IJCSE International Journal of Computer Sciences and Engineering Open Access
Review Paper Vol.-6, Issue-12, Dec 2018 E-ISSN: 2347-2693

Overview on Single Image Shadow Removal Using Different Techniques

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Available online at: www.ijcseonline.org

Accepted: 16/Dec/2018, Published: 31/Dec/2018

Abstract— Shadow in the image degrades the quality of the image. So it is necessary to remove the shadow from the image. The detection of shadow and removal of the shadow from the images can be done through many different methods like reintegration method, cubic spline etc. The shadow in the image can be detected through user-assisted method that uses Support Vector Machine (SVM) and Markov Random Field (MRF) methods. Shadow from single image is removed using 3D intensity surface modelling to preserve texture without any loss in image. Using 3D intensity surface modelling method the accuracy can be increased i.e., the exact texture can be recovered in the shadow region after the shadow removal as compared to previous methods.

Keywords— Cartoon Image, Shadow Detection, 3D intensity surface modelling, Shadow Removal.

I. INTRODUCTION

When direct light from any source is blocked partially or totally by an object then the shadow is created. The Shadow detection and the shadow removal from the images play an important role. Shadow can be removed only after the detecting the shadow in the image by segmenting the image into shadow region and non-shadow region. Rich information of object shapes can be provided by shadow. Shadow in the image often decreases the visual quality of images. Moreover, the shadow region is divided into umbra region and penumbra region. Umbra region is the region where light is blocked totally by an object and the region where it is partially blocked is known as penumbra region.

Generation of the high-quality shadow free image from the shadow image is a challenging task in image processing. Many shadow removal algorithms have been proposed in literature. The shadow has to be detected first in the image and later some shadow removal algorithms have to be applied on it to remove shadow from the image. There are different types of shadows and shadow surfaces. So, it is difficult to remove the shadow from the image easily. Umbra and penumbra mask can be used to detect the shadow. There are two methods for shadow detection: automatic shadow detection and user assisted shadow detection method. User-assisted method for shadow detection is more workable than the automatic shadow detection method. It is easy to extract shadow mask from shadow image using the user assisted method. Shadow mask S is the combination of umbra and penumbra. Automatic shadow detection method doesn't require any input from user and it automatically detects the shadow and removes the shadow from the image but the main disadvantage of automatic shadow detection method is that it cannot remove the shadow completely from the curved surfaces. User assisted method can overcome the limitation of automatic shadow detection method.

The different features of shadow can be useful for shadow detection are the intensity, chromaticity, physical properties, geometry and texture. Chromaticity is measurement of colour independent of intensity. Most of the shadow detection methods based on features use the colour information. The region under the shadow becomes darker but the chromaticity remains the same. Physical properties are different illumination sources in images. Illumination sources provide the pure white light. The two major illumination sources are the sun (white light) and light reflected from the sky (blue light). Geometry is the orientation, size and even the shape of shadow that can be predicted with the exact knowledge of illumination sources, ground plane and object shape. Texture is appearance of the surface in the image. Texture provides the information about the spatial arrangement of colour or intensities in an image. Image textures can be used for segmentation or classification of the images.

II. RELATED WORK

G.D Finlayson et al [1], proposed On the removal of shadows from the images. The color and statistical information method is proposed where the probabilistic function helps to obtain shadow and non-shadow pixels based on illumination model. Shadow edges are removed from the original image by edge in-painting method. Reintegration method and threshold edge map methods are introduced and 3D shadow-free image is derived. Shadow-free image can be represented into three different ways. They are 1D invariant based on simple constraints on lighting and cameras, 2D chromaticity representation equivalent to 1D representation with some color information retained and 3D full color image. The main advantage of this paper is it effectively removes the shadow from the image that yields very good performance. 2D chromaticity representation of image is useful and additionally shadow is removed from the representation. The limitation of the proposed method is it is poorly conditioned and requires high cost of computation. It is difficult to identify the shadows and calculating the effects since both the color and intensity of the scene illumination effects the shadow.

Eli Arbel et al [2], proposed shadow removal using intensity surface and texture anchor points. Shadow is detected using selected RGB values and shadow and non-shadow regions are calculated to extract shadow mask. A cubic spline is used to recover scalar factors in the penumbra region. Shadow mask and surround mask is calculated. Surround mask is a region of the penumbra. Anchor points selection smoothens the umbra region. Anchor points are a collection of the new shadow mask and surround mask. Finally, shadow mask edges are extracted that are to be used. Intensity surface is applied to the shadow mask. Then the shadow is removed. It removes the shadow from curved surface images. The problem of this approach is computation time is dependent on the size of the shadow region that affects approximation time.

Ruiqi Guo et al [3], proposed paired regions for shadow detection and removal. Shadow can be detected using pair wise relationships between regions provide valuable additional information about the illumination conditions of regions. Each individual region can be considered separately based on illumination condition on their appearances. Segmentation of the image can be done using mean shift algorithm and to estimate that each region is in the shadow region. Detection of same illumination pairs is based on their intensities, chromatic alignments and their distances in the image. Detection results are later refined by image matting. Image matting is used to get smooth changes between the detected shadow region and non-shadow region. Matting algorithm calculates coefficient values of majority pixels. The shadow-free image will be recovered by relighting each pixel. This method can detect the shadow boundary accurately and is easy to implement but it may have chances of misclassification of regions. The problem of this approach is it implicitly assumes that all surfaces should contain shadow roughly planar and parallel to each other.

L. Zhang et al [4], proposed image shadow removal based on illumination recovering optimization. The shadow can be detected in the input image through image decomposition. Then shadow alpha matting can be used on shadow image to detect shadow. Shadow matting patches are to be extracted both from the shadow region and lit region based on the texture similarity. Denser patches will be out on shadow boundaries and lit patch based on illumination change. Building the correspondence between shadow patch and lit patch on illumination and similarity in texture optimized illumination recovering operator is developed. Optimized illumination recovering operator can be used to remove shadows from the image and recover texture details under shadow patches. Using coherent illumination processing among neighbouring patches, obtain high-quality image i.e., shadow-free image. Image obtained after shadow removal can be effectively recovered and will be consistent with the surrounding environment. The main advantages of using illumination recovering operator, it provides effective results on images with both non-uniform shadow and shadow image with multi-texture types. The problem of this approach is when the textures of both the shadow region and lit regions are different then it is difficult to find correct match of shadow patch and lit patch.

S. H. Khan et al [5], proposed automatic shadow detection and removal from a single image. New approach for robust shadow detection combining both regional and across-boundary learned features in a probabilistic framework involving CRFs. The most relevant feature representations from the raw pixels values are learnt automatically. The shadow properties from the shadow regions and properties at the boundaries in the image are considered. These features are considered on the basis of ConVet architecture. To extract the boundaries in the image, bilateral filter is used. Shadow mask is detected as the shadow regions and non-shadow region is extracted. After shadow detection, the umbra, penumbra mask and object shadow boundary is estimated. CRF model is applied to estimate object-shadow boundary in the image. Bayesian shadow removal method is applied to obtain shadow-less image and extracts the shadow matte from the shadow image. To enhance the shadow free image Poisson Smoothing is performed to conceal shadow boundary artifacts.

Kai He et al [6], proposed shadow removal using 3D intensity surface modelling from a single image. Selection of test points in the shadow image to calculate the interval between the test points. After the selection of test points from the shadow image, the image has to be decomposed. The image can be smoothened using edge-preserving filter and then obtain cartoon image through it, as intensity surface modelling on the original image directly changes greatly due to the high-order textural details. So intensity surface modelling can be performed on cartoon image that significantly changes on the same texture region. After smoothening of shadow image, detect the shadow region and non-shadow region through which shadow mask is detected. Once the shadow mask is detected then intensity surface modelling has to be modelled on the image so that the shadow is represented through any RGB channel. Shadow can be removed from the shadow-free RGB image and image can be compensated that adjusts the pixels in the shadow region after removal of shadow from the image. Shadow-free image can be obtained without loss of texture in the shadow region.

III. PROPOSED WORK

Our proposed system may recover the shadow free image from the input shadow image by overcoming all listed limitations. This method not only recovers the shadow free image but recovers it with higher accuracy and high quality image while preserving the texture of the shadow region in the image. Shadow can be removed even from the curved surface region using this intensity surface modeling method. Reintegration method can be used to obtain shadow free image in three different ways: 1D, 2D, 3D color image but the limitation of using reintegration method is that it is poorly conditioned and requires high cost of computation. Another method that can be used to remove the shadow from the image using cubic spline. A cubic spline is used to recover scalar factors in the penumbra region but the limitation of using this method is that computation time is dependent on the size of the shadow region. Pairwise relationship is another technique that can be used to segment the image using mean shift algorithm but the limitation of this approach is that it implicitly assumes that all surfaces should contain shadow roughly planar and parallel to each other. Illumination recovering operator method that provides effective results on images with both non-uniform shadow and shadow image with multi-texture types. The problem of this approach is when the textures of both the shadow region and lit regions are different then it is difficult to find correct match of shadow patch and lit patch. All the limitations of above methods can be recovered by using intensity surface modelling method. This method recovers the shadow free image from the input shadow image by overcoming all the above listed limitations.

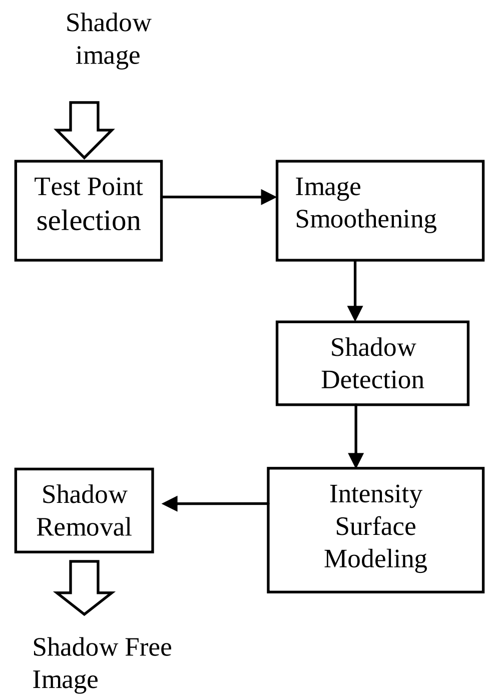

Figure 1: System Architecture

Figure 1 shows the system architecture of shadow removal from a single image using 3D intensity surface modelling. The system consists input given as a shadow image and image smoothening technique like mean shift filter has to be applied on to the image so that the image is smoothened and to preserve the edges of the image. Edge preserving filter is used to preserve the edge of shadow and smoothen the image i.e., the cartoon image has to be obtained. Shadow mask S can be detected through shadow region and non-shadow region. Intensity surface modelling can be functional to model intensity surfaces in the shadow region with the same texture and shadow can be removed from the image.

IV. CONCLUSION

In this study we have given a survey of shadow detection and removal techniques in the shadow image. The shadow in the image can be detected through user-assisted method that uses region growing method. Shadow from single image is removed using 3D intensity surface modeling to preserve texture without any loss in image. Using 3D intensity surface modeling method the accuracy can be increased i.e., the more texture can be recovered in the shadow region after the shadow removal as compared to previous methods. In future, Texture preservation techniques are used as an extension.

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