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Shadow Detection and its Removal from Images Using Strong Edge Detection Method

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Abstract: *Shadows cause problems in image processing. In this paper, a new methodology for shadow removal based on Strong Edge Detection (SED) method is proposed. The strong shadow edges are recognized by learning the patch based characteristics of shadow edges and then image features are analyzed to guide a Shadow Edge Classifier. Also, spatial patch smoothing is used to enforce uniformity between adjacent patches. The entropy and standard deviation results of both earlier Patch based Shadow Edge Detection Method and proposed SED method are calculated and compared with each other. The results show that the proposed SED method is better than the previous Patch Based Shadow Edge Detection method.*
Keywords: *Strong Edge Detection, Shadow Removal, Shadow Edge Classifier, Shadow Edges, Shadow Removal*

I. Introduction

Eliminating Shadows from images is a complicated task. To get a high-quality shadow-free image that is a replica of a true shadow-free scene is even more difficult. Different lighting circumstances, variety of shadowed surfaces etc affects shadows in images. Furthermore, shadow regions may undergo contrast enrichment, which may introduce perceptible artifacts in the images without shadows. The shadowing effect is compounded in region where there are striking changes in surface elevation mostly in urban areas [1]. The obstruction of light by objects creates shadows in a scene. The shadow areas are less illuminated than the surrounding areas. The shadows are classified as hard and soft on the basis of intensity. The soft shadows retain the texture of the background surface, whereas the hard shadows are too dark and have little texture [2].

In Satellite images, shadows occur due to imaging conditions and the presence of various high-rise objects and this is mostly in urban areas [3]. In moving shadows the real challenge is to classify moving shadow points which are many times misclassified as moving object points in a video sequences causing problems in vision applications. Moving cast shadows deform the evaluation of shape and color characteristics of target objects [4, 11]. For creating virtually realistic worlds and visualization applications, Front-projection displays are being used. However, these systems have drawback that Users and different objects present in the environment can easily and involuntarily obstruct projectors, creating shadows on the displayed image [5]. Though in some cases, the shadows provide useful information, such as the relative position of an object from the source but they create complexities in visualization applications like segmentation, detecting objects and object classification [6]. An object sometimes cast a shadow i.e. self-shadow on itself. Self-shadows in comparison to hard shadows have more brightness. Usually Cast shadow comes under hard shadows, divided into umbra and penumbra region [7], 8]. The detection of hard shadows is complicated as they may be flawed as dark objects rather than shadows [9]. Also it is difficult to distinguish dark objects and shadows from a single image. As shadows are time dependant and possess seasonal characteristics, variation of shadow casting condition alters the image [12]. Thus to recognize shadows and to eliminate them always remain a pre-requisite task.

This paper explains the work carried for detecting and removing shadows. This paper has been organized into five sections, described as: Section I defining the basic introduction, Section II includes basics of feature extraction technique. Feature extraction technique is followed by Section III containing proposed methodology. This section explains different steps that are executed to get the end results. In sections IV & V, results and conclusions are drawn respectively.

II. Basics Of Feature Extraction

When the input to an algorithm is very large to be analyzed and it is redundant (e.g. repetitiveness of images presented as pixels), then it is transformed to limited features (portions or shapes of an image). This phenomenon is feature Extraction. The extracted features will contain significant information from the input and task is carried out.

As the color ratio between shadow and non-shadow and texture based methods did not worked well in previous studies [10], so illuminant-invariant features, illumination direction features and neighboring similarity features are considered. In illuminant-invariant feature, reflectance of road surface is its inherent property which can be utilized to differentiate a shadow edge patch from a non-shadow edge patch. Illumination direction feature deals with two dimensional Log chromaticity. Neighboring similarity features uses patches on both sides of an edge to distinguish shadow edges from non-shadow edges [13].

III. Proposed Methodology For Shadow Removal

In this paper a methodology is proposed for shadow removal which is based on Strong Edge Detection (SED) method. The algorithm for strong edge detection methodology has following steps:

1. All the edge candidates of an input image are generated.
2. In feature extraction & edge classifier stage, edges are extracted which were obtained in step 1 & shadow edges are then differentiated from non shadow edges.
3. In spatial smoothing stage, all the edges obtained in feature extraction & edge classifier stage are smoothened.
4. After that image showing only shadow edges which are shown in step 3 is obtained by removing all non shadow edges.
5. The Gaussian filter is used to further filter out the shadow edges.
6. The image obtained in step 5 is used to remove shadow.

Fig. 1 shows the flowchart of proposed methodology for shadow removal which is based on Strong Edge Detection (SED) method.

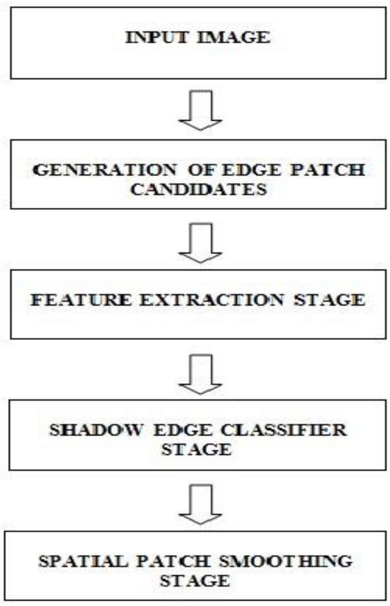

Fig. 1 Flowchart of proposed methodology for shadow removal which is based on Strong Edge Detection (SED) method.

IV. Results & Discussions

Seven sets of images are used to test the effectiveness of proposed SED method. It is also compared with Patch Based Shadow Edge Detection method [13]. For the proposed methodology based on SED, Entropy and standard deviation parameters are calculated. These parameters are also calculated for Patch Based Shadow Edge Detection method. The comparison between proposed SED method and Patch Based Shadow Edge Detection method shows that proposed methodology gives smaller entropy value & large standard deviation for better results. In table 1 comparison between the proposed SED method and Patch Based Shadow Edge Detection method is shown. In Patch based edge detection method, entropy value calculated for the first image is 7.4676 and standard deviation is 44.6146. But in proposed SED method entropy value is calculated for the first image is 6.5905 and standard deviation is 50.3112. This shows that in proposed SED method entropy is decreased by 0.8771 and standard deviation is increased by 5.6966.

Table 1: Comparison between the proposed SED and Patch based Edge detection for Entropy and standard deviation calculations.

	EARLIER METHOD (Patch Based Shadow Edge Detection)		PROPOSED METHOD (Strong Edge Detection)	
S.No	Entropy	Standard deviation	Entropy	Standard deviation
1	7.4676	44.6146	6.5905	50.3112
2	6.7198	26.4343	5.9737	48.2154
3	6.7497	26.6579	6.47	53.5977
4	6.4638	22.9975	5.5576	44.6919
5	6.7384	26.5529	6.1019	47.3817
6	6.7057	26.1991	6.5537	57.7581
7	7.1892	36.3658	6.6325	49.1597

Table 1. Performance Comparison

The Fig. 2 explains the proposed SED Method :

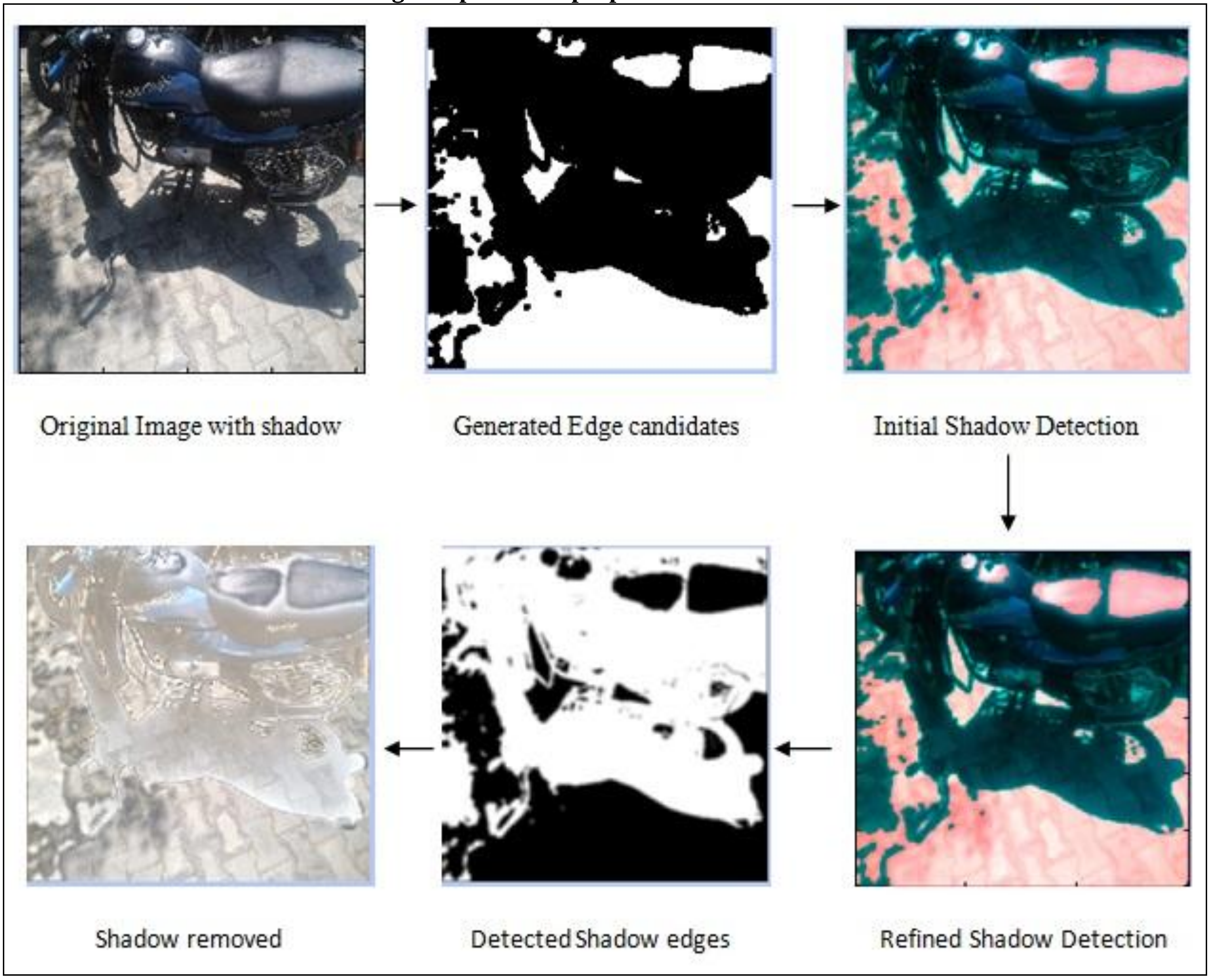

Fig. 2 Pictorial representation of proposed SED Method

V. Conclusions

On the basis of performance comparison table, the proposed SED method is obviously better than the Patch Based Shadow Detection method. Even though the difference between the images as obtained from both the algorithms could not be spotted with naked eyes, but the value of entropy and standard deviation of each of the images is obtained for Patch Based Shadow Detection method and proposed SED method. The proposed methodology gives smaller entropy value & large standard deviation for better results. For future work, the proposed algorithm can be tested with different variables (other than entropy and standard deviation). This can be used to clean shadowy images for better path detection.

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