Shadow Detection and its Removal in Images: A Review

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Abstract— *Detecting objects under the influence of shadows is a difficult in computer vision. Shadows acts as barrier in correcting feature extraction of image features like buildings, towers etc. In urban regions, shadows cause artificial color nature and shape deformation of objects, which degrades the quality of images. In apparent path detection application, strong shadows on the road troubles the detection of the boundary between clear path and obstacles, making clear path detection algorithms less robust. Shadows affect many object detection algorithms. This paper is aimed to provide a survey on methodology and various algorithms and methods of shadow detection and removal.*

Keywords—Shadow Detection, Shadow Removal, Computer Vision

1. INTRODUCTION

Producing a high-quality shadow-free image which is indistinguishable from a reproduction of a true shadow-free scene is even more difficult. Physical phenomena such as lighting conditions, type and behaviour of shadowed surfaces, occluding objects, etc affects shadows in images. Additionally, if contrast of shadow regions is enhanced, noticeable artifacts are introduced in the shadow-free images. The shadowing effect is compounded in region where there are dramatic changes in surface elevation mostly in urban areas [1]. The obstruction of light by objects creates shadows in a scene. An object may cast a shadow on itself, i.e. a self-shadow. The shadow areas are less illuminated than the surrounding areas. Though in some cases, the shadows provide useful information, such as the relative position of an object from the source but they cause problems in computer vision applications like segmenting, object tracking and counting objects. Thus shadow detection and removal is a pre-processing task in many computer vision applications. Based on the intensity, the shadows are of two types − hard and soft shadows. The soft shadows retain the background surface texture, whereas the hard shadows are too less bright with little texture. Thus the detection of hard shadows is complicated as they may be mistaken as dark objects rather than shadows [2]. Most of the shadow detection methods need multiple images for camera calibration. But the best technique must be able to extract shadows from a single image.

Also it is difficult to distinguish dark objects and shadows from a single image. The shadows in high-resolution satellite images are usually caused by the constraints of imaging conditions and the existence of high-rise objects, and this is particularly so in urban areas [3]. Shadow detection and removal is an important task in image processing when dealing with the outdoor images. Shadow occurs when light is occluded by objects. Shadows give variety of information about the object shapes as well as light orientations.

The real challenge in moving shadow detection and removal is to classify moving shadow points which are many times misclassified as moving object points in a video sequences causing problems in computer vision [4]. Front-

projection displays are being used to generate seamless, visually immersive worlds for virtual reality and visualization applications with reasonable cost and maintenance overhead. However, these systems suffer from a fundamental problem: Users and other objects in the environment can easily and inadvertently block projectors, creating shadows on the displayed image [5]. Hence reliable detection of shadow is very essential to remove it effectively.

2. RELATED WORK

Shadows and shadings in images lead to undesirable problems in image analysis. Moreover, shadows imply a geometric relationship between objects, light source, and viewpoint. This means that real images including shadows are used for image synthesis only in a limited situation where the lighting condition is consistent with that of the real image. That is why attention has been paid to the area of shadow detection and removal over the past decades, covering many specific applications, such as traffic surveillance face recognition and image segmentation. In Shadow Detection Using Color and Edge Information [6], a shadow detection method using both color and edge information is presented. The shadow pixels based on each of these calculated features i.e Hue-Saturation-Intensity (HSI), extended gradual C1C2C3, YCbCr (Luminance, Chroma Blue, Chroma Red) color space are detected separately before combining the results. To detect missing pixels edge information is used. In order to improve the accuracy of shadow detection using color information, a new formula is used in the denominator of original c1c2c3. The Equations can be represented as follow :

C1=1/tan[R/MAX(B,G)] **(1)**

C2=1/tan[R/MAX(B,R)] **(2)**

C3=1/tan[R/MAX(R,G)] **(3)**

In Review on Shadow Detection and Removal Techniques/Algorithms [7], survey is done on various algorithms and methods of shadow detection and removal with their advantages and disadvantages. This survey uses the detailed approach of shadow detection and removal in indoor outdoor scene, traffic surveillance images etc.

Sometimes we cannot recognize the original image of a particular object. Shadow in image reduces the reliability and often degrades the visual quality of images. Algorithm for Shadow Detection in Real Colour Images [8], shows that it is possible to detect shadow from image without losing a large amount of pertinent data by using RBG ellipsoidal region technique with Feature extraction from three different domains i.e spectral, spatial & temporal. As shadow pattern rely on size of objects and the angles of lighting source, normally problems in scene understanding, object segmentation, tracking and recognition occurs causing image mismatches. Shadow Detection and Removal in Colour Images Using Matlab [9], shows that pepper and salt noise is removed by applying contra harmonic filter. To remove shadow properly, average frame is computed to determine effect of shadow in each of the three dimensions of colour i.e in RBG color model,

(Red+ Blue + Green)light = Broad array of colors which represents dark pixels of shadowed regions) **(4)**

Shadows detection = (Average R, B, G values) / (Respective original values). **(5)**

So the colours in shadow regions have larger value than the average, while colours in non-shadow regions have smaller value than the average values. Shadow Detection and Removal from a Single Image Using Lab Color Space [10], a simple method to detect and remove shadows from a single RGB image is proposed. A shadow detection method is selected which is based on the mean value of the RGB image in A and B planes of LAB equivalent of the image i.e (mean (A) + mean (B) ≤ 256). The shadow removal is done by multiplying the shadow region with a constant and filtering is done to reduce the errors in the shadow boundary.

Shadow Detection: A Survey and Comparative Evaluation of Recent Methods [11], survey and a comparative evaluation of recent techniques for moving cast shadow detection is presented. The survey covers methods published during the last decade, and places them in a feature-based taxonomy comprised of four categories: chromacity, physical, geometry and textures. The assessment indicates that all shadow detection approaches make different contributions and all have individual strength and weaknesses.

However, one of the most challenging problem is extracting moving objects from video sequences. Cast shadows induced by moving objects often cause serious problems to many vision applications. Moving Cast Shadow Detection using Physics-based Features [12], One pixel based Gaussian Mixture Model for each pixel to learn the local shadow features is used. The proposed method can rapidly learn model parameters in an unsupervised way and adapt to illumination conditions or changes in the environment.

A Procedure for the Detection and Removal of Cloud Shadow from AVHRR Data over Land [13], proposed a new multispectral algorithm for cloud shadow detection and removal in daytime AVHRR scenes over land. The cloud height using solar zenith angle (Z) is calculated as:

H= (Ls/tan Z*) **(6)**

It uses a combination of geometric and optical constraints, derived from the pixel-by-pixel cross-track geometry of the scene and image analysis methods to detect cloud shadow.

As shadows are seasonal and time-dependent, even though there is no change in the land-cover, a change in the shadow casting-condition gives a false change to the image. Due to these reasons, it is very useful if the radiance of shadowed areas is corrected to the same radiance level of shadow-free areas. In Characteristics of shadow and removal of its effects for Remote sensing imagery [14], QuickBird image is introduced and the spectral characteristics of sunlight and shadowed areas are investigated. Based on these observations, a method to detect shadowed areas and restore the shadow-free radiance for the multispectral bands is proposed.

3. PROPOSED WORK

Shadow cause problems in segmentation, object counting etc. To resolve such problems, we are presenting an algorithm to detect strong shadow edges, which will enable us to remove shadows. Shadow removal will rely on the classification of image edges as shadow edges or non-shadow edges. The proposed method will be used for strong shadow edges. Therefore, the elimination of shadow edges will remove the changes caused by illumination, thus reduce the shadow effects.

The Edge candidates will be generated. By analyzing the patch-based characteristics of shadow edges and non-shadow edges (e.g., object edges), the proposed detector can discriminate strong shadow edges from other edges in images by learning the distinguishing characteristics. In addition, the proposed method will partially process the soft shadows.

4. CONCLUSIONS

In this paper, first the basics of shadows that how shadows are created, types of shadows, effects of shadows and its detection are discussed. Comprehensive survey of related work done earlier along with methodology and various algorithms is given. At last, work to be done is mentioned.

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