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Shadow Detection and Its Removal from Images Using Advance Strong Edge Detection Method (ASED)

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Abstract: Shadow causes dilemma during the recognition of objects from images in different computer vision applications, so it is a very critical job to confiscate shadow from images that's why in this paper a new method for shadow removal based on Advance Shadow Edge Detection (ASED) method is projected. First of all an image is converted into the gray-scale image then this resulted image produces the edge patch candidates and after applying feature extraction and edge classifier technique on the resulted edge patch candidates strong shadow edges are generated. Additionally spatial smoothing is used for get improved shadow recognition results at the end Gaussian filter is applied for shadow elimination task. After Shadow removal some image parameters (Mean Square Error, Maximum Squared Error and ratio of squared norms) outcome of both earlier Patch based Shadow Edge Detection Method and projected ASED method are calculated and compared with each other.

The consequences demonstrate that the projected ASED method is better than the previous Patch Based Shadow Edge Detection method. Mean square error and Maximum squared error are less than earlier method which shows the shadow detection and removal are more efficiently performed through our Advance Shadow Edge Detection (ASED) method.
Keywords: Entropy, Mean Square Error, Maximum Squared Error, Ratio of squared norms, Shadow, and Image

I. INTRODUCTION

Shadows are essential element of several ordinary images. Although shadows, and predominantly cast shadows, can give precious information on an acquired scene, e.g., cues for spatial layout and surface geometry, they can also pose difficult problems and limitations for various computer vision algorithms. The existence of shadows has been accountable for reducing the consistency of many computer vision algorithms, together with segmentation, object recognition, scene analysis, stereo, tracking, etc. Shadows can either aid or mystify scene analysis, depending on whether we form the shadows or pay no attention to them. If we can recognize shadows, we can recovered confine objects, recognize object shape, and detect where objects make contact with the ground. Shadow elimination, whether from video stream or a single still image, is an significant research problem, and developing an efficient shadow removal algorithm can help in improving the results of other elementary algorithms in computer vision if applied as a pre-processing step.

Many shadow removal and illumination invariance algorithms aim at re-moving shadows for the purpose of enhancing the image as a pre-processing step, e.g., preceding to segmentation or identification. As a pre-processing step, these algorithms may use various assumptions related to the specific algorithm they are designed to enhance. For example, in [1], the authors describe a method for shadow and highlight removal intended to help segmentation algorithms. The purpose of this algorithm is to make coherent surfaces appear similar, regardless of whether they include shadow or highlight regions. In this paper, center of attention will be on the dilemma of shadow recognition and elimination from images. Given a shadow image, the ultimate goal is to produce a high-quality shadow-free image which would seem to have been taken in the same scene but without shadows.

II. RELATED WORK

In 2014, Gayatri Gaurav et.al [2] reviews on various shadow recognition and deduction technologies and evaluate them vitally. In 2013, Zvi Figov et. al [3] projected a technique for the recognition and deduction of shadows in RGB images. The proposed method begins with a segmentation of the colour image. It is next determined if a segment is a shadow by test of its nearby segments. In 2013, Maryam Golchin et.al [4] proposed a work for shadow detection which uses both colour and edge information. In order to develop the exactness of shadow detection using colour information, a new formula is used in the denominator of unique c1 c2 c3. In 2013, Shibam Das et.al [5] proposed a professional and straightforward approach for shadow detection and removal based on HSV colour representation in difficult urban colour remote sensing images for solving troubles caused by shadows.

III.PROPOSED ALGORITHM (ASED)

In this work an algorithm for shadow detection and removal is proposed which is based on Advance Shadow Edge Detection method. In this work a new approach is defined to detect and remove shadow from images.
Step1: First of all obtain grey scale image.
Step2: Now shadow edge candidates are generated from the image obtained from the step1.
Step3: Now the resulted image obtained from the step2 goes through the feature extraction and shadow edge classifier stage and gives initial shadow detection result.
Step4: In the fourth step image obtained from second step goes through spatial smoothing phase which gives us refined shadow detection result.
Step5: Now we get the shadow edges by removing the non-shadow edges from the resulted image obtained in step4.
Step6: After getting the shadow edges we apply the Gaussian filter over the image obtained in step 5 for further filtering the image.
Step7: The resulted image obtained in step 6 is used to remove shadow from the original image
Now we proceed with the fair explanation of each step of our ASED methodology.

A. Obtain Grey scale Image

In the first step of ASED methodology we have to convert the original image into grey scale image. This step is essential for the better results at the end. Grey scale conversion of image gives the better shadow removal results as compared to RGB or coloured images.

B. Edge Patch Candidates Generation

Gradients caused by surface changes (object edges) and illumination changes (shadow edges) have large magnitudes while road surface changes lead to gradients with small magnitudes. Image gradients whose magnitude smaller than threshold & whole image gradients are calculated separately for regression model. Threshold value extracts strong shadow edges. Extract shadow edge using patches instead of pixels. Any patch containing more than x edge pixels is classified as edge patch candidate.

C. Feature Extraction

As the colour ratio between shadow and non-shadow and texture information not work well in previous study so we use 3 types of features illuminant-invariant features, illumination direction and neighbouring similarity features.

1) *Illuminant-invariant:* Convert RGB space into illuminant-invariant colour space & extract its two features:
   First, variance of colours as pixel values from same surface in shadow edge patch have a smaller variance while pixel values from different surfaces in object patches exhibit a larger variance.
   Second, Entropy of gradients: as in the absence of illumination effects, the texture of surface in shadow edge patch can be described by gradients with smaller entropy whereas texture of multiple surfaces in non-shadow edge patch leads to larger entropy of gradients.
2) *Illumination Direction:* 2D log-chromaticity values of shadow edge patch from the same colour surface fit a line parallel to the calibrated illumination direction. Also they have a small variance after projecting on to the illuminant-invariant direction.
   2D log-chromaticity values of non-shadow (object) edge patch fits a direction other than the illumination direction and generates the projection to its perpendicular direction with large variance.
3) *Neighbouring Similarities:* Neighbouring patches on both sides of an edge can also provide evidence to distinguish shadow edges from non-shadow edges. To characterize properties of edges in a patch, we examine the filter responses of the Gabor filters at all orientations (different angles). We employ two features which capture the texture differences between the pair of neighbouring patches: The gradient features are represented as a histogram of a set of Gabor filter responses computed.

The texture features are a set of emergent patterns sharing a common property all over the image.

D. Shadow Edge Detection

Every patch is classified as either being a shadow edge patch or a non-shadow edge patch. For this propose, we employ a binary Support Vector Machine (SVM) classifier. This classification method provides a fast decision and outputs probabilities. We use maximal likelihood estimate to detect shadow edge patch & non shadow edge patch.

The initial probabilities and classifier decisions are used as inputs to spatial patch smoothing module for achieving improved results. After obtaining patch-based detection results, we use the edge pixels from all detected shadow edge patches to generate a shadow edge map.

E. Spatial Patch Smoothing

The initial detection makes a decision based on a local patch without considering neighbouring patches, which could yield missing shadow edges. However, shadow edges and non-shadow edges have neighbouring connectivity and directional consistency, which can be utilized to improve detection results. Thus, we propose a spatial smoothing approach to exploit the consistency across neighbouring edge patches to maintain global edge contours and remove isolated false detection.

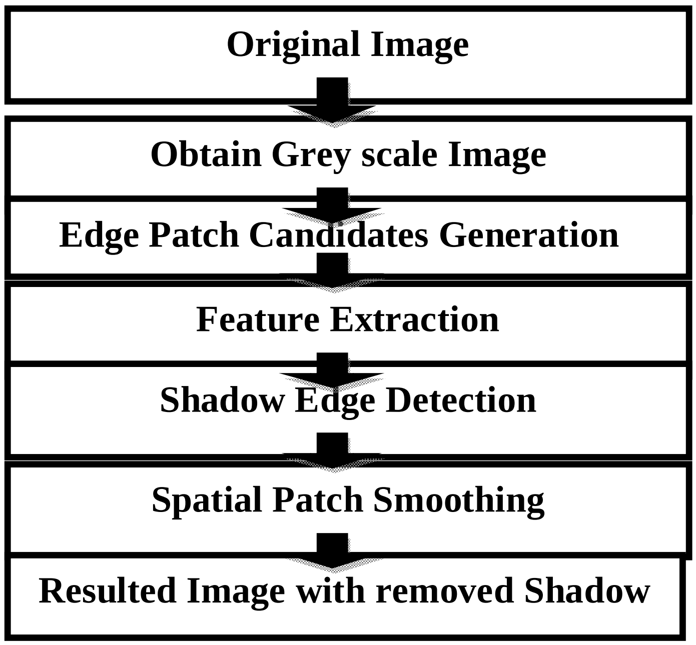

Fig 1. Pictorial Representation of Proposed ASEDR Method

IV. EXPERIMENTAL RESULTS

In this paper we have used the 6 images to test the effectiveness of our algorithm as compared to earlier algorithm. For the proposed Advance Shadow Edge Detection (ASED) method we have calculated the various parameters like mean square error, maximum squared error and ratio of squared norms.

We have calculated the same parameters for the earlier patch based shadow detection method. Here we are giving the details of all image parameters. The comparison between proposed methodology ASED and earlier method Patch Based Shadow Edge Detection method shows that projected method gives the smaller value of Mean Square Error and Maximum Squared Error & large value of Ratio of Squared Norms for better results.

A. Mean Square Error (MSE)

The Mean squared error is an increasing error between the compressed and the new image. The value of MSE should be lower because lower value of MSE generates the lower error. The mean square error stuck between an image, A and an estimation B, is the squared norm of the difference divided by the K number of elements in the image: $MSE = \frac{||A-B||^2}{K}$

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TABLE I
COMPARISONS OF MSE: EARLIER V/S PROPOSED METHODS

S.NO	Earlier Method	Proposed Method
1.	2929.5683	1083.9403
2.	3436.0919	1271.354
3.	4007.8997	1482.9229
4.	5347.3638	1978.5246

MSE of an image should be smaller for the better results as we can see proposed ASEDR method have smaller MSE value as compared to previous method.

B. Maximum Squared Error (MAXERR)

Maximum Squared Error is the maximum absolute squared deviation of the real-valued image, from the approximation with a size equal to that of the input image.

TABLE II
COMPARISONS OF MAXERR: EARLIER V/S PROPOSED METHODS

S.NO	Earlier Method	Proposed Method
1.	96	63.36
2.	124	81.84
3.	105	69.3
4.	124	81.84

MAXERR of an image should be smaller for the better results as we can see proposed ASEDR method have smaller MAXERR value as compared to previous method.

C. Ratio of Squared Norms (L2RAT)

L2RAT is the ratio of the squared norm of the image approximation with a size equal to that of the input image, to the real-valued input image.

TABLE III
COMPARISONS OF L2RAT: EARLIER V/S PROPOSED METHODS

S.NO	Earlier Method	Proposed Method
1.	1.7248	2.3629
2.	1.5899	2.1781
3.	1.4209	1.9466
4.	1.9062	2.6115

L2RAT of an image should be large for the better results as we can see proposed ASEDR method have larger L2RAT value as compared to previous method. So we can say our proposed ASEDR method is better than the previous patch based edge detection method.

V. CONCLUSION

Based on the parameters as given in the table above, we can declare that the projected method is clearly better than the earlier method. Although we cannot mark the distinction between the images as obtained from both the methodology with bare eyes, we can most correctly see the value of MES, MAXERR and L2RAT of each of the images as obtained after the use of earlier and proposed technique. For future work, we can test the proposed methodology with different variables (other than above parameters). We can use this to clean vague images for improved path recognition. There are a number of directions which could be used in this method to get better detection and discrimination rates in the future such as finding a proper way to combine the results of each step. The performance can be improved further by employing region-based techniques to recover the shadow region. A logical future direction is to use extra features in the existing methods, as all the currently used features largely provide independent contributions.

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