International Journal on Future Revolution in Computer Science & Communication Engineering ISSN: 2454-4248
Volume: 4 Issue: 4 732 – 737

Shadow Detection and Removal using Artificial Neural Network

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Abstract-- Shadow detection and removal is an important task when dealing with colour images. Shadows are generated by a local and relative absence of light or a shadow appears on an area when the light from a source cannot reach the area due to obstruction by an object. Shadows are, first of all, a local decrease in the amount of light that reaches a surface. Secondly, they are a local change in the amount of light rejected by a surface toward the observer. However, they cause problems in computer vision applications, such as segmentation, object detection and object counting. Thus shadow detection and removal is a preprocessing task in computer vision. This thesis work proposes a simple method to detect and remove shadow from a single RGB image using artificial neural network. A shadow detection method is selected based on the phenomena of back propagation algorithm. Back propagation artificial neural network classifier has been used to train and test the neural network based on the extracted feature. The shadow removal is done by multiplying the shadow region by a constant.

Keyword--*Shadow detection; shadow removal; back propagation; artificial neural network.*

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I. INTRODUCTION

Image processing has been one area of research that attracts the interest of wide variety of researchers. Image processing; basically deals with processing of images, pictures, video etc. Image processing is any form of signal processing for which the input is an image, such as a photograph or video frame the output of image processing may be either an image or, a set of characteristics or parameters related to the image. Image processing deals with various aspects like image zooming, image segmentation, image enhancement etc.

Image processing helps advances in various real life fields such as, optical imaging (cameras, microscopes) and, medical (CT, MRI, Ultrasound, diffuse, optical, advanced, microscopes), Astronomical imaging (telescopes), video and imaging compression and transmission (JPEG, MPEG, HDTV, etc.), computer vision (robots, license plate reader, tracking, human, motion), commercial software's (Photoshop) and many more[1]. Nowadays, surveillance systems are in huge demand, mainly for their applications in public areas, such as airports, stations, subways, entrance to buildings and mass events.

Shadows and shadings in images occur when objects occlude light from a light source and they appear as surface features. Shadow detection is an important aspect of most object detection and tracking algorithms. Shadow points are easily misclassified as foreground since they typically differ significantly from the background. Shadow detection and removal over the past decades covers many specific applications such as traffic surveillance, face recognition and image segmentation. Image shadow detection has been a field of research for several decades. Most researches focus on providing a technique for arbitrary scene images and obtaining "visually pleasing" shadows free images.

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. [2]Shadows can be divided into two types: cast and self shadow which is shown in Figure 1.

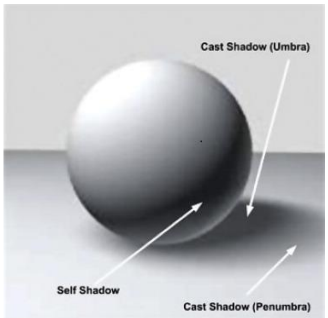

Figure 1. Different types of shadow

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 iscompletely blocked by its object is called umbra, while the part where direct light is partially blocked is called penumbra.
Based on the intensity, the shadows are of two types − hard and soft shadows. The soft shadows retain the texture of the background surface, whereas the hard shadows are too dark and have little texture. Thus the detection of hard shadows is complicated as they may be mistaken as dark objects rather than shadows. Though most of the shadow detection methods need multiple images for camera calibration, the best technique must be able to extract shadows from a single image[3].

Most of the shadow detection methods need multiple images for camera calibration. But the best technique must be able to

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extract shadows from a single image. Also it is difficult to distinguish dark objects and shadows from a single image. This paper provides a simple method to detect and remove shadow from a single RGB image. As the aim is to identify a particular region in a digital image so, it is a problem of segmentation under digital image processing. A shadow detection method is selected based on the training of the Artificial Neural Network of the RGB image. The shadow removal is done by multiplying the shadow region with a constant.

This project consists of

1. Design a SDR system for detection of shadows in images.
2. Shadow is extracted from an image.
3. Shadow-free image is displayed.

II. RELATED WORK

A brief literature review is needed in order to understand work done by various scholars in this field.
In 2013, Ashraful Huq Suny et.al [4] projected a straightforward technique to distinguish and eliminate shadows from a single RGB image. This shadow recognition technique is elected on the basis of the mean value of RGB image in A and B planes of LAB equivalent of the image and shadow deduction technique is based on the recognition of the quantity of illumination impinging on a surface. In 2014, The algorithm generated by Hongya Zhang et.al [5] in which shadow features were taken into consideration during image segmentation, and according to the statistical features of the images, suspected shadows were extracted. In 2014, Kaushik Deb et.al [6] proposed a framework using the YCbCr color space to detect and remove shadow from images. After shadow recognition, a shadow density model is applied, according to this model the image is segmented into a variety of areas that have the comparable density.

A region-based approach to detect and remove the shadows from an image was proposed by Guo, Dai, and Hoiem [7]. The segmented regions in the image are classified based on relative illumination and using a graph cut, the labeling of the shadow and non-shadow regions is done. The lighting of shadow-pixels is done to recover a shadow-free image. The method “paired region technique”, relies on group soft shadow with non shadow region so unable to detect soft cast shadow. Region growing fails when the pixel intensity varied widely in the shadow regions.

In [8], Ms. Chithra K , Mr. Rahul Ramachandran, Ms. Aleena T .A. describe two methods namely, IOOPL and KMeans clustering. In first method, the Inner Outer Outline Profile lines or IOOPL are obtained by reducing the boundary of shadow inwards and afterwards expanding it outwards. The features of objects on both sides of the boundary are thus obtained. After comparing the inner and outer loop, the color is inserted again and shadow is removed and the output is the image without any shadows. While, in the K-MEANS clustering methodology the main parameter for identifying the data points into separate clusters is done by keeping certain distance between each data point. After clustering the data points, the points that show the shadow region and the mask are compared which
gives us the perfect shadow area. Compared to IOOPL method, clustering using K-MEANS method is better.

D. Usha Nandini, Dr. Ezil Sam Leni, A. Mary Binu [9] proposed a method of combining intensity with TAM image. Shadow detection based on TAM information and the accuracy of shadow is improved by intensity information. By combining TAM and intensity, it is improving quality of results. It avoids segmentation and requires one threshold. TAM used to detect shadows that describes attenuation relationship between shadow and non-shadow regions. It requires rough segmentation and four thresholds. It fails to give accurate results in complex scenes. All simple and complex shadow in outdoor images is detected and comparisons validated its effectiveness.

Xiaoyan Xu and Xiaoming Liu [10] proposed a novel and fast shadow detection method based on the Tricolor Attenuation Model. Analyze the spectral property of outdoor light sources to estimate the parameters of TAM. Then method is proposed by integrate the TAM feature and intensity information. Method can extract shadows in only a single and uncelebrated image that takes advantage of the spectral property. Use only a single color image when detect the shadow in it without needing any prior knowledge.

Prajkta Khaire and Manoj Sabnis, [11] proposed two techniques to detect the shadows of outdoor images. Outdoor images which have a constant background but the lighting conditions are variable are used. In first technique, global thresholding. Measure the ratio map by using the H and V values of HSV. Afterwards, global image threshold is obtained from Otsu's method and binary image from ratio map is obtained. Gradient map is found using the Sobel operator and V of HSV is obtained. Thus, the shadow area is obtained from the gradient map drawn using Global Image Threshold. In second technique, HSV image gets converted to RGB’s color image. Ratio map R is constructed. Afterwards, threshold is calculated using the Otsu Method. Then threshold is performed on image to get the resultant binary image. Region Labeling to eliminate any smaller regions to obtain the local threshold from Otsu’s method and local threshold is used to get shadow area of the image.

Priya Garg and Kirtika Goyal [12] proposed algorithm uses the chromaticity to detect and remove the shadow. Find the invariant direction, and so grayscale and hence an L1chromaticity intrinsic image that is shadow-free, without any need for a calibration step or special knowledge about an image.

In [13] G. Gayathri presented the method in which to get shadow detection result, image segmentation considering shadows is applied first. Then, suspected shadows are selected through spectral features and spatial information of objects, and false shadows are ruled out. For shadow removal, after the homogeneous sections have been obtained by IOOPL

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matching, relative radiation correction for the objects is performed in order to remove the shadows.

III. SHADOW DETECTION AND REMOVAL TECHNIQUES

Shadow detection and removal has a major role in deducting the changes that happens in the remote sensing images. Which is applicable to identify the natural disasters like landslides, earthquakes etc. To determine whether a particular area is a shadow, we can compare with the nearby regions of image that are likely to be of the same material. There are several techniques followed to achieve the shadow detection which has drawbacks and even now seems to be a tough area to handle the detection methods.

Detecting and removal method [14], begins with a segmentation of the color image. It is then decided if a segment is a shadow by examination of its neighboring segments. They use the method introduced in Finlayson to remove the shadows by zeroing the shadow's borders in an edge representation of the image, and then re-integrating the edge using the method introduced by Weiss. This is done for all of the color channels thus leaving a shadow-free color image. The present method requires neither a calibrated camera nor multiple images.

They use Removing Shadows from Images method [15], set out in to derive a 1-d illumination invariant Shadow-free image. They then use this invariant image together with the original image to locate shadow edges. By setting these shadow edges to zero in an edge representation of the original image, and by subsequently re-integrating this edge representation by a method paralleling lightness recovery, They are able to arrive at our sought after full color, shadow free image.

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 [16]. 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 [16].

A relative study on the shadow detection methods, 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 [17].

One of the method of shadow detection is Adaboost classifiers in a co-training framework [18] labeled data sets are taken with weak classifiers and converted into strong classifiers. White area indicate foreground and gray pixel signifies shadow, 320*240 pixel image is taken, black region means background, accuracy comparison is calculated by finding shadow detection rate and shadow discrimination accuracy.

In the detection process shadow and non shadow regions are separate by SVM classifier [19]. 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) [19].

IV. PROPOSED WORK

In this proposed work a new approach is defined to detect and remove shadow from images. The consequences of the planned algorithm are far better than the earlier techniques. In this algorithm approach adapted to perform the shadow detection and removal is explained.

Artificial neural networks (ANN)[21,22,23,24] are considered a powerful tool for solving complex engineering problems like pattern classification, clustering/categorization, prediction/forecasting etc. They are in general classified into two categories namely feed-forward networks and recurrent (or feedback) networks. The ANN inputs are derived using several image processing techniques, the desired output is thought to be a clear distinction between different patterns. We have chosen a feed-forward neural network which is one of the most frequently implemented network types. The network construction comprises an iterative back-propagation training method.

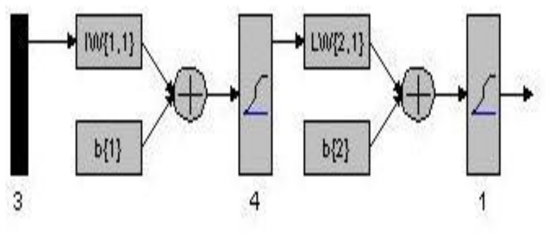

Figure 2 The structure of the applied network

The network has three neuron layers with equally logistic sigmoid processing elements. This neural transfer function has a simple derivative, which is a very valuable feature, since it is allows very fast training. The parameters of the network, which are to be defined during the training, are the weight matrices IW and LW and bias vectors b for all two layers.

A. Shadow Detection

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Based on the training of the RGB image using neural network tool, shadow detection method is selected.

Shadow Detection Algorithm

Step 1 : We present the image in RGB color space.
Step 2 : Then we take the data set from the RGB image for neural network training.For training, we take trainscg as the training function and logsig as the transfer function.
Step 3 : After training we take the whole image for simulation.
Step 4 : Store simulation result in an array of size 1 * (row * col).
Step 5 : The array of size 1 * (row * col) obtained in step 4 is converted to a 2-D frame of size row * col.
Step 6 : The original image is multiplied with the frame to give the shadow detected image.
Step 7 : Then the image is converted into grayscale image and filter is applied.

B. Shadow Removal

The shadow removal technique is done by multiplying the shadow regions by a constant and finally the shadow edge is corrected by using filters.

Shadow Removal Algorithm

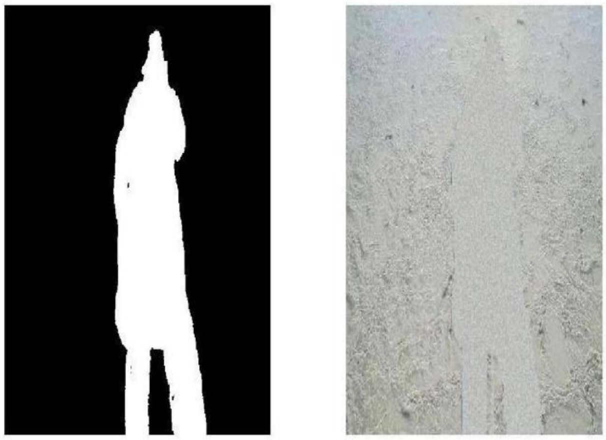
Input: Original Image with shadow and the o/p of neural network.
Output: Image without shadow.
Step 1: Convert the images from rgb to ycbcr color model.
Step 2: Find the difference between original image and neural network trained image.
Step 3: Compute the average of shadow and non shadow pixels.
Step 4: For each pixel of neural network trained image approximate the value of the corresponding pixel of original image.
Step 5: Filter the resulting image in case of visible boundary.

V. SIMULATION AND RESULT ANALYSIS

The shadow detection and removal module was implemented in MATLAB R14 Version 7.0. Here aim is to illustrate the system working, and test the proposed system on some real life images consisting of shadows.

System Working:
Initially an image is presented to the system (Figure 3 (a)) . User interacts with the figure to point out the shadow and non-shadow regions required to train ANN. First of all, training of system is done by using different data set or sample. And then system is tested for few of the given sample. The data set was partitioned into two parts. The first part is used for training the system and the second was for simulation purpose. For each data set, the proposed feature were computed and stored for training the network to classify. After completion of training shadow is detected (Figure 3 (b) & Figure 3 (c)). Shadow-free image is shown in figure 3 (d). Results on other image are shown in figure 5. The NN training graphs of different images are shown in figure 4,6.

(a) Original image (b) NN trained image



(c) Shadow detected image (d) Shadow-free image
Figure 3

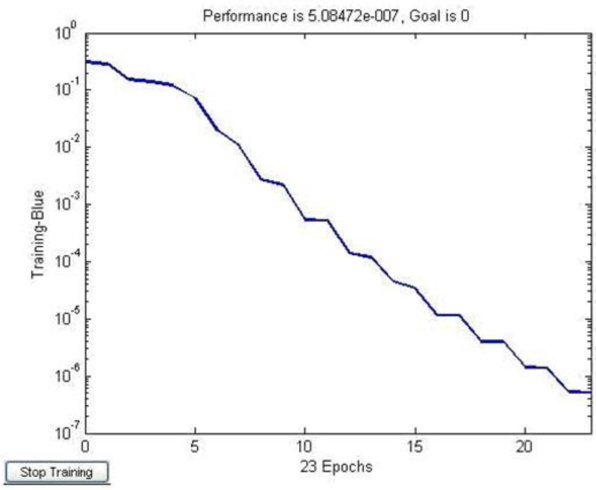


Figure 4 NN training graph of image(in figure 3)

International Journal on Future Revolution in Computer Science & Communication Engineering
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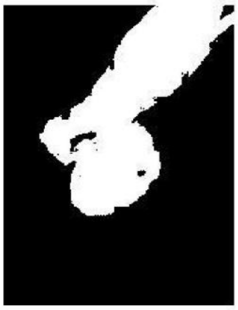
(a) Original image (b) NN trained image




(c) Shadow detected image (d) Shadow-free image
Figure 5

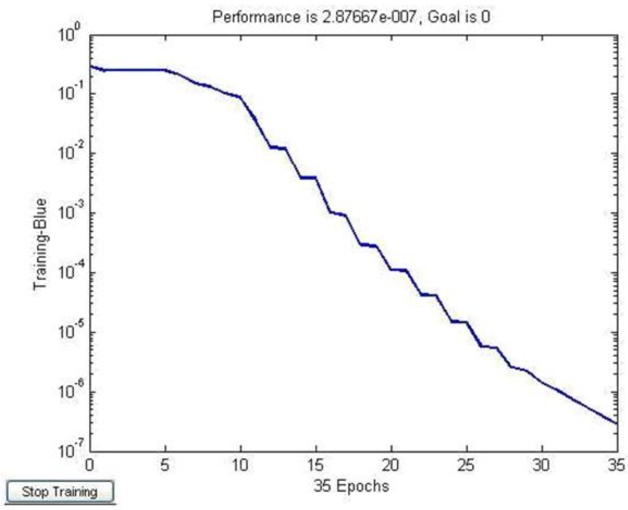


Figure 6 NN training graph of image(in figure 5)

VI. CONCLUSIONS

An interactive tool to detect and remove shadows from a single RGB image is proposed. A shadow detection method is selected on the basis of training the Artificial Neural Network. ANN training is a powerful tool and is found suitable in shadow detection.The shadow removal is done by taking the difference between the ycbcr image of the original image and the Neural Network trained image. The Neural Network approach has better performance in comparison to other approaches. The approach is dependent on the training set selected.

VII. FUTURE WORK

A challenging future work in this field can be the situations when we have two light sources and getting two shadows for single objects. Generally these situations happen when we walk on the street in night and we get our two shadows because of continuous street lights standing from starting point to end point.

In future this method may be extended for unsupervised mode of operation.

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