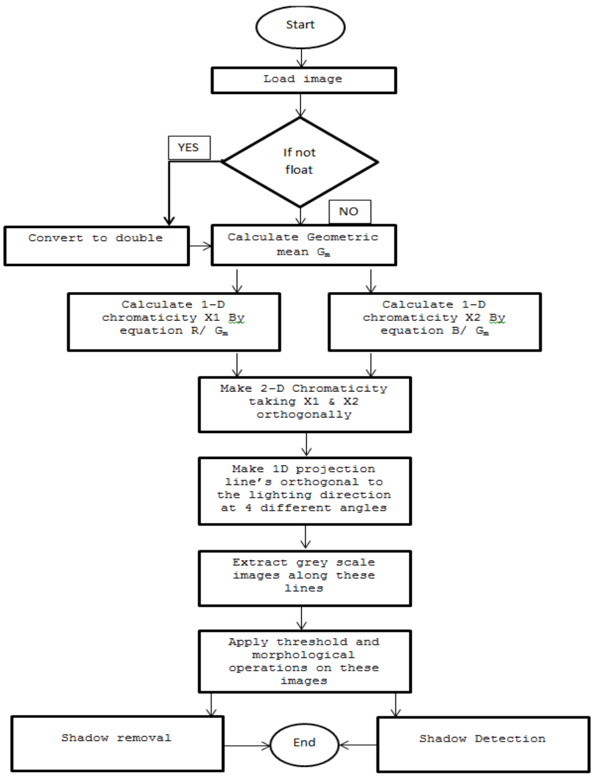
x = X / (X + Y + Z)……………………………1
y = Y / (X + Y + Z)…………… …………………2
z = Z / (X + Y + Z) = 1 - (x + y)………………….3

Any two of these (conventionally x and y are used) plus the luminance, Y, fully capture the standard observer's color match to the test light. Graphs of the x and y coordinates of lights are called chromaticity diagrams. Chromaticity diagrams have two of the three dimensions of color, the third being luminance. One of the most useful properties of chromaticity diagrams is their convenient representation of mixtures of two lights.

Chromaticity Diagrams

- Linear combinations of colors form straight lines.
- Any color in the interior (i.e. convex hull) of the "horse shoe" can be achieved through the linear combination of two pure spectral colors.
- The straight line connecting red and blue is referred to as "line of purples".
- RGB primaries form a triangular color gamut.
- The color white falls in the center of the diagram.

1.2 Flow Chart for the Present Work



II. RELATED WORK

A lot of work has already been done in this field and there is a scope of lot more as well. A brief review is presented as follows:

The method based on color space shadow elimination algorithm considers that the value of the shadow pixels are linearly attenuated comparing with the corresponding background pixels. This linear attenuation property has been employed in different colors spaces like RGB [3], HSV [1], and YUV [2].

In [3], the proposed algorithm users consider that cast shadow reduces surface brightness and saturation while maintaining chromaticity properties in the RGB color space. [1] Explores color differences between shadow and the corresponding background pixels in different color space.

Finlayson et al., where they treat shadow removal as an reintegration problem based on detected shadow edges [4].

Arbel and Hel-Or [5], [6] use cubic splines to recover the scalar factor in penumbra regions, and remove non uniform shadows on curved and textured surfaces. Their region-based shadow detection enables us to pose shadow removal as a matting problem.

Chuang et al. [7] and Wu et al. [8] both methods depend on user input of shadow and non-shadow regions, while we automatically detect and remove shadows in a unified framework.

Specifically, after detecting shadows, we can apply the matting technique of Levin et al. [9], treating shadow pixels as foreground and non-shadow pixels as background.

Using the recovered shadow coefficients, we can calculate the ratio between direct light and environment light and generate the recovered image by relighting each pixel with both direct light and environment light. To evaluate our shadow detection and removal, we will use pictures from previous papers as well as our own.

III.PROPOSED METHODOLOGY

The presented algorithm has been applied on number of images having different backgrounds taken from different cameras. Images are taken from internet with varying lighting conditions. Results have been shown below as the outputs from the matlab.

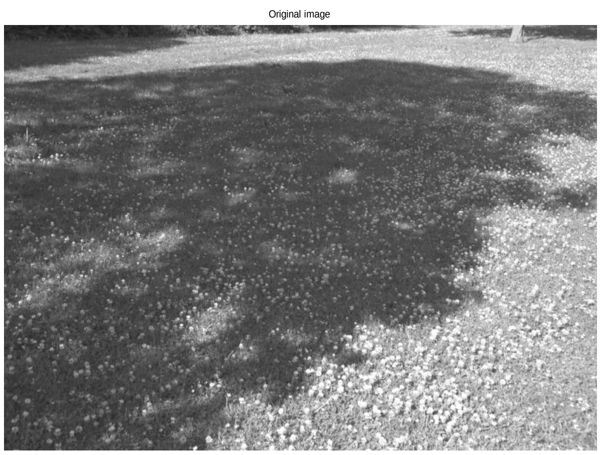


Figure 1: Original image of grass texture background

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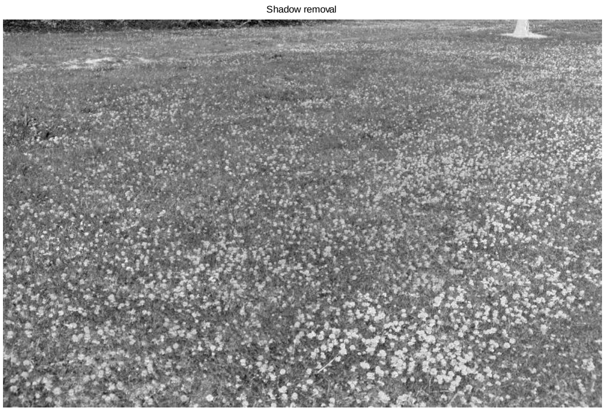

Figure 2: Resulted output after shadow removal.

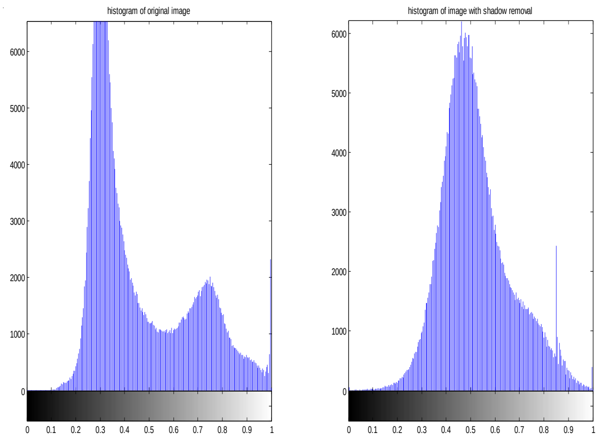

Figure 3: Histograms of original image and image after shadow removal.

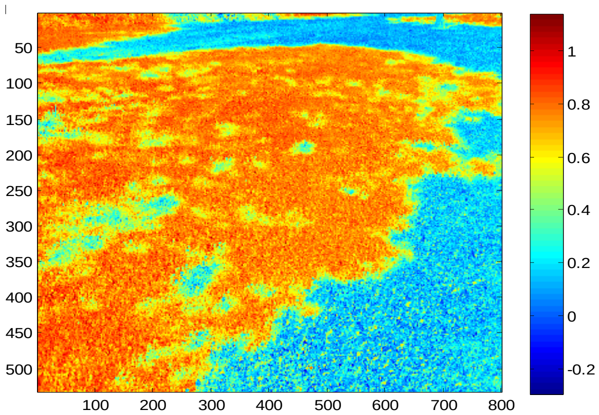

Figure 4: Shadow area marked as high intensity values and non-shadow as low intensity values

In this work, in order to objective evaluate the performance of shadow removal system, the statistical parameters were compared using information mean and average gradient. Average gradient can express the ability of small details and can be used to evaluate the clarity of the image, the greater its value, the more clear that the image. In addition, to some extent, the mean can be used to evaluate the image contrast. Below is the table which shows mean and average gradient of the image.

Image Type	Mean	Average Gradient
With shadow	0.4585	0.0370
Shadow removal	0.5216	0.0611

From the table increased values of mean and average gradient shows the decrease in overall contrast area due to shadow removal in the image

Similarly results for other images are shown below

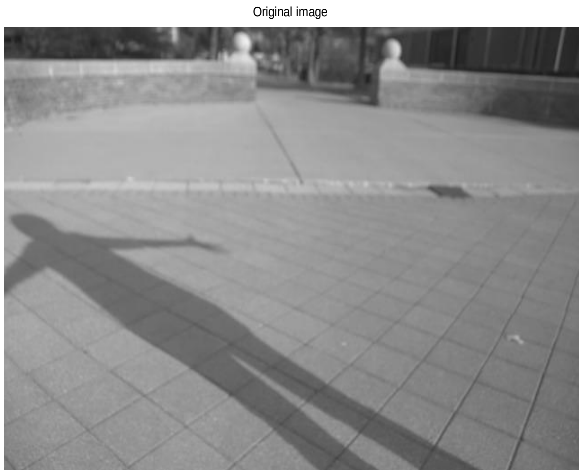

Figure 5: Image with cast shadow on concrete bricks

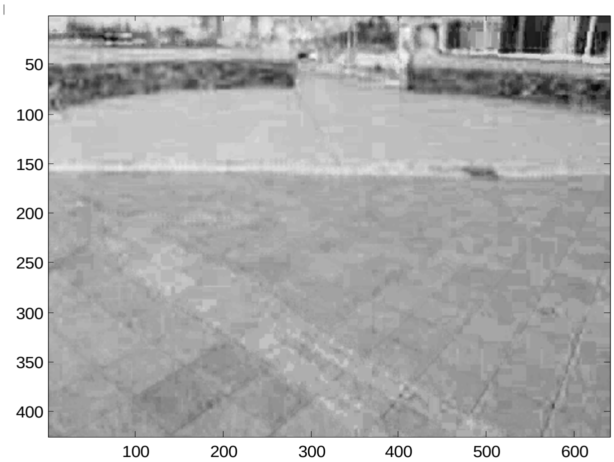

Figure 6: Image with shadow removal

Image Type	Mean	Average Gradient
With shadow	0.5331	0.0069
Shadow removal	0.5490	0.0129

IV. CONCLUSION

The presence of cast shadows in an image can modify the perceived object shape and cause its incorrect segmentation. In this work, we remove the shadows using log chromaticity. The method based on chromaticity can keep the foreground outline well although some foreground pixels will be misclassified as shadows. Shadow removal method is selected by taking one dimensional log chromaticity of red And blue channel with average of RGB colors and then plotted on orthogonal axis which results in shadow free gray scale image.

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