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# Review on Shadow Detection and Removal Techniques/Algorithms

[1]Rajni Thakur, [2]Shveta Chadda, [3]Navjeet Kaur
[1,2,3]Dept. of CSE, Lovely Professional University, Phagwara, Punjab, india

**Abstract**
Shadow detection and removal in various real life scenarios including surveillance system, indoor out door scenes, and computer vision system remained a challenging task. Shadow in traffic surveillance system may misclassify the actual object, reducing the system performance. There are many algorithms and methods that help to detect a shadow in image and remove such shadow from that image. This paper is aimed to provide a survey on various algorithms and methods of shadow detection and removal with their advantages and disadvantages. This paper will serve as a quick reference for the researchers working in same field.

**Keywords**
Shadow Detection, Shadow Removal, Surveillance System

## I. Introduction

Image processing has been one area of research that attracts the interest of wide variety of researchers. Image processing; basically deals with processing of images, pictures, video etc. Image processing is any form of signal processing for which the input is an image, such as a photograph or video frame the output of image processing may be either an image or, a set of characteristics or parameters related to the image. Image processing deals with various aspects like image zooming, image segmentation, image enhancement etc.

Image processing helps advances in various real life fields such as, optical imaging (cameras, microscopes) and, medical (CT, MRI, Ultrasound, diffuse, optical, advanced, microscopes), Astronomical imaging (telescopes), video and imaging compression and transmission (JPEG, MPEG, HDTV, etc.), computer vision (robots, license plate reader, tracking, human, motion), commercial software's (Photoshop) and many more. Nowadays, surveillance systems are in huge demand, mainly for their applications in public areas, such as airports, stations, subways, entrance to buildings and mass events. In this context, reliable detection of moving objects is the most critical requirement for any surveillance systems. In the moving object detection process, one of the main challenges is to differentiate moving objects from their shadows. Moving cast shadows are usually misclassified as part of the moving object making the following analysis stages, such as object classification or tracking, to perform inaccurate. In traffic surveillance, system must be able to track the flow of traffic. Shadows may lead the misclassification of traffic, due to that exact traffic flow is difficult to determine. It will become major drawback of a surveillance system.

Shadow detection and removal is an important task in image processing when dealing with the outdoor images. Shadow occurs when objects occlude light from light source. Shadows provide rich information about the object shapes as well as light orientations. Some time we cannot recognize the original image of a particular object .Shadow in image reduces the reliability of many computer vision algorithms. Shadow often degrades the visual quality of images. Shadow removal in an image is an important pre-processing step for computer vision algorithm and image enhancement.

Fig. 1: An Object Showing Cast and Self-Shadows

Fig. 2, shows an object with two types of shadow self-shadow and cast shadow. Self-shadow is objects its self and another is cast-shadow. Distinction between these types of shadows is important for object recognition successful shadow removal aims to remove cast shadows while recognizing self-shadows as part of the object of interest and therefore preserving them. Both cast and self-shadow has different brightness value.

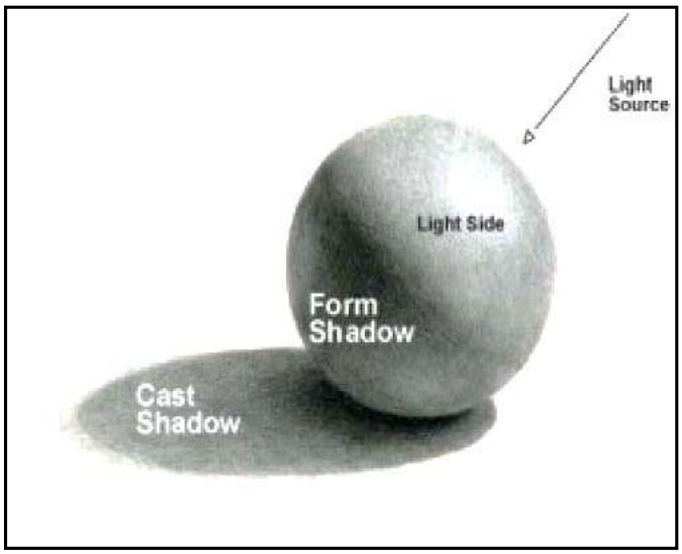


Fig. 2: Shadows can be Broadly Divided into Cast and Self-Shadow

The brightness of all the shadows in an image depends on the reflectivity of the object upon which they are cast as well as the illumination from secondary light sources. Self-shadow usually have a higher brightness than cast shadows since they receive more secondary lighting from surrounding illuminated objects.

## II. Shadow Detection and Removal Techniques/Algorithms

Table 1: Various Techniques/Methods/Algorithm

| Sr. No. | Technique | Key Idea | Advantages | Disadvantages |
|---|---|---|---|---|
| 1 | Region Growing | Seed pixels have been selected and set as shadow group. Mean and standard deviation are calculated. | Orientation based technique. | Region growing, failed when the pixel intensity varied widely in the shadow region. |
| 2 | Dual-Pass 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. | It is computational inexpensiveness. | Performance is poorest. |
| 3 | Edge Subtraction and Morphology | Canny edge detection is used to detect background edge and foreground edge. Resultant edge image is calculated by difference of both background and foreground edge. Centroid of vehicle-shadow region is found by formula. | Method is best when scenes containing light and dark vehicles. | It is most computationally expensive. |
| 4 | Gradient-based background subtraction | Fixed threshold is set for T vertical and T horizontal, boundary of object is extracted using neighbored ratio. Foreground is extracted by using mixture of Gaussians. | Location is used to detect the shadow. Shadow detection is done correctly. Real time applications take advantage of this algorithm. | |

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| 5 | Illumination Assessment Method | Presence of shadow in object is confirmed by illumination assessment method, cast shadow is separated from the object by subtracting background edges from foreground edges. Stationary Cameras are taken. | It takes Less Processing time. Only foreground figure is considered. This technique examines presence of shadow. | It ignores some application not applied for all kind of application. |
| 6 | The principal Components analysis (PCA) and luminance based multi-scale Retinex (LMSR) algorithm | | Visibility of features is Improved. | There may be chance of Improvement in Shadow Regions. |
| 7 | Adaboost Classifiers in a Co-training Framework | White area indicate foreground and gray pixel signifies shadow, 320*240 pixel image is taken, black region means background, accuracy comparison is calculated by finding shadow detection rate and shadow discrimination accuracy. | Algorithm is feasible and effective for indoor and outdoor scene. | There is lack of good partition about the features. |
| 8 | Hierarchical Graph cut | Image is over segmented to produces the set of super pixels, lazy snapping is used to Specify shadow, non-shadow, and background region. | This method solves problems 3 to 16 times faster than alpha expansion method. It solves multi-labeling problems. Image restoration shadow removal and stereo matching is done by hierarchical graph cut algorithm. | An initial value is required. Only single image is considered to remove the shadow. |

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| 9 | Method to Check the Reliability of the color Property | Four property of color based approach, color feature, texture feature, luminance feature, contour generation is calculated. | This algorithm is proved to be effective and robust both for indoor and outdoor scenes, and both for humans and vehicles. Works on Moving cast shadow. Geometric center detection step improves the efficiency of the algorithm. | Color feature is unreliable. |
| 10 | Susan algorithm | Video highway data is taken with avi format, edge is detected from Susan method and mixed gauss. Background is obtained by distribution. | Speed is enhanced. Method is simple and convenient, low complexity, high adaptability and high accuracy. It gives good detection effect. | |
| 11 | Harris Algorithm | Neighboring point eliminating method used to detect corner efficiently. | More efficient then Susan algorithm. It avoids clustering. | |
| 12 | Based on Intensity Information | Standard deviation is calculated for ratio value. Conditions are set for a shadowed pixel. | | Actually the pixel intensity value is susceptible to Illumination changes. |
| 13 | Based on Photometric Invariants Information | Intensities in the neighbor pixels in the foreground region is equal to the ratio of neighbor pixels in the background image in the presence of shadow. | Performance is better by using robust features. It takes little time. The average time consumption is good for real-time application. | |

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|---|---|---|---|---|
| 14 | Color and Statistical Information | K distribution is sorted with the value of weight. Color intensities are computed. Intensity of the pixel in the current Foreground image is compared with the background image. | | It takes more time for computation. |
| 15 | Color/Spectrum-based shadow Detection | | Color feature is extracted. | Not reliable because only color information is used. |
| 16 | Texture-based Shadow Detection | | | Due to faint Textural information of the scenes traditional methods doesn't work effectively. |
| 17 | Geometry-Based Shadow Detection | | This method revolves around the Geometric model in objects in the scenes change in model leads to ineffective results. | Method will be ineffective when geometric representation of object will change. |
| 18 | Partial Differential Equations | Different filters are used to smooth the image. Gradient vector is used to detect shadow. Image information is used. | Shadow detection is successful and effective. | |

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. Shadow removal from traffic images [1], 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. Edge subtractions and morphology method is best when scenes contain light and dark vehicles. Gradient-based background subtraction [2], method in shadow detection for moving humans cast shadow is removed without affecting self -shadow, this scheme does not use any color information some rules are followed to detect the shadow in image, shadow does not change the texture of the background and cast shadow lies outside the boundary of an object. Result of this method shows 90% correctly distinction between shadow and object. Illumination assessment method [3] is used to confirm presence of shadow in an image. This is the first step of shadow detection in an image, traffic images are taken with stationary cameras this method is applicable for real time applications.

The principal components analysis (PCA) and luminance based multi-scale Retinex (LMSR) algorithm [4] this algorithm helps to improve the visibility of features. One of the method of shadow detection is Adaboost classifiers in a co-training framework [5] labeled data sets are taken with weak classifiers and converted into strong classifiers. White area indicate foreground and gray pixel signifies shadow, 320*240 pixel image is taken, black region means background, accuracy comparison is calculated by finding shadow detection rate and shadow discrimination accuracy. Algorithm is feasible and effective for indoor and outdoor scene. Shadow removal from a single image using hierarchical graph cut [6], this method works on single image, hierarchical graph cut solves multi-label MRF problems. Moving cast shadow detection and removal with reliability checking of the color property [7]. This algorithm is proved effective and robust both for indoor and outdoor scene and both for humans and vehicles. 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 [8], 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. Harris algorithm [9], gives best result than Susan algorithm of corner detection. A comparative study on the shadow detection methods [10], based on Intensity information, based on photometric invariants information, and color and statistical 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. Method [11], performance is found to be better as compare to other two shadow detection methods because of the robust features it used. Partial differential equations used to detect shadow in urban color aerial images [12]. Different filters are used to smooth the image, gradient vector is used to detect shadow, image information is used, and Shadow detection is successful and effectively done by this method for urban Aerial images.

## III. Conclusion

In this paper, we have provided a comprehensive survey of shadow detection and removal in indoor 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 with their advantages and disadvantages. At last, a discussion about reasonable performance evaluation is given.

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Rajni Thakur received her graduate degree in science in 2008 and Masters in computer science in 2010 from Guru Nanak Dev University, Amritsar, India. She is pursuing M.Tech CSE from Lovely Professional University, India. Her research interests include image processing, networking and Neural Networks. She has attended several conferences at national and international level.

Shveta Chadda received her graduate degree in science in 2008 and Masters in information technology in 2010 from Guru Nanak Dev University, Amritsar, India. She is pursuing M.Tech CSE from Lovely Professional University, India. Her research interests include image processing, fuzzy logic and networking. She has attended several conferences at national and international level.

Navjeet Kaur received her graduate degree in science in 2008 and Masters in IT in 2010 from Guru Nanak Dev University, Amritsar, India. She is pursuing M.Tech CSE from Lovely Professional University, India. Her research interests include image processing, fuzzy logic and software engineering. She has attended several conferences at national and international level.