International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169
Volume: 3 Issue: 5 3315 - 3319

An approach for Shadow Detection and Removal based on Multiple Light Sources

Rohini Mahajan
Student, M.Tech, Dept. of Computer Science&Engg.
Nagpur Institute of Technology
Nagpur, India
rohini09joshi@gmail.com

Abhijeet Bajpayee
Assistant Professor, Dept.of Computer Science&Engg.
Nagpur Institute of Technology
Nagpur, India
abhijeet_bajpayee@live.com

Abstract- Shadows in images are essential but sometimes unwanted as they can decline the result of computer vision algorithms. A shadow is obtained by the interaction of light with objects in an image surface. Shadows may letdown the image analysis processes and also cause a poor quality of information which in turn leads to problems in execution of algorithms. In this paper, a method has been proposed to detect and remove the shadows where multiple sources of light is been estimated, as we can take an example of playground stadium where multiple floodlights are fixed, multiple shadows can be observed originating from each of the targets. To successfully track individual target, it is essential to achieve an accurate image of the foreground. Also, an effort has been done to list some of the very crucial techniques related to shadow detection and removal. Many times, the shadow of the background information is merged with the foreground object and makes the process more complex.

Index Terms— *Shadow detection, shadow removal, edge detection, invariant image.*

*****

I. INTRODUCTION

Shadows are everywhere. Yet, the human visual system is so skilled to filter them out; that we never give shadows a second thought; that is until we need to deal with them in algorithms. Since the very beginning of computer vision, the presence of shadows is blamed for wreak failure on a variety of applications such as segmentation, detection of object, analysis of scene, stereo etc. On the other hand, a shadow plays a crucial role for finding the type of illumination in the scene and the shapes of objects that cast them. A shadow is known by the interaction of light with objects claims a portion of the image surface. Shadows in images hold importance for a multiple reason. If we can identify shadows, the object can be better localized; the shape of object can be detected and can also determine where objects make contact with the ground. On one hand, shadows can lead to the failure of image quality and also cause decline in the quality of information which in turn leads to problems in implementation of algorithms, say like object recognition. But, on the other hand, they are useful for cues as building detection, path finding, change detection caused due to natural disasters like tsunamis. Since, shadows sometimes create unwanted effects on images, thus shadow detection is the first step. It is also useful for recognition of face and segmentation of image. Thus, shadow detection and removal has become very important in image processing.

A. Shadow

A shadow is shaped when direct light from any source of lighting is blocked either partially or totally by an object. Such path of light leads to the creation of shadows as light always travels in straight lines and cannot bend or curve shadow is usually created behind opaque objects when light falls on them. Hence, when light is blocked, an image is created known as shadow.

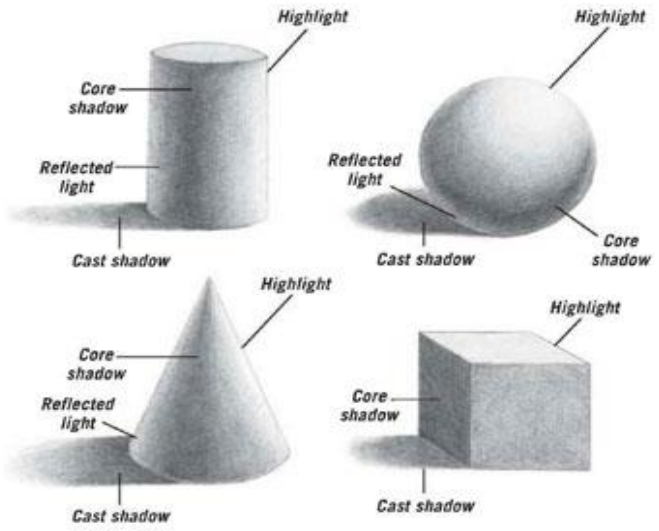


Fig. 1. Types of Shadow

Shadows can be classified as- Core shadow and Cast shadow. Core shadow is one which falls on a part or portion of object whereas Cast shadow does not fall on object but are projected on neighboring surface. Cast shadows are classified as umbra and penumbra. These regions are created due to numerous lighting. The difference is that they lie in the contrast to the background. Self shadows usually do not have hard boundaries and hence are referred to as blurred; the reason is the regular intensity change. Cast shadows whereas have obviously defined boundaries.

B. Shadow Identification

Shadows can be identified using the features extracted from three domains: spectral, spatial and temporal. The temporal features are not very reliable because they depend mostly on the object speed and the frame rate of the camera. Particularly, the following uniqueness is used to detect shadow. They are a shadow darkens the surroundings area on which it falls, a

shadow only falls on the view plane and a shadow changes luminance of an area but does not crash color .The method called "color invariance" has been broadly used in recent years. Color invariance features are not responsive to estimate change. Color invariance features mainly consist of YUV, RGB, hue (H) and saturation (S). Shadows usually change the intensity of the surface that they cover with but rarely change the color invariance features. Therefore, using the shadow invariant image, hard shadow edge mask can be detected by comparing the original image and the invariant image. But, these methods cannot totally remove the illumination effect and thus, are mostly useful in simple scenes.

II. LITERATURE SURVEY

In recent years, several methods have been proposed to remove shadows from images. All of them require shadows to be detected first. Various algorithms are used to detect and remove the shadow. Out of which there are several pros and cons of each algorithm, some of them are listed below.

A. Deriving intrinsic images from images sequences

The first group of method is based on image sequences; in a sequence of outdoor images, images taken from the same viewpoint, the major differences between images are due to illumination variations. This idea, explained by Y.Weiss [8], Y. Matsushita, K. Nishino, K. Ikeuchi, and M. Sakaushi [9], which enables to obtain invariant -independent of the illuminant- images and remove shadows from surveillance camera images.

B. Removing Shadows from images

Another method, which works on only single image, was proposed G. Finlayson, S. Hordley, and M. Drew [1] and G. Finlayson, M. Drew, and C. Lu. [2]. In this work, invariant images are obtained by finding an image that is orthogonal to the direction of intensity and color change.

C. Hamiltonian path based shadow removal

Shadow edges are the difference between the edge maps of the invariant and non-invariant images. Reintegrating the gradient field obtained by differentiating the image and thresholding shadow edge gradients using a Poisson equation yields a shadow-free image. These results have recently been improved upon by constraining the problem and using a Hamiltonian path based approach for the integration which is explained by C. Fredembach and G. Finlayson [3].

Several relative algorithm and the techniques which are implemented earlier and also the advantages and disadvantages of each algorithm is described briefly. According to the survey of the earlier algorithms, it finds that the current algorithms have more advantages

D. Indoor shadow detection for video segmentation and insignificant shadow detection for video segmentation

Dong Xu, Xiaoou Tang [4] & [5] provides shadow detection comprehensive method for video segmentation in which region growing algorithm is used which is used examines neighboring pixels of initial seed points and determines whether the pixel neighbors should be added to the region. The advantage of this algorithm is can provide the original images which have clear edges with good segmentation results but the disadvantage is that requires a lot of power and time consumption.

E. Shadow detection and reconstruction in High-Resolution Satellite Images via morphological Filtering and Example-Based Learning

Luss, Van den Bergh [6] & [7] provides adaptive threshold hold based shadow masking in which threshold based method is used which is based on bimodal histogram used to determine shadow and non-shadow pixels. The advantage of this method is that it is simple and fast, but the disadvantage is that it requires post- processing as results might be incoherent or blurred and may have holes, noise.

F. Shadow detection using color and edge information

Leone, Distante, Buccolieri [17] classify a texture based approach for shadow detection in which texture based method is used which takes in account the similarity between background and shadow texture as well as the difference in foreground and background textures. The advantage is that the threshold method provides accurate results under stable illumination conditions and is best for indoor scenes, but the disadvantage is that difficult to implement and poor performance for outdoor scenes as texture cannot be captured.

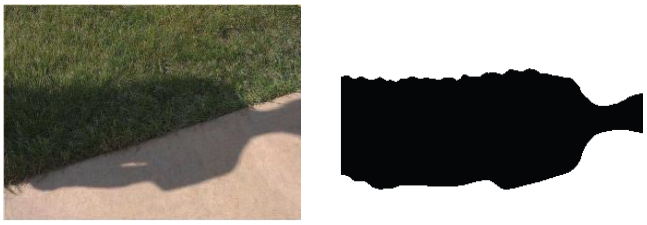
G. Efficient shadow detection of color aerial images based on successive thresholding scheme

Kuo-Liang Chung, Yong-Huai Huang [18] presents an efficient shadow detection of color aerial images. Color based algorithm is used in which spectral information is exploited. 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 defined. The advantage of this algorithm is that it is reliable technique for colored images but fails when intensity of shadow and background is same, color of objects same as or darker than background.

H. A Strategy to Detect the Moving Vehicle Shadows based on Gray-Scale Information

Yu yang,Yu Ming,Ma Yongchao and Jacques Raupp Musse [19] [20] presents a strategy to detect the moving vechile shadow based on based on gray scale information which works on the principal that comparison between current frame and background helps in shadow detection as only luminance information is present. The advantage is that it saves computational time but it depends on synthetic training. Y.Wang and S.Wang [21] presents an algorithm called partial differential equation in which the image smoothing is done via filters and gradient value is used for shadow detection. The advantage of the algorithms is that it is flexible, simple to implement, additional information other than image is not required but the disadvantage is that it does not perform well on edges which span large gaps or holes. Thus after analyzing after various algorithms and methods here are some results of the images after detection of shadow. Prior to removing shadows, we first need to detect them. To this effect, we use the invariant image method proposed in [2] with the additional "closed region" constraint developed in [3]. For shadow detection, an evaluation is done how explicitly modeling the

pair wise region relationship affects detection results and how well detector can generalize cross datasets. Figure 2, shows how the shadow is detected which was proposed by Ruiqi Guo, Qieyun Dai, Derek Hoiem,[22].



(a) (b)

Fig. 2(a) An image with shadow and (b) shadow mask after thresholding proposed by [22].

The pixel-based method may classify some non shadow pixels as shadow pixels. Only regions with a number of pixels greater than a threshold can be considered as shadow regions. Figure 3, gives the shadow area detected which was proposed by Ashraful Huq Suny and Nasrin Hakim Mithila[10].

(a) (b)

Fig. 3 Shadow area detected as white proposed by [10] (a) Original image (b) Detected shadow region.

III. EXSISTING SYSTEM

An approach to detect and remove shadows from a single still image is implemented till now. For shadow detection, a pair wise relationship between regions provides valuable additional information about illumination condition of regions is used, compared with simple appearance-based models. Thus it is observed as in previous approach simple shadow removal method is used for single input image only. Derivation of 2-D intrinsic image from a single RGB camera image based solely on colors, particularly chromaticity is used. A method to recover a 3-D intrinsic image based on bilateral filtering and the 2-D intrinsic image is used. Ariel Amato [13] summarizes the categorization of shadow detection techniques which is given by Wei Zhang [14] where moving cast shadow detection methods have been classified as: (a) color/spectrum-based methods (b) texture-based methods and (c) geometry-based methods. According to [9] moving shadows can be detected based on: (a) intensity information, (b) photometric invariant information and (c) color and statistical information. Also, in [15] shadow removal methods have been categorized as (a) chromaticity-based methods (b) physical methods(c) geometrical-based methods and (d) texture-based methods.
Figure 4(c) shows the result of applying the method proposed by Ashraful Huq Suny and Nasrin Hakim Mithila[10] on some images. The results are compared to the shadow removal method proposed by Saritha Murali, V.K.Govindan [23]. It can be clearly seen from c of Figure 4 that the texture of the surface that was under the shadow is preserved to a good extend and no harsh transition between the shadowed parts and non-shadowed parts can be seen which was proposed by Saritha Murali, V.K.Govindan [23].

Fig. 4 (a) shows the original image, (b) shows the shadow removed area proposed by [23], (c) shows the removed shadow region using [10].

IV. .PROPOSED SYSTEM

The proposed system is aimed at designing and development of the shadow detection from static image which is created by the multiple light sources. The system will then examine and show result in graphical format about the light altitude, intensity and the distance of the light source. Considering an example as a stadium environment with multiple overhead floodlights, many shadows can be observed originating from each of the targets. To successfully track individual targets it is essential to achieve an accurate demonstration of the foreground. Thus considering an example of stadium with multiple overheads floodlights will implement using new and efficient approach. Proposed system will employee following modules for successful completion of system. The following are the steps of the proposed methodology:-
Step1:-Load shadow image.
Step2:-Convert the RGB image into color image.
Step3:-Calculate the edge of image using Canny Edge detection method.
Step4:-Calculate invariant image and mask the edge image.
Step5:-Detect the shadow in an image.
Step6:-Creates the intrinsic image by Finlayson.
Step7:-Remove the shadow and cover the shadow by background color images.

The above steps are used for detection and removal of shadow based on multiple light sources. The Canny edge detection method is proposed for edge detection in an image. This algorithm is one of the best algorithms used in image analysis and processing. The algorithm is followed by 5 detach steps:-

1. Smoothing: Blurring of the image to remove noise.
2. Finding gradients: The edges should be marked where the gradients of the image has large magnitudes.
3. Non-maximum suppression: Only local maxima should be marked as edges.
4. Double thresholding: Potential edges are determined by thresholding.
5. Edge tracking by hysteresis: Final edges are determined by suppressing all edges that are not connected to a very certain (strong) edge.

Once the shadow is detected, it can be removed from images by applying different algorithms. Primarily, if 2 pixels on both sides of the shadow edge have the same reflectance, then they should have the same value once the shadow is removed, that means their gradient should be equal to 0. Secondly, within the

shadow regions, log ratios between pixels are preserved when the shadow is removed; this assumption being in line with most lightness algorithms. It is thereafter assumed that all images are first transformed to the log domain and then exponentiated when the shadows have been removed. Shadow-free images can therefore be obtained by taking the derivatives of the original image, locating the shadow edges derivatives to 0 and finally reintegrating the image. Two different methods for reintegrating shadow-free images have recently been proposed. One reintegrates the image by solving a Poisson equation, a 2-dimensional method [1]. The other method uses random Hamiltonian paths and 1-dimensional integration [3].The following are the techniques used for shadow removal:-

A. Model based techniques

Model based techniques have limited application and are applied to specific problems. These are reliant on information about illumination conditions and scene geometry as well as the object which is one of the drawback proposed by Arevalo[11]. These techniques revolve around the idea that the desired structures do have repetitive geometries. Hence, probabilistic models could be easily implemented for segmentation purpose proposed by Salvador[12].

B. Property based techniques

Property based shadow detection methods have less limitations as compared to the model based techniques. They are known to be much superior since, in these not only geometrical features are used but they are also combined with the spectral properties of shadow like color or brightness etc. These approaches have been mostly used in literature since they are simple and easy to implement. They can be classified as: a) thresholding-based b) color-transformation-based c) region-growing-based and d) classification-based which is stated by Huihui[6].

C. Additive shadow removal

Another rather simple shadow removal technique was an additive correction of the color intensities in the shadow area. The average pixel intensities are calculated in the shadow and lit areas of the image and added this difference to the pixels in the shadow areas.

D. Combined shadow removal

The third shadow removal method is a combination of the previous two ones. The images are converted to the YCbCr color-space. After, the additive method is used for the correction on the Y channel and model-based is used for Cb and Cr channels.

V. CONCLUSION

In this paper, a survey of various shadow detection and removal techniques has been presented. Also, survey is done on various types of images real time application or traffic images various shadow detection approaches have been summarized and compared by discussing their advantages and limitations. Shadow detection can be performed by either using the methods described above individually or in combination with one or more of the techniques.

The algorithms used for shadow detection and removal till now has a number of limitations. The shadow removal process, which is used, makes an assumption that all surfaces that contain shadows should be roughly planar and parallel to each other. Thus till now the detection and removal of shadow has been done only for single light source i.e. the light source may be from indoor light or sun as a light source. In proposed system we have defined an approach to detect and remove the shadows based on multiple light sources.

ACKNOWLEDGEMENT

The authors would like to thank and grateful to the reviewers for their valuable comments and suggestions to improve this paper.

REFERENCES

[1] G. Finlayson, S. Hordley and M. Drew “Removing Shadow from Images”, European Conference on Computer Vision (ECCV), 2002.

[2] G. Finlayson, M. Drew, and C. Lu. “Intrinsic Images by Entropy Minimization” European Conference on Computer Vision (ECCV), 2004.

[3] C. Fredembach and G. Finlayson.” Hamiltonian path based Shadow Removal”. British Machine Vision Conference (BMVC), 2005.

[4] Dong Xu, Jianzhuang Liu, Zhengkai Liu, Xiaoou Tang, "Indoor Shadow Detection for Video Segmentation," IEEE International Conference on Multimedia and Expo, 2004. ICME '04. 2004, vol.1, no., pp.41, 44 Vol.1, 27-30 June 2004.

[5] Dong Xu, Jianzhuang Liu, Xuelong Li, Zhengkai Liu, Xiaoou Tang, "Insignificant Shadow Detection for Video Segmentation," IEEE Transactions on Circuits and Systems for Video Technology , vol.15, no.8, Aug. 2005.

[6] Huihui Song; Bo Huang; 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, vol.52, no.5, May 2014.

[7] Luus, F.P.S.; van den Bergh, F.; Maharaj, B.T.J., "Adaptive threshold-based Shadow masking for across-date settlement classification of panchromatic Quickbird Images," Geoscience and Remote Sensing Letters, IEEE, vol.11, no.6, June 2014.

[8] Y.Weiss, “Deriving Intrinsic Images from Images Sequences”. In International conference in Computer Vision (ICCV),2001.

[9] Y. Matsushita, K. Nishino, K. Ikeuchi, and M. Sakaushi, “Illumination Normalization with time-dependent Intrinsic Images for Video Surveillance”. IEEE Trans. on Pattern Analysis and Machine Intelligence, 2004.

[10] Ashraful Huq Suny and Nasrin Hakim Mithila, “A Shadow Detection and Removal from a Single Image using LAB color space”, International Journal of Computer Science Issues, Vol. 10, Issue 4, No 2, July 2013.

[11] Arevalo V, González J, Ambrosio G, "Detecting Shadow Quickbird Satellite Images," ISPRS 2006 Commission VII Mid-term Symposium 'Remote Sensing: From Pixels to Processes'. Enschede, the Netherlands, 8-11 May.

[12] E. Salvador, A. Cavallaro, and T. Ebrahimi, “Cast Shadow Segmentation using Invariant Color Features,” Computer Vis. Image Understand., vol. 95, no. 2, Aug. 2004.

[13] Ariel Amato, Ivan Huerta, Mikhail G. Mozerov, F. Xavier Roca and Jordi Gonz`alez, "Moving Cast Shadow Detection Methods for Video Surveillance Application," 2013.

[14] Wei Zhang, Q.M. Jonathan Wu, and Xiangzhong Fang, "Vision Systems: Segmentation and Pattern Recognition of Moving Cast Shadow Detection."

[15] Andres Sanin, Conrad Sanderson, and Brian C. Lovell, "Shadow Detection: A survey and Comparative Evaluation of Recent Methods," Pattern Recognition, Vol. 45(4), April 2012.

[16] Dong Xu, Jianzhuang Liu, Zhengkai Liu, Xiaoou Tang, "Indoor Shadow Detection for Video Segmentation," IEEE International Conference on Multimedia and Expo. vol.1, no., Vol.1, 27-30 June 2004.

[17] Maryam Golchin, Fatimah Khalid, Lili Nurliana Abdullah and Seyed Hashem Davarpanah, "Shadow Detection using Color and Edge Information", Journal of Computer Science, Vol. 9 (11), 2013.

[18] Kuo-Liang Chung, Yi-Ru Lin, Yong-Huai Huang, "Efficient Shadow Detection of Color Aerial mages based on Successive Thresholding Scheme," Geoscience and Remote Sensing, IEEE Transactions on , vol.47, no.2, Feb. 2009.

[19] Yu Yang; Yu Ming; Ma Yongchao, "A Strategy to Detect the Moving Vehicle Shadows based on Gray-Scale Information," Second International Conference on Intelligent Networks and Intelligent Systems, ICINIS '09, vol., no., pp.358, Nov. 2009.

[20] Jacques, J.C.S., Jung, C.R., Raupp Musse, S., "Background Subtraction and Shadow Detection in Grayscale Video Sequences," 18th Brazilian Symposium on Computer Graphics and Image Processing, 2005.

[21] Y. Wang and S. Wang, "Shadow Detection of Urban Aerial Images based on Partial Differential Equations," in Proc. ISPRS Congr., Comm. II, Jul. 3–11, 2008.

[22] Ruiqi Guo, Qieyun Dai and Derek Hoiem "Paried Regions for Shadow Detection and Removal", IEEE Transaction on Pattern Analysis and Machine Intelligence, vol. 35, No.12, December 13.

[23] Saritha Murali, V.K.Govindan, "Shadow Detection and removal from a Single Image Using LAB Color Space" Cybernetics and Information Technologies, Vol. 13, 2013.

[24] D.R. Martin, C. Fowlkes and J. Malik, "Learning to Detect Natural Image Boundaries using Local Brightness, Color and Texture Cues," IEEE Trans. Pattern Analysis and Machine Intelligence, vol. 26, no. 5, May 2004.

[25] C.-C. Chang and C.-J. Lin, "LIBSVM: A Library for Support Vector Machines," ACM Trans. Intelligent Systems and Technology, vol. 2, 2011.

[26] M. Baba and N. Asada, "Shadow Removal from a Real Picture", Proc. ACM Siggraph, 2003.