Shadow Detection and Removal Techniques: A Perspective View

Avinash Kumar Singh[1], Ankit Pandit[2]

[1]PG Scholar, [2]Assistant Professor

[1,2]Department of EC, RTU, Bhopal, Madhya Pradesh, India

How to cite this paper: Avinash Kumar Singh | Ankit Pandit "Shadow Detection and Removal Techniques: A Perspective View" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-4, June 2019, pp.1596-1599, URL: https://www.ijtsrd.com/papers/ijtsrd25201.pdf

IJTSRD25201

ABSTRACT

Shadow detection and removal from single images of natural scenes is the main problem. Hence, Shadow detection and removal remained a challenging task. Significant research carried out on different shadow detection techniques. Over the last decades several approaches were introduced to deal with shadow detection and removal. Shadows are visual phenomena which happen when an area in the scene is occluded from the primary light source (e.g. sun). Shadows are everywhere around us and we are rarely Confused by their presence. This article provides an overview of various methods used for shadow detection and removal using some main components like texture analysis, color information, Gaussian mixture model (GMM) and deterministic non model based approach. Texture; Color; This paper is aimed to provide a survey on various algorithms and methods of shadow detection and removal with their comparative study.

Keywords: *Shadow, Shadow Detection, Shadow Removal, Enhancement*

I. INTRODUCTION

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 detection and 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, and illumination.

Many techniques have been proposed over the years, but shadow detection 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. Shadow is a dark area or shape produced by a body coming between rays of light and a surface. If the light energy is fallen less, that area is represented as shadow region whereas if the light energy is emitted more, this area is represented as non shadow region. Shadows can be divided into two types: cast and self shadow which is shown in Figure 1.

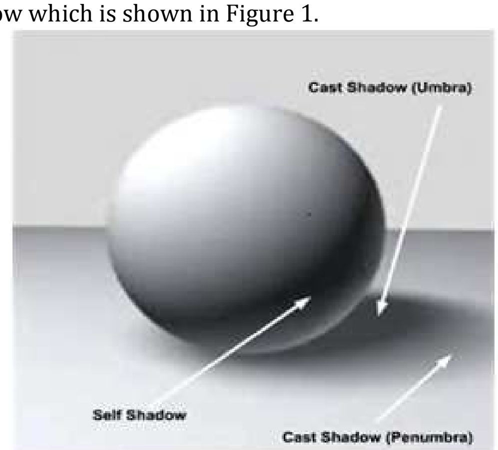

Figure 1: Different types of shadow

In order to understand the shadows, one needs to understand what an image is and how it has been formed. An overview of image formation has been explained in the figure below. Mechanism of image formation depends upon these two factors:

1. Light from a radiation source is reflected by surfaces in the world. Reflected light from the world hits the sensor.
2. Images are formed when a SENSOR registers RADIATION that has interacted with PHYSICAL OBJECTS.

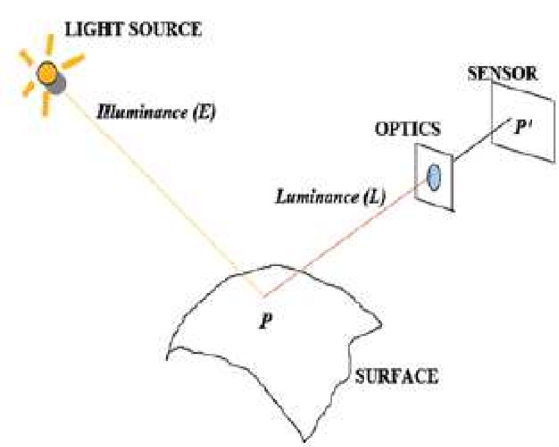

Figure 2: Mechanism of image formation.

These parameters determine the intensity/color of a given image pixel
1. Illumination (type, number, intensity, color-spectrum)
2. Surface reflectance properties (material, orientation)
3. Sensor properties (sensitivity to different electromagnetic frequencies)

These parameters determine where on the image a scene point appears
- Camera position and orientation in space
- Camera optics (e.g. focal length)
- Projection geometry

Luminance (L) amount of light striking the sensor depends on Illuminance (E) amount of light striking the surface as well as Reflectance (R) which depends on material properties $L(x,y,\lambda) = E(x,y,\lambda)$ Intensity at a particular location and wavelength * $R(x,y,\lambda)$ To determine properties of objects in the world (e.g. their colors), we need to recover R, but we don't know E so this is difficult. Measuring surface properties is a big factor in deciding color on an image.

II. LITERATURE SURVEY

Tomas F. et. al, The objective of this work is to detect shadows in images. We pose this as the problem of labeling image regions, where each region corresponds to a group of super pixels. To predict the label of each region, we train a kernel Least-Squares Support Vector Machine (LSSVM) for separating shadow and non-shadow regions. The parameters of the kernel and the classifier are jointly learned to minimize the leave-one-out cross validation error. Optimizing the leave-one-out cross validation error is typically difficult, but it can be done efficiently in our framework. Experiments on two challenging shadow datasets, UCF and UIUC, show that our region classifier outperforms more complex methods.

Vu Nguyen et. al, We introduce scGAN, a novel extension of conditional Generative Adversarial Networks (GAN) tailored for the challenging problem of shadow detection in images. Previous methods for shadow detection focus on learning the local appearance of shadow regions, while using limited local context reasoning in the form of pairwise potentials in a Conditional Random Field. In contrast, the proposed adversarial approach is able to model higher level relationships and global scene characteristics.

Yasser Mostafa et. al, High-resolution satellite images contain a huge amount of information. Shadows in such images generate real problems in classifying and extracting the required information. Although signals recorded in shadow area are weak, it is still possible to recover them. Significant work is already done in shadow detection direction but, classifying shadow pixels from vegetation pixels correctly is still an issue as dark vegetation areas are still misclassified as shadow in some cases. In this letter, a new image index is developed for shadow detection employing multiple bands.

Jiayuan Li et. al, Shadows, which are cast by clouds, trees, and buildings, degrade the accuracy of many tasks in remote sensing, such as image classification, change detection, object recognition, etc. In this paper, we address the problem of shadow detection for complex scenes. Unlike traditional methods which only use pixel information, our method joins model and observation cues. Firstly, we improve the bright channel prior (BCP) to model and extract the occlusion map in an image. Then, we combine the model-based result with observation cues (i.e., pixel values, luminance, and chromaticity properties) to refine the shadow mask. Our method is suitable for both natural images and satellite images.

Nan Su et. al, The existence of shadows in very high-resolution panchromatic satellite images can occlude some objects to cause the reduction or loss of their information, particularly in urban scenes. To recover the occluded information of objects, shadow removal is a significant processing procedure for the image interpretation and application.

This paper gives survey on various Shadow detection and Removal methods / Algorithms with their advantages and disadvantages. The comparative analyses of various Shadow detection and Removal methods / Algorithms are shown in table 1.

Table 1: Comparative analysis of various Shadow detection and Removal Techniques

Sr. No.	Method	Key Idea	Advantages	Disadvantages
1	Intensity based	Standard deviation is calculated for ratio value. Conditions are set for a shadowed pixel.	Function for pixel intensity is estimated directly from the data without any other assumptions	Actually the pixel intensity alue is susceptible to Illumination changes.
2	Threshold based	Predefined threshold level based on bimodal histogram used to determine shadow and non-shadow pixels.	Simple and fast.	Requires post- processing as results might be incoherent or blurred and may have holes, noise etc.
3	Classification based	Classification techniques like SVM are used based on the properties possessed by shadow pixels.	Can detect probable shadow boundaries accurately. Simple and easy to implement.	There are chances of misclassification. Shadows of small objects are missed sometimes.

4	Color Based	Color tune value of shadow and background same but different Intensity. Color differences of shadowed pixel and background pixels as well as illumination Invariance are used.	Reliable technique for Colored images.	It takes more time for computation. Fails when intensity of shadow and background is same.
5	Texture based	Takes in account the similarity between background and shadow texture as well as the difference in foreground and background textures.	Accurate results under stable illumination conditions.	Poor performance for outdoor scenes as texture capturing is difficult. Difficult to implement.
6	Geometric Properties based	Sets of geometric features are matched.	Effective detection under simulated and controlled environment.	Method will be ineffective when geometric representation of object will change.
7	Chromaticity based	Hue and saturation combined together are known as chromaticity.	Highly accurate. Can select proper features for shadow.	Tends to misclassify.
8	Region Growing based	Standard deviation and Mean are calculated.	Shape matching results are good.	Region growing failed when the pixel intensity varied widely in the shadow region.
9	Dual-Pass Otsu Method	Pixels value is separated into high and low level intensity. Threshold is set to distinguish between self and cast shadow.	It is Less Expensive method.	Poorest Performance
10	Edge subtraction and Morphology	Canny edge detection is used to detect background and foreground edge.	It gives best results when scenes containing light and dark vehicles.	Computationally expensive method.
11	Susan Algorithm	Video highway data with avi format, Edge is detected from Susan method.	Speed is enhanced. Method is simple, Convenient.	Less Efficient than Harris Algorithm.

From Table 1, on Shadow detection and removal in various scenarios, it is clear that different methods and different algorithm gives different results for different scenario. A relative study on the shadow detection methods [1], based on Intensity information, based on photometric invariants information, method gray-scale pixel intensity value in the presence of illumination changes fails to detect shadow region accurately. Actually the pixel intensity value is susceptible to illumination changes. Partial differential equations used to detect shadow in urban color aerial images [7]. In the detection process shadow and non shadow regions are separate by SVM classifier [5].

This classification procedure is used to implement in a supervised way by means of a support vector machine (SVM), which showed the effectiveness in data classification. The classification task is performed to extract the features of the original image with the help of wavelet transform. Initial level wavelet transform is applied on each spectral band which consists of frequency features. Morphological filters are introduced to deal with the problems occurred and to improve the quality by their effectiveness and to increase the capability in the shape preservation is performed by the possibility to adapt them according to the image filtering techniques (extracting the borders and shape of the surface) [6]. To detect shadow pixels using the color information, first the Hue- Saturation-Intensity (HSI) color space, extended gradual C1C2C3 color space, YCbCr (Luminance, Chroma Blue, Chroma Red) color space and LAB color space. These color features are selected due to their remarkable difference between the shadows, background and object pixels. The shadow pixels based on each of these calculated features are detected separately. Then the results are combined using a Boolean operator (logical AND) to construct the shadow image based on the color information [8]. Color spaces represent colors with different vector values.

One of the most common examples is the RGB space where a pixel has three values which represent the amount of red, green and blue. These three values span a color space that can represent most of the colors that can be detected with the human eye [8]. Shadow removal from traffic images [15], give three methods first method attempts to remove shadow s by using Otsu method Pixels value is separated into high and low level intensity, threshold is set to distinguish between self and cast shadow, cast shadow pixels are than replaced by background pixels. But this method shows unsatisfactory performance than other methods proposed like region growing and edge subtractions and morphology. Region growing fails when the pixel intensity varied widely in the shadow region. Shadow in image with a moving object is another challenging task to remove that shadow, intelligent transportation system may face this problem of moving shadow, Susan algorithm [20], detecting the image edge, for removal of shadow from image detection of edges is too an important task once edges of object are efficiently detected shadow will removed easily, to detect edges of an image more accurately.

III. CONCLUSION

It is observed that Shadows are everywhere around us and we are rarely confused by their presence. Tracking or detection of moving objects is at the core of many applications dealing with image sequences. One of the main challenges in these applications is identifying shadows which objects cast and which move along with them in the scene. Shadows cause serious problems while segmenting and extracting moving objects, due to the misclassification of shadow points as foreground. In this paper, we have provided a comprehensive survey of shadow detection and removal in indoor and outdoor scene, traffic surveillance images etc. survey is done on various types of images real time application or traffic images. A survey on various shadow detection and removal method and algorithm.

REFERENCES

[1] Tomas F. Yago Vicente, Minh Hoai and Dimitris Samaras, "Leave-One-Out Kernel Optimization for Shadow Detection and Removal", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 40, No. 3, March 2018.

[2] Vu Nguyen, Tomas F. Yago Vicente, Maozheng Zhao, Minh Hoai and Dimitris Samaras, "Shadow Detection with Conditional Generative Adversarial Networks", IEEE International Conference on Computer Vision, 2017.

[3] Yasser Mostafa and Ahmed Abdelhafiz, "Accurate Shadow Detection from High-Resolution Satellite Images", IEEE Geo Science and Remote Sensing Letters, Vol. 14, No. 4, April 2017.

[4] Jiayuan Li, Qingwu Hu and Mingyao Ai, "Joint Model and Observation Cues for Single-Image Shadow Detection", MDPI Journal of Remote Sensing, 2016.

[5] Nan Su, Ye Zhang, Shu Tian, Yiming Yan and Xinyuan Miao, "Shadow Detection and Removal for Occluded Object Information Recovery in Urban High-Resolution Panchromatic Satellite Images", IEEE Journal of Selected Topics in Applied Earth Observations And Remote Sensing, Vol. 9, No. 6, June 2016.

[6] Huihui Song, Bo Huang, Associate Member, IEEE, and Kaihua Zhang, "Shadow Detection and Reconstruction in High-Resolution Satellite Images via Morphological Filtering and Example-Based Learning", IEEE Transactions on Geoscience and Remote Sensing, 2014.

[7] Chunxia Xiao, Ruiyun She, Donglin Xiao and Kwan-Liu Ma, "Fast Shadow Removal Using Adaptive Multi-scale Illumination Transfer", COMPUTER GRAPHICS forum, 2013.

[8] Tomás F. Yago Vicente, Chen-Ping Yu, Dimitris Samaras, "Single Image Shadow Detection using Multiple Cues in a Supermodular MRF", IEEE Access Journal, 2013.

[9] Guangyao DUAN, Huili GONG, Wenji ZHAO, Xinming TANG, Beibei CHEN, "An Index-Based Shadow Extraction Approach On High-Resolution Images", Springer Journal of Image Processing, 2013.

[10] Jiu-Lun Fan, Bo Lei, "A modified valley-emphasis method for automatic thresholding", Elsivier Journal of Pattern Recognition, 2012.