Removal of Shadow from a Single Image

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ABSTRACT
A frame work for detecting the shadow and removal of the shadow from a single image in the real world pictures. Till now the work on detecting the shadows had more effort for design of hand-craft features. Shadows distroits the image in computer pictures. For instance, the decrease of performance of objects recognition and object scene analysis. This shadow inpainting technique does not perform well in the case of non-uniform shadows. In the cases of shadows in dark environments, this method does not perform well for detecting the shadow. To address these issues the frame work consists of learning the features which are relevant. The Baysian formulates so that the shadow inpainting is done efficiently. The method formulates so efficiently that the shadow detection process in shadowed part is detected and the shadowed region is obtained. The proposed method improves the image quality on curved surfaces and visual quality of photographs and real world images.

Keywords
Bayesian shadow Inpainting, Conditional Random Field, Convolutional Neural Networks, Shadow Inpainting.

1. INTRODUCTION
In computer graphics applications there are lots of algorithms for image inpainting we are going to focus on shadow inpainting. Shadows occur often in digital image ,and their detection and simulation are important in many computer applications and in computer graphics. Shadows are used to get the object shape and size and to estimate the light source. Shadows cause disturbance in computer application tasks. Shadows disturb the digital image features such as image segmentation or image reconstruction and environment analysis. In digital image, detection and shadow inpainting can help in improving the quality of the digital image. By this system the shadows are detected and then inpainted by the surrounding pixels. The convolutional neural networks learn the features that are relevant to the shadow and the features that are relevant to the boundary of the shadow region. The system detects the shadow and the non-shadow region and then the shadow region is inpainted by the pixel intensities of the surrounding pixels [1].

The shadow detection method consists of information of the shadow part and also the information of the boundary of shadowed part. As the features of the shadow part and the boundary of that part are different so the detection of shadow is separated on to two different portions. Different convolutional network layers work on different features extracted from the image or around the boundaries of the shadow part. The predictions by convolutional networks are not efficient so for this reason they are interacted with the surrounding pixels around them. Due to this reason conditional random field is involved so that assigns the labels to the graph on an image.

By the mask of the detected shadow the shadow part and the no-shadow part are considered and then the inpainting of the shadow part is completed.

A general shadow creation module is introduced for creating of the shadow and shadow free part. The shadow inpainting method or process gives a smooth surface on the shadow part that can be used for the different computer applications

2. LITERATURE SURVEY
This Section explains the methods studies of all existing systems are included which were used pre-viously. By studying this, it gives all information, advantages, disadvantages and limitations of the existing systems.

Shadow Detection: A famous method known to detect the shadow was the variant and invariant cue which used the static and dynamic characteristics of the shadow in an image. The features which are extracted were focused on the color chrome, texture and on the light source. Across time some works were focused on the color difference around the boundary of the shadow and the ratio of the color difference of the shadow part and around the boundary and across the boundary. These features and assumptions were useful but it was not true in all cases. For example the variant and invariant cues assume that the color intensity is different across the boundary of the shadow part and the features of texture are consistent in an image. But the approach fails when the shadow is in the dark region. And also the approach required the human effort for extraction of the features from an image and to detect the shadow. [1]

For detecting the shadows different assumptions were made which consists of the intensity of the color around the pixels and the textures intensity of the shadow part and the shadow free part.

Salvador et al. [2] consists on object shadows. In computer applications shadows interfere with the recognition of the object. Due to this issue the shadow segmentation is method is introduced in this paper. The segmentation algorithm introduced is used for the static and dynamic images. Their technique gives the physical properties to perform the task. The initial hypotheses are formulated on the fact that the shadow part is somewhat dark compared to the shadow free part. In final information it selects or does not select the region.

Joshi et al [3] in this paper they explore the technique of pixel information. It performs classification on the basis of the color intensity segmented regions. By the use of graph cut method the shadow region results are derived. The result of detection of the shadow is made by highlighting the pixels of shadow free part. A shadow free image dataset is used to compare the images which are inpainted and the image which are shadow free for verifying the result.

Vazquez et al [7] this technique can detect both the casted and self-shadow. The method exploits local color consistency properties which are cause of reflectance in excess of shadowed regions. They use all three type of colour space in their work. Illumination edges are used to correlate local and global and low and high band of frequency. The light and colors features are given input to the adaboost to detect shadows edges. The simulation results give us an idea about the performance of the method is good with boundary marking on shadow and non shadow region with high accuracy.

Shadow Removal and Matting : In time span many shadow removal techniques were implemented using information based. A famous method was to detect the shadow manually with intrinsic properties of an image. The result of this method was used to reduce the parameters of shadow removal.

Finlayson et al. [5] it address the issue of edges of the shadow part. It adds the integrating factor so as to scale the image. The integration requires the solution of 2D with the 1D Poisson distribution. The technique used was based on region based which was different from the pixel or information based. It considers individual regions separately and classification is done pair wise on the basis of intensity illumination of the regions. The classification results are used to make a graph of the regions which are segmented and the labels are given by the graph cut method. The results are then evaluated using shadow removal method and the shadow less image is obtained.

Hamiltonian path [4] proposed for shadow removal although the gradient methods does not consider for the shadow variations in the shadow regions. Simultaneously the technique of bilateral filtering was used for detection of the shadow region and boundary of the shadow region. But these techniques were time consuming and also the feature selection or parameters selection was to be done carefully so as to avoid more computation. Due to these issues new methods were introduce to so as the color statistics can be transferred from the shadow lees region to the shadow region.

Many assumptions were made due to the less efficient of shadow detection and removal techniques were not reliable. The camera parameters were required and in many techniques the intrinsic parameters were extracted by sequence of images.

3. IMPLEMENTATION DETAILS

The proposed system has several advantages over existing one:

1) Proposed system is better enough to detect shadows on plain as well as on curved surfaces in digital images.
2) Proposed method can detect well the edges of the shadowed part or region by canny edge detection algorithm
3) Matting of shadowed region along with the boundaries of the shadow with different surroundings is the key part of removal of shadow.[17]

3.1 Shadow Detection

Canny Edge Detection

The aim of JFC was to develop an algorithm that is optimal with regards to the following criteria :

1. Detection: The probability of detecting real edge points should be maximized while the probability of falsely detecting non-edge points should be minimized. This corresponds to maximizing the signal-to-noise ratio.
2. Localization: The detected edges should be as close as possible to the real edges.
3. Number of responses: One real edge should not result in more than one detected edge

The Canny Edge Detection Algorithm

The algorithm runs in 5 separate 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. The gradient magnitudes (also known as the edge strengths) can then be determined as an Euclidean distance measure by applying the law of Pythagoras

$$\left| G \right| = \sqrt{G_x^2 + G_y^2}$$

3. Non-maximum suppression: Only local maxima should be marked as edges.
4. Double thresholding: Potential edges are determined by thresholding.The edge-pixels remaining after the non-maximum suppression step are (still) marked with their strength pixel-by-pixel. Many of these will probably be true edges in the image, but some may be caused by noise or color variations for instance due to rough surfaces. The simplest way to discern between these would be to use a threshold, so that only edges stronger that a certain value would be preserved
5. Edge tracking by hysteresis: Final edges are determined by suppressing all edges that are not connected to a very certain (strong) edge.[17]

Implementation of Canny Edge Detection

1. The (source) image and the thresholds can be chosen arbitrarily.
2. Only a smoothing filter with a standard deviation of = 1.4 is supported.
3. The implementation uses the “correct” Euclidean measure for the edge strengths.
4. The different filters cannot be applied to edge pixels. This causes the output image to be 8 pixels smaller in each direction.

Convnets:

Convolutional neural network works on pixel level to detect the shadow in an image. There are layers which learns the different features of the shadow part of an image. After the training of the layers the output is in RGB form given as an input to give a distribution against binary class. Only the desired points are extracted as convolutional neural networks only works on equi-sized windows. The architecture of the convolutional neural network consists of convolutions and sub sampling process alternatively . The convolutional layers consists of filters which are used to convolute the input image feature map. The sub sampling layers are used to derive the variant and invariant presentations. The convolutional networks which are been trained on the boundary of the shadow region learns to differentiate the patches of the shadow regions or part and the boundary of the shadow part. And the convolutional networks which are trained on the shadow part are able to separate the shadow part and the shadow free part in an image.

While the training process, the features are learnt automatically in a supervised discipline. The loss function is minimum used the back tracking function. The unexpected samples are used for fast learning as the neural network learns rapidly.

3.2 Shadow Removal

The regions of the shadow and the regions of the non shadow are to be detected. The boundary or the edge of the shadow is also needed to be detected so as to inpaint the region properly. The detection of shadow part and the boundary of shadowed part helps in simplifying the errors. The works which was done before need to process manually through human interaction. The proposed system simply works to produce the shadow and the boundary of the shadow part and non shadowed part. The object shadow boundary is not visible in the dark regions or in dark environment. The inpainting of the shadow boundary is done efficiently until the boundary of shadow of the object is as large as the total shadow boundary.

The boundary of the shadow region is estimated by drawing the curves and normal direction along the boundary of the shadowed part. This process is more reliable compared to other normals which are local and give some error on the output. The boundaries along the normal direction are estimated and the regions are specified on the basis of intensity change. The result of this gives the boundary of the shadowed part. Then this part is removed by the use of mask of shadow and the other region is then the shadow region. Then the part or region which is next to the shadow boundary with more intensity compared to the boundary of the shadow is recognized as the shadow less or shadow free region.

Accordingly the boundary of the object shadow is dark as compared to normal shadow region. The difference in the intensities can be observed normally. The boundary points cluster is made by observing the normals. This results in segments of separate boundary which form the boundary line around the shadow.

Shadow region is inpainted by using the neighbor pixel intensity. The shadowed region is removed or inpainted by the surrounding pixels

3.3 Process Block Diagram

First the image should contain the shadow in it. Then the shadowed image is converted into gray scale and after that the process starts of bilateral filtering in which the noise reduction and smoothing of digital image is done. After bilateral filtering the process of shadow region and shadow boundary is detected by the use of canny edge algorithm. The shadow is detected and its boundary.

Second, now the part of shadow matting or removal of shadow is done by matching the pixels of the surroundings around the shadow part. The shadow part is inpainted by the surrounding pixels in the image. If shadow part consists of different environments or surroundings then also it is inpainted.

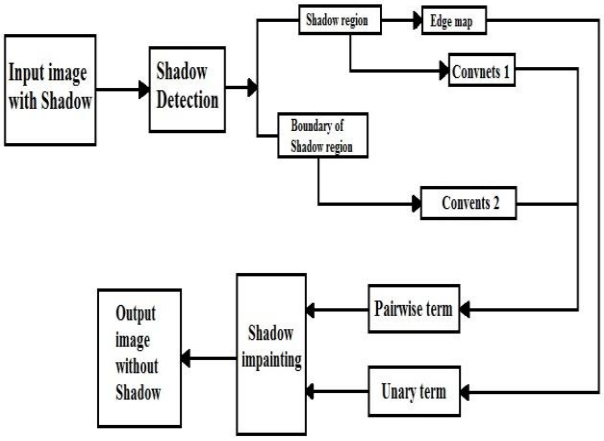

Fig. 1: Block Diagram of the proposed system

4. RESULTS AND DISCUSSION

The results are that the shadow will be detected on the curved or non uniform surfaces. The main part is the detection of shadow on curved surfaces. As the shadow is detected it is removed by inpainting. The shadowed region on the curved surface will be removed and the shadow free image will be obtained.

Fig 2 Input Image from UCF Dataset

Fig 3. Shadow detection of the input image

Fig 4. Shadow mask of input image

Fig 5. Shadow free image of input Image

The proposed infrastructure of the shadow detection and removal consists of detection and inpainting techniques in which for shadow detection canny edge algorithm is used for detection of boundary of shadow part and for inpainting of the shadowed part the pixels are matched with the surrounding pixels.

A) Input Image: The proposed methodology is tried for both shadow and non shadow picture datasets. The input image is taken from UCF dataset shown in figure 4.

B) Shadow Detection: The detection of the shadow is done with the use of canny edge detection algorithm in which the edges of the shadowed part is detected and shown. The algorithm detects shadow on plain as well as on curved surfaces. The edges of the shadow are perfectly detected by this algorithm.

C) Shadow Inpainting: In this step the shadow mask shows the shadowed part or shadow region and then the shadow part or region is inpainted by the surrounding pixels. The value of pixel is calculated of the shadow part and then the pixel value of each pixel in shadowed part or region is changed with the pixel value of the surrounding pixel or adjacent pixel to the shadow boundary. After inpainting of the shadowed part the shadow free image is obtained.

4.1 Performance Metrics

Accuracy is measured in terms of pixel wise.

All performances are reported in terms of pixel-wise accuracies.

UCF Dataset	CMU Dataset	UIUC Dataset
78	88.79	93.16
78.6	89.9	93.5

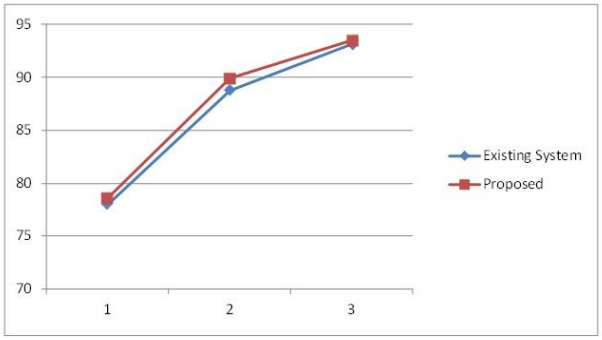

Table 1.Comparision Table

4.2 Mathematical Model

Consider a set S

S = {e, i, f, c, s, E}

e - End state

i - Input image

f - Features learned

c - Convolutional results

s - Result

Consider a set of algorithms used A

A = {r, c, b}

r - Conditional random field

c - canny edge algorithm

b - Baysian shadow removal

E = End User

5. CONCLUSION

A approach that is data driven which learns the relevant features for the detection of shadows from a single image. In the proposed shadow removal system the shadow matte is extracted within the image. A Bayesian formulation consists of the basis of shadow removal process and makes use of an improved shadow generation model. Shadow detection uses the combination of boundary and region convolutional neural network with the CRF model. For shadow removal, the multi-level color transfer followed by the Bayesian refinement is used. The proposed framework has a number of applications including image editing and image enhancement tasks.

5.1 Future Work

In future one can forward this research by detecting the shadow in dark regions and to remove the shadows from the dark digital images. Work on different inpainting regions can also be done in this research area.

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