International Journal of Recent Trends in Engineering & Research
ISSN(ONLINE) : 2455-1457
IMPACT FACTOR : 3.344

A Survey on Various Shadow Detection and Removal Methods /Algorithms

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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. Although, many algorithms and methods have been developed for different environmental conditions to detect and remove shadow from the images. 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

Image processing has been area of research that attracts the interest of wide variety of researchers. It deals with processing of images, video, pictures etc. with various aspects like image segmentation, image enhancement, image compression(JPEG, MPEG etc.), video transmission, computer vision (robots, license plate reader), Photoshop. Shadow detection and removal is an important task in image processing. Shadows provide rich information about the object shapes and light orientations. It is used for land monitoring, remote sensing, change detection, image segmentation, face recognition etc.

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.

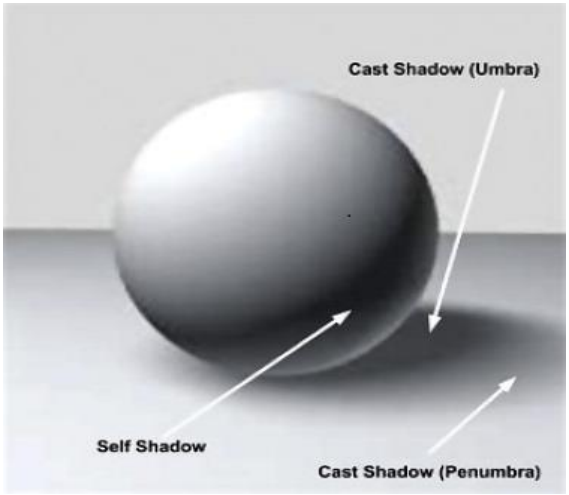

Figure 1. Different types of shadow

Cast shadow is caused by the projection of the light source in the direction of the object. Self shadow is object its self. Both cast and self shadow has different brightness value. Again cast shadow can be classified into two parts: umbra and penumbra. The part of a cast shadow where direct light is

completely blocked by its object is called umbra, while the part where direct light is partially blocked is called penumbra.

II . SHADOW DETECTION AND REMOVAL METHODS / ALGORITHMS

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

Table 1. **comparative** ***analysis of various Shadow detection and Removal methods / Algorithms***

Sr. No.	Method	Key Idea	Advantages	Disadvantages	Author
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 value is susceptible to Illumination changes.	Habib Ullah et.al [1], Shibam Das et. al. [7]
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.	Song et al. [2], Luus et al. [3], Kuo et al. [4]
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.	Guo et al. [5], Liu et al.[6]
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.	Maryam Golchin et. al. [8]

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.	Leone et al. [9], Leone et al. [10], Golchin et al. [8], Heikkila et al. [11]
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.	Asaidi et al. [12] , Golchin et al. [8]
7	Chromaticity based	Hue and saturation combined together are known as chromaticity.	Highly accurate. Can select proper features for shadow.	Tends to misclassify.	Liu et al. [13], Shi et al. [14], Song et al. [2]
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.	Xu et al. [15], Xu et al. [16]
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	Otsu et al. [17]
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.	Muhammad Shoaib et al. [19]
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.	Huang Siming et al. [20]

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

In this paper, first the basics of the shadow, how shadow occurs, then different types of shadows are mentioned which can appear in the images. Secondly, comparative survey for analyzing different shadow detection and removal methods is done. After analysis we like to conclude that; there is no ‘the best Algorithm/method/classifier’. The choice of the best lgorithm/method/classifier is depend on data-set characteristics which being processed. For any application, a particular classifier which performs very well it may also give poor performance in a different setting. As well the cost plays import role while selecting the algorithm.

IV. ACKNOWLEDGMENT

The authors would like to express our gratitude to the people who helped and supported us throughout this paper. The authors also like to thank the anonymous reviewers for their comments and suggestions to improve this paper.

REFERENCES

1. Habib Ullah, Mohib Ullah et.al, "Comparative Study: The Evaluation of Shadow Detection Methods", International Journal of Video & Image Processing and Network Security IJVIPNS-IJENS, Vol. 01, No. 02, April 2010
2. 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, pp.2545,2554, May 2014 .
3. Luus, F.P.S, van den Bergh, F., Maharaj, B.T.J., "Adaptive Threshold-Based Shadow Masking for Across-Date Set- tlement Classification of Panchromatic Quick-Bird Images," Geoscience and Remote Sensing Letters, IEEE, vol.11, no.6, pp. 1153, 1157, June 2014.
4. Kuo-Liang Chung; Yi-Ru Lin; Yong-Huai Huang, "Efficient Shadow Detection of Color Aerial Images Based on Successive Thresholding Scheme," IEEE Transactions on Geoscience and Remote Sensing, vol.47, no.2, pp.671, 682, Feb. 2009.
5. Ruiqi Guo, Qieyun Dai, Hoiem, "Single-image shadow detection and removal using paired regions," IEEE Conference on Computer Vision and Pattern Recognition (CVPR), vol., no., pp.2033,2040, 20-25 June 2011.
6. Xin Liu, Bin Dai, Hangen He, "Real-Time On-Road Vehicle Detection Combining Specific Shadow Segmentation and SVM Classification," I\ Second International Conference on Digital Manufacturing and Automation (ICDMA), IEEE, vol., no., pp.885,888, 5-7 Aug. 2011.
7. Shibam Das, Ambika Aery, "A Review: Shadow Detection And Shadow Removal from Images", International Journal of Engineering Trends and Technology (IJETT), ISSN: 2231-5381, Volume 4, Issue 5, May 2013.
8. Maryam Golchin, Fatimah Khalid, Lili Nurliana Abdullah, Seyed Hashem Davarpanah, "Shadow Detection Using Color and Edge Information", Journal of Computer Science, ISSN: 1549-3636, Volume 9, Issue 11, 2013.
9. Leone, A. Distante, Buccolieri, "A texture-based approach for shadow detection," IEEE Conference on Advanced Video and Signal Based Surveillance, 2005. AVSS 2005., vol., no., pp.371,376, 15-16 Sept. 2005.
10. A.Leone, C.Distante, "Shadow Detection for Moving Objects based on Texture analysis," Pattern Recognition, Vol. 40(4), pp. 1222, 1233, April 2007.
11. Heikkila, M. Pietikainen,, "A texture-based method for modeling the background and detecting moving objects," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol.28, no.4, pp.657 ,662, April 2006 .
12. Asaidi, Aarab, Bellouki, "Shadow detection approach combining spectral and geometrical properties," IEEE International Conference on Multimedia Computing and Systems (ICMCS), vol., no., pp.389,393, 10-12 May 2012.
13. Jiahang Liu, Tao Fang, Deren Li, "Shadow Detection in Remotely Sensed Images Based on Self-Adaptive Feature Selection," IEEE Transactions on Geoscience and Remote Sensing, , vol.49, no.12, pp.5092,5103, Dec. 2011.
14. Wenxuan Shi, Jie Li, "Shadow Detection in Color Aerial Images Based on HSI Space and Color Attenuation Relationship," EURASIP Journal on Advances in Signal Processing, 2012:141, 2012.
15. Dong Xu, Jianzhuang Liu, Zhengkai Liu, Xiaoou Tang, "Indoor shadow detection for video segmentation," IEEE International Conference on Multimedia and Expo, Vol.1, 27-30, pp.41, 44, June 2004.
16. 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, pp.1058,1064, Aug. 2005
17. Otsu, N. "A Threshold Selection Method from Gray-Level Histograms". IEEE Transactions on Systems, Man and Cybernetics, Vol. 9, No. 1, 1979, pp. 62-66.
18. Ryan P. Avery, Guohui Zhang and Yinhai Wang, "An Investigation into Shadow Removal from Traffic Images," University of Washington, 2007.
19. Muhammad Shoaib, Ralf Dragon, Jörn Oster Mann IEEE, "Shadow Detection for Moving Humans using gradient Based background subtraction". Acoustics, Speech and Signal Processing IEEE International Conference, 2009.
20. Huang Si-ming, Liu Bing-han, Wang Wei-zhi, "Moving shadow detection based on Susan algorithm", Computer Science and Automation Engineering (CSAE), 2011 IEEE International Conference, 2011.

