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Detection of Splicing in Digital Images Based on Illuminant Features

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ABSTRACT: Nowadays digital images are widely used in our day to day life. Image forgery is the process of manipulation of an image to hide some meaningful information of the image. Today digital image forgery become easy due to the availiability of powerful computers, advanced photo editing softwares so that even ordinary users have more access to the digital doctoring tools than even before. The driving forces for the detection of forgered images are the need of authenticity and to maintain the integrity of the image. In this paper an automatic machine learning method for detecting the forgery due to image composition or splicing is considered. Here GLCM features and edge based features are extracted from the illuminant map of an image and 'then provide to a machine learning approach for obtaining the result. Here we use kNN classifier for classifying the image as whether it is original or forgered.

KEYWORDS: Edge detection, GLCM features, illuminant estimator, image splicing detection, kNN classifier, machine learning

1 INTRODUCTION

Today digital images are everywhere from our mobile phones to the online sites. This means a huge amount of visual information is available to the users everyday. With the availiability of low cost digital cameras, high speed internet facilities as well as powerful image editing softwares it is very easy to tamper the images without having a brilliant knowledge. It will badly affect the authenticity of the image. Therefore Digital Image Forensics is an emerging research area that aims at authenticating the images and to detect various image forgery possibilities.

Before thinking about the actions that is to be performed in an questionable image, one must be able to detect whether the image is manipulated or not [1].There are various techniques available for tampering decision.

There are various image manipulation techniques such as copy-move, splicing, retouching, steganography etc. Among these image composition or image splicing is the most common image manipulation technique. Image splicing is a technique in which two or more images are combined to create a false image. An example of image splicing is shown in figure 1.The manipulation performed in this figure is not a harmful one. But in certain cases this type of manipulation will create serious issues.

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Fig. 1. Example of a spliced image

The effective technique for splicing detection is illumination inconsistencies. There are various illuminant estimates to create an intermediate representation called illuminant map. It is hard to achieve proper adjustment of all the illuminant conditions. Create face pairs for each image and classify the illumination of each pair of faces as either consistent or inconsistent. If any of the face pair is classified as inconsistently illuminated, then tag the image as manipulated.

2 METHOD OVERVIEW

The method consist of five main components

- Dense Local Illuminant Estimation - The input image is segmented into regions of similar color. Estimate the illuminant color for each of the segment and recolor each of the segments with the estimated illuminant color. Then an intermediate representation called illuminant map.
- Face Extraction – Each of the faces in the input image is extracted. It can be done in automatic or semiautomatic method. Here semiautomatic face detection is used. Operator sets bounding boxes around each of the faces in the image under investigation and then crop bounding boxes out of each illuminant map.
- Estimation of Illuminant Features – For each face regions both texture based and edge based features are extracted. The texture features are computed using Gray Level Co-occurrence Matrix and edge features using HOGedge.
- Paired Feature Creation – Create all possible pair of faces in an image to check whether any one of the face pair is inconsistently illuminated. The joint feature vectors consisting of all possible face pairs is constructed.
- Classification – An automatic machine learning approach is used to classify the feature vectors. Here kNN classifier is used to classify each pair of faces as either consistently or inconsistently illuminated.

The block diagram representation of the method is shown in figure 2.

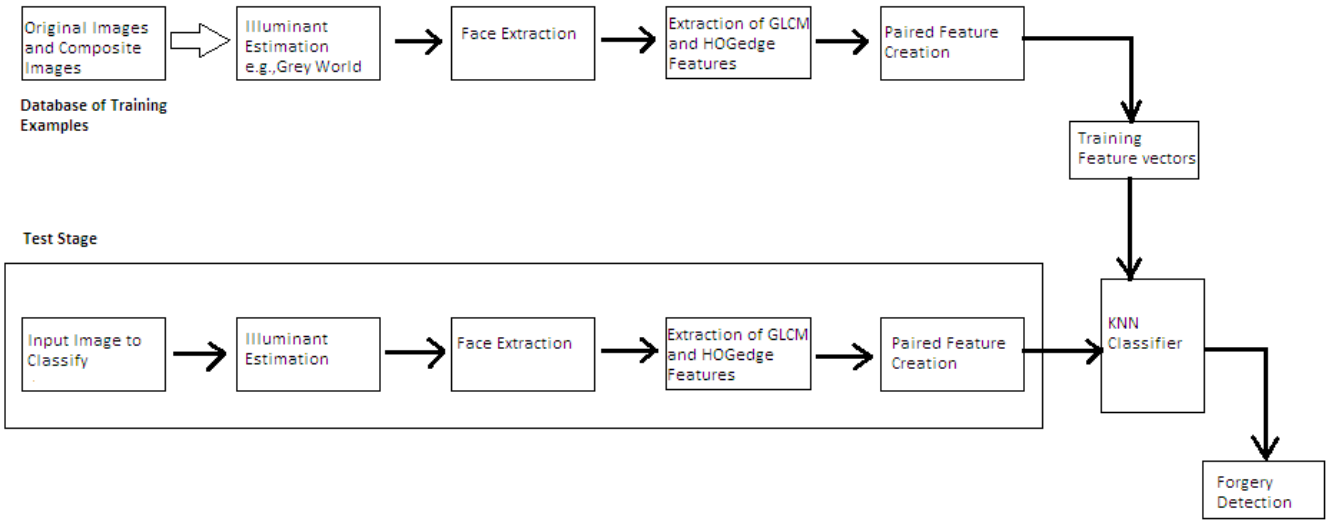

Fig. 2. Method Overview

3 METHOD DETAILS

3.1 DENSE LOCAL ILLUMINANT ESTIMATION

Dense local illuminant estimation is performed by subdividing the input image into superpixels [2].The illuminant color of each superpixel is estimated. Here we use generalized gray world illuminant estimator. In Gray world, the average color of scene is considered as gray. Any deviation from this assumption is due to the illuminant.

The color of the illuminant e is estimated as

$$ke^{n,p,\sigma} = \left(\int \left| \frac{\partial^n f^\sigma(x)}{\partial x^n} \right|^p dx \right)^{1/p}$$

Integration is performed over all the pixels in the image where x denote pixel co-ordinate, k is scaling factor, ð is differential operator, $f^\sigma(x)$ is the observed intensity at x and σ is the Gaussian kernel. Then recolor each of the superpixels with the estimated illuminant color.

3.2 FACE EXTRACTION

The illuminant color estimation is error prone and is affected by different materials in the scene. Local illuminant estimates are most discriminative when comparing objects of similar material. Therefore here consider the illuminant of each of the faces in the image [3].It can be performed either in automatic or semiautomatic method. Here semiautomatic face detection is used to avoid false detection of faces.

It is the only step where a human operator is required to draw bounding boxes around each of the faces in the image and crop the bounding boxes out of the illuminant map to obtain the illuminant estimates of only the face region.

3.3 EXTRACTION OF ILLUMINANT FEATURES

Feature extraction is a reduction process in which the input data is transformed into a reduced representation. This type of transformation of input data into a set of features is called feature extraction. Both texture based and edge based features are extracted from each of the faces in the image. Texture feature extraction is based on Grey Level Co-occurrence Matrix (GLCM) and edge information is provided by a new feature descriptor called HOGedge.

Extraction of texture information : The Grey Level Co-occurrence Matrix, GLCM also called Gray Tone Spatial Dependency Matrix gives information about the occurrence of different combinations of pixel brightness values in a gray scale image. That means GLCM calculates how a pixel with gray level value i occur horizontally, vertically or diagonally to a nearby pixel with value j [4].

Extraction of edge points : Edge points can be extracted using Canny Edge Detector [5].The statistics of these edges differ in original images and doctored images. These edge discontinuities are characterized by a feature descriptor called HOGedge.

At first extract equally distributed edge points and determine the HOG descriptor for each of the edge points. The computed HOG descriptors are summarized in a visual dictionary. The appearance and shape of objects in an image are determined from the distribution of edge directions. Firstly divide the image into small regions called cells and compute local 1-D histogram of each cell. The feature vectors are constructed by combining and contrast-normalizing the histogram of all cells within a spatially large region.

3.4 PAIRED FEATURE CREATION

In this step all the face pairs in the image are detected and feature vector of each of the face is concatenated with other face in the pair. The idea behind this is that feature concatenation from two faces is different when one face is original and the other is spliced. If an image contain n_f faces ($n_f \geq 2$), there are $(n_f(n_f-1))/2$ possible face pairs.

3.5 CLASSIFICATION

In this step illumination for each face pairs are classified as either consistent or inconsistent. If any of the face pair is illuminated inconsistently then tag the image as spliced one. Here classification is performed by k-Nearest Neighbor (kNN) classifier. The classification is machine learning based to improve the detection performance. The classifier stores all the training data and when a new data is given, the classifier look up its k nearest data points and label the new data to the set that contains majority of its k neighbours.

4 CONCLUSION

In this paper a new method for detecting the forgery in digital images using illuminant color estimator has been proposed. Here the illuminant color is estimated by the generalized gray world illuminant estimator. The texture informations are extracted using GLCM and edge point informations are obtained from HOGedge algorithm. Then classification of face pairs are performed using KNN classifier. This method requires only a minimal user interaction and provide a correct statement on the authenticity of the image.

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