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Exposing Forgeries and IPT Construction using Faces from Image

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Abstract - Images are powerful tool for communication, after images are posted on internet, other users can copy resize and re-encode them and then repost their version by generating similar but not identical copies due to availability of powerful digital image editing software. The main task is to find out original image between near duplicate image is difficult. It is difficult to adjust the illumination condition when Image composition or splicing operation performed on image to create composite image. Due to these illumination inconsistencies gives clue to detect forgery. But method that operate on illuminant color affected by material in the scene so further improvement can be achieved by advanced illuminant estimator as skin color of the faces automatically detected in the image. Machine learning approach is used for forgery detection and technique is applicable to images containing two or more people. Physics and statistical based illuminant estimators are applied on image. For all face region texture and gradient based feature are extracted and provided to machine learning approach for automated decision making. After classification of image whether it is forensic or normal, relationship within faces of image is shown by Image Phylogeny Tree (IPT) which is constructed by calculating paired distance feature of faces from image.

Keywords **- Color constancy, Forgery detection, Illuminant color, Image composition or splicing , Image Phylogeny Tree**.

1. Introduction

Past few years have seen a considerable rise in the availability and sophistication of digital imaging technology (cameras, scanners, software) and their use in manipulating digital images. **I**mages are posted on the Internet, other users can copy perform some transformation on them and then repost their versions. Images are distributed by different information channel such as newspaper, magazines, websites and television. Due to availability of powerful tool we can easily

Fig. 1 (a) Original image (b) Manipulate Image

manipulate image by using image processing techniques. Images which are posted generating similar copies but not identical ,due to which illegal content are spread over internet to identifying such duplicate images problem researchers give name as NDDR(Near Duplicate Detection and Recognition) . It has several applications such as

a) **Security and law-enforcement** (e.g., authentication of image by different version);
b) **Forensics** (e.g., find out original image from near duplicate image for analysis)
c) **Copyright enforcement** (e.g., tracing source of leaked file without watermarking or fingerprinting);
d) **News tracking services** (e.g., can form opinion in terms of time and space based on document relationships)
e) **Content-based retrieval systems** (e.g. without searching large database can show same photo with different photographers).

By considering the concept of biological evolutionary process with analogy we generate a tree named as Image Phylogeny Tree(IPT) to find out the history of transformation that generate this image to show the

relationship between near duplicate image but the main task is to find out original image between near duplicate image . Image composition (or splicing) is one of the most common image manipulation operations. Consider example in fig. 1 in which image published in Egyptian newspaper. Egyptian minister leads the peace talk but in reality Barak Obama leads the peace talk. Authenticity of an image is investigated by forensic investigator by using all the available sources of tampering evidence. It is difficult to adjust illuminant condition during creation of manipulated image, due to illuminant inconsistencies gives clue to detect image forgeries.

In this proposed method image contain faces are automatically detected .Illuminant Map is constructed by dividing the image into homogeneous region and each region is colored with extracted illuminant color .Features are computed based on texture and gradient based and form joint feature vector consisting of all possible pair of faces. An image as a forgery if at least one pair of faces in the image is classified as inconsistently illuminated but method that operated on illuminant color are prone to estimation error, it can be further improved by using advanced illuminant estimator as skin color information using a rough skin detector.

In Section II present related work regarding to find out the relationship between near duplicate image and also work regarding color constancy and illumination based approach to detect doctored image. Section III explains the problem definition followed by methodology which is used in section IV. Section V present proposed flow of work with result and discussion in section VI. Conclusion and future work is discussed in section VII.

2. Related Work

Forgery detection method based on illumination are either geometry based or color based .In geometry based ,more focus is on inconsistencies between light source position [1]-[7] between objects whereas in color based focus is on inconsistencies between light color and object color [8],[9].

Johnson and Farid [3] describe lightening based forensic technique for detection of forgery image. The main idea behind that it is difficult to adjust lightening condition, It is more appropriate in single lightning environment, but less in more complex lightning environment. Inconsistencies in the lighting model are then used as evidence of tampering. After that Kee and Farid [5] extended this approach for 3D lighting environment, with knowledge of 3-D surface normal, the direction to the light source can be estimated. In the case of faces, a dense grid of 3-D normal improves the estimate of the illumination direction. 3D surface normal cannot be determined from single image for that they considered 2-D surface normal at occluding boundaries. It remove all the ambiguities from in 2D lightening technique. Fan *et al.* [6] used shape-from-shading technique and for the description lightening environment 3D surface normal is used. Gholap and Bora [8] introduced method based on illumination color estimation cues to image forensics and proposed a method to find the forgery in digital images by exploiting color mismatches among the objects in the image. The notion behind these are various mismatches introduced in image during creation of composite image. Dichromatic reflectance model is used to show inconsistencies in specularities.

Specularity segmentation on real world images is challenging [11].Limitation is additionally specularities present on all region of interest in real world image to overcome this limitation Wu and Fang assumes [9] purely diffuse reflectance and use proper illuminant estimator. Due to splicing operation inconsistencies are introduce .Color inconsistencies which are introduced are use for forgery detection in which image is divide into block .Illuminant color is estimated from each block and difference between illuminant color is measured if greater than threshold then block is labeled as splice block. But limitation of this method is it requires manual selection of manual “reference block”.

The phenomenon of color constancy: how a visual system is able to ensure that the colors it perceives remain stable, regardless of the prevailing illumination, has received considerable attention in the context of both human and computer vision. A visual system might achieve color constancy by a variety of means and it is useful to classify approaches into color invariant, or illuminant estimation procedures. In illuminant estimation procedures, color constancy is achieved by first obtaining an estimate of the illuminant in a scene from the image data recorded for that scene. Once the scene illuminant is known, the recorded image data is corrected to discount the color of the scene light and thus render the image color constant. Color invariant approaches on the other hand, achieve constancy without explicitly estimating the scene.

Ebner [10] presented an approach to multi-illuminant Estimation but in practice oversmooths the illuminant boundaries. Gijsenij [11] presented methodology that enables color constancy under multiple light sources. The methodology is designed according to the following criteria:

1) It should be able to deal with scenes containing multiple light sources;
2) it should work on a single image;
3) No human intervention is required; and
4) no prior knowledge or restrictions on the spectral distributions of the light sources is required. Although the proposed framework is designed to handle multiple light.

Moritz, Hans and Erik [12] proposed a novel method to estimate illuminant color from skin color feature. Heng Yao et al.[13] propose an image forgery detection method using perspective constraints with minimal camera information. Constraint-based methods expose image forgery using some physical or geometric relationship inherently existing in the image.

Based on the notion of tolerated transformation Joly et al [14] proposes a definition what duplicate is, according to him if $I_1=T(I)$, $T \varepsilon T$, Where T is set of tolerated transformation , I is original image. If image goes under family of transformation such as $I_3=T_3oT_2oT_1$ (I) on original image I, we can construct a tree of all near duplications. If an image has I_1 and I_1 has direct duplicate I_2 then Image I_2 is in turn duplicate of I. There are two different approaches 1) Watermarking and Fingerprint based 2) content based.

Watermarking and fingerprint rely on embedding signature in original Image while content based rely on analysis of image in order to extract relevant feature. Kennedy et al.[15] proposed the problem of parent child relationship between pairs of image , their low level pixel content give significant clue about parent child relationship. De Rosa *et al.* [16] aim at exploring image relationships based on the conditional probability of dependency between two images. If there is dependency between two images I_A and I_B, one of the two images can be obtained by applying image processing function to other image .In this paper work is based on De Rosa et al. Approach to construct IPT.

In this paper, we build upon the ideas by [4][5] and [14],edge based color constancy information by Gijsenij [17]and estimate illuminant color from skin color by Moritz[12]to remove drawback in[13].

3. Problem Definition

In Existing Heng Yao et.al.[13] identify the forensic object in the photography. Our aim is to determine whether two objects in an image have proper relationship in size satisfying the perspective rules.Therefore, we only need to find the ratio of the objects' heights, rather than calculate their absolute heights, which are hard to get since the camera height is generally unavailable.

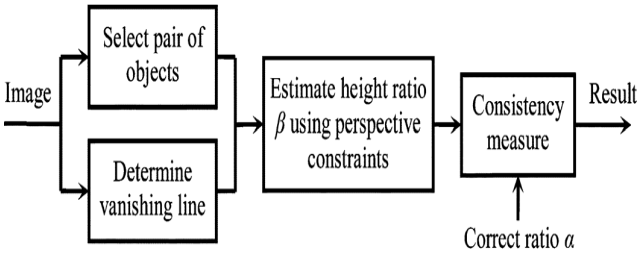

Fig. 2. Existing Method proposed in [13]

To remove drawback of existing method we compare objects in an image with illuminant feature. The input image is subdivided into homogeneous region of similar color .an illuminant color is locally estimated using pixel within each superpixel.Recoloring each superpixel with it's local illuminant color estimator gives an intermediate representation called Illuminant Map. It is difficult to argue based on illuminant map that given image is manipulated or normal because estimation of illuminant color is error prone and affected by material in the scene. Hence We need advanced illuminant color estimator as skin color particular to faces which provide reliable information to form scene illuminant estimator. The notion behind this is the light penetrates into the body of material where it is scattered and selectively absorbed that form the characteristic of material. The body reflection provides characteristic of object color. Skin composed of thin layer epidermis and dermis which is thick layer. Epidermis has the property of optical filter. In dermis light is absorbed and scattered [12]. Pigmentation is the most effective skin characteristics but it depends upon many factor. However the intra-material variation is smaller than estimation error occurring due to material in scene.

4. Methodology

4.1 SASI: Statistical Analysis of Structural Information

(SASI)[18] Algorithm for texture descriptor is used to extract texture information from IM. The main advantage of using SASI is its capability of capturing small granularities and discontinuities in texture pattern. Different illuminant color interacts with surface and generates different illuminant structure. It measures the structural properties of textures based on the autocorrelation of horizontal , vertical and diagonal pixel line over an image at different scale, computing mean and standard deviation of such pixel yields two feature

dimensional .Repeat this computation for different feature orientation, scale and shifts yields dimensional feature vector. In final step this feature vector are normalized by subtracted from mean value and dividing it by its standard deviation.

4.2 Interpretation of Illuminant Edges HOG edge Algorithm

Differing illuminant estimates in neighboring segments can lead to discontinuities in IM. Dissimilar illuminant estimates can occur for a number of reasons: changing geometry, changing material, noise, retouching or changes in the incident light. When an image is spliced the statics of image is different from original image Thus, one can interpret an illuminant estimate as a low-level descriptor of the underlying image statistic, to characterize such edge HOG edge algorithm is used. HOG. Main focus is on faces in an image HOG edge algorithm is apply on extracted faces in a n image .

Algorithm include following step.

1) Extraction of edge point: Edge points of face region which is extracted from illuminant map by using canny edge detector [19].Starting from seed point other edges are eliminate in region of interest around seed point and edge point which are close to the ROI are chosen as seed point for next iteration. By iterating process we can reduce number of points but ensure that every face has comparable density of points.

2) Point description: the distribution of selected edge point is described by computing Histograms of Oriented Gradient and HOG edge descriptor is constructed around each of edge point and neighborhood of edge point called a cell. Feature vector are constructed by combining the histogram of all cells and normalized.

3) Visual Vocabulary: Feature of fixed length are obtained by visual dictionary creation because HOG vectors extracted varies due to size and structure of face under examination.

4) Quantization of visual dictionary creation: for quantization HOG feature vector are mapped with visual dictionary. Feature vector is represented by closest word in dictionary with respect to Euclidean distance.

4.3 Image Phylogeny

Evolution of near duplicate images which are gone through transformation is described by an Image Phylogeny tree. That requires the prior knowledge of the set of near duplicates, and also a dissimilarity function d that computes small values for similar images, and large values for distinct images, those that have suffered more significant transformations.

Let T_β be the transformation from a family T then dissimilarity function between two images I_A and I_B is given as

$$d\, I_{A,}\, I_B = | I_B - T_\beta(I_A) | \quad (1)$$

In above equation distant is calculated by subtracting Image I_A from image I_B which we got performing some In above equation distant is calculated by subtracting Image I_A from image I_B which we got performing some Transformation on Image I_A , By making use fo that equation for calculating distance for detected faces in an image by comparing feature. There are two important factor while constructing image phylogeny tree from set of near duplicate image; dissimilarity function and tree building algorithm.

There are some possible image transformations an image can undergo to produce near duplicate of itself.

- Quality transformations (like blur, noise, re-encoding, and change of brightness or contrast).
- Postproduction transformations (like cropping, insertion of text or logos, picture in picture, and background replacement).
  Here we mainly focus on Post production transformation.

For the construction of image phylogeny tree modified oriented Kruskal's Minimum Spanning Tree algorithm is used .Input require for algorithm is dissimilarity matrix M with respect to n number of detected faces in an image .

Tree shows that detected faces with similar and non similar feature.The main task are to detect original image between n near duplicate image .Following section explain how to detect original image within n near duplicate image.

5. Proposed method

Method consist of seven component

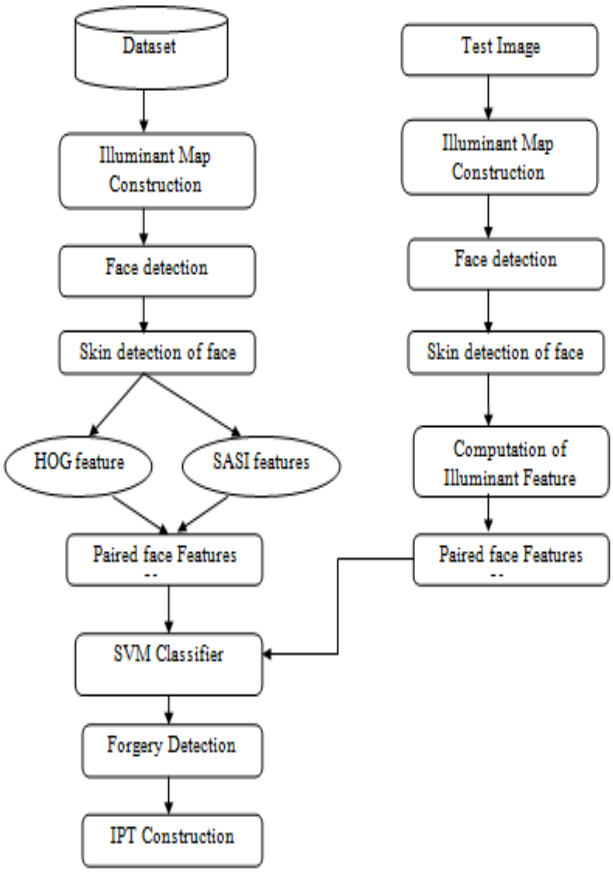

Fig. 3 Flow of Proposed work

5.1Illuminant Map Construction

The input image is segmented into homogeneous region and color of illuminant is estimate, each region is recolor with extraction of illuminant color and give Illuminant Map(IM),. Here two illuminant maps are obtained using separate color estimator as an extension of statistical generalized gray world by Weijer et al[20] and physics based inverse intensity chromaticity space proposed by Tan et al. [21].

5.2 Face Detection

Faces are extracted from an images represented by bounding boxes around all faces in an image .

5.3 Skin Detection

Illuminant color estimator prone to estimation error and affected by illuminant material in the scene. Hence we limit our detector to skin and in particular to faces . Hence We need advanced illuminant color estimator as skin color which provide reliable information to form scene illuminant estimator. This method is based on the assumption that skin colors form a sufficiently compact cluster in the color space in order to represent a valid clue for illuminant estimation. Skin of faces is extracted by using skin detector.

5.4 Computation of Illuminant Feature

Texture and gradient based feature are extracted from IM for all face region. Statistical Analysis of Structural Information (SASI) feature are calculated over Y channel from YC_bC_r color space.HOG edge also applied on Y channel from YC_bC_r color space on skin of extracted faces.

5.5 Paired Face Features

Same descriptor for each of two faces is compare because feature concatenation from two faces is different when one face is original and one is spliced.

If image contain n_f faces then number of face pair is(n_f (n_f -1))/2 .mainly the focus is on to assess whether pair of face in image is consistently illuminated. The SASI and Hogedge descriptors capture two different properties of the face regions. Joint feature vector are formed such as SASI with generalized gray world, SASI with IIC , Hogedge with generalized gray world, Hogedge with IIC.

5.6 Classification

Image classified as forgery if at least one pair is inconsistently illuminated**.** Machine learning approach is used to classify the feature vector .Individual feature vector SASI or Hogedge with gray world or IIC based illuminant map are classified using Support vector machine (SVM) classifier.

Fusion technique is used because The information provided by the SASI features is complementary to the information from the Hogedge features .Thus, machine learning-based fusion technique for improving the detection performance is used.

5.7 IPT Construction

Image phylogeny tree is constructed using segmented faces extracted from image.

6. Result and Discussion

6.1 Illuminant Map Construction

Input Image which is to be detected whether it is normal or forensic is select then apply illuminant estimator algorithm and apply illuminant conversion because Hogedge calculation and SASI descriptor perform on Y channel of YCbCr so we get an Illuminant Map as shown in figure 4.

Fig. 3 (a)Input image (b)Illuminant Map

6.2 Face Detection

Faces are extracted from an image

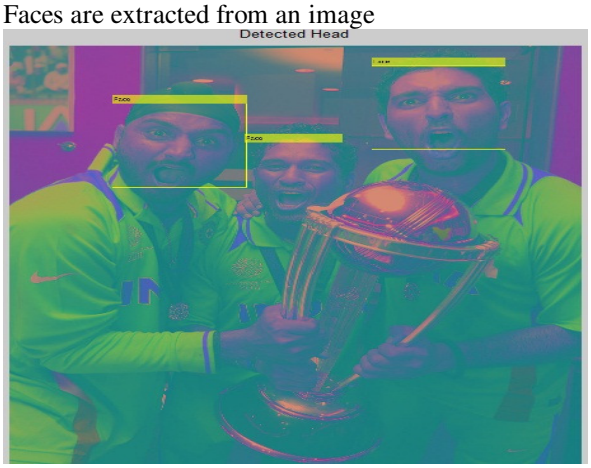

Fig. 5 Face Detection

6.3 Skin Detection

Skin color of each face is detected by using skin detector

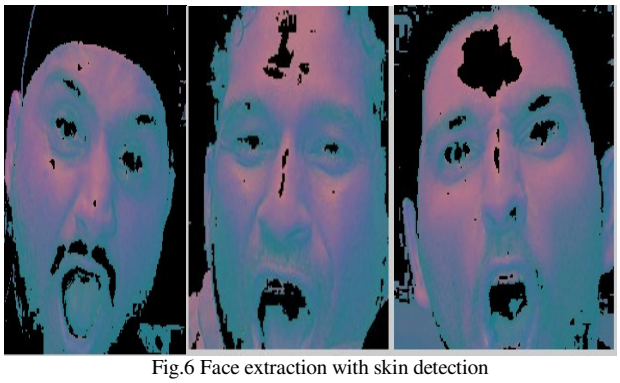

Fig.6 Face extraction with skin detection

6.4 Computation of Illuminant Feature

Texture based feature are extracted using SASI algorithm to check inconsistencies in texture pattern in accordance with contrast , scaling and periodicity. Gradient based feature are extracted using HOG algorithm, apply on each faces extracted from image.

Fig. 7(a)Face with skin detection (b) result of Canny edge detector

6.5 Paired Face Feature

Metafusion technique is used to form joint feature vector because features which are extracted using SASI and HOG are complementary to each other. Feature vector is given as input to SVM classifier.

12	13	14	15	16	17	18	19
0.3083	0.2876	0.2594	0.3494	0.3520	0.4647	0.2680	0.3191

Fig.8 Snapshot of Feature vector

5.6 Classification

Image is classified as forgery if at least one pair is inconsistently illuminated.

Fig. 9 Message box for normal image and Forensic Image

6.7 IPT Construction

Image Phylogeny tree is constructed using segmented faces from image according to their feature characteristic as shown in figure 9.

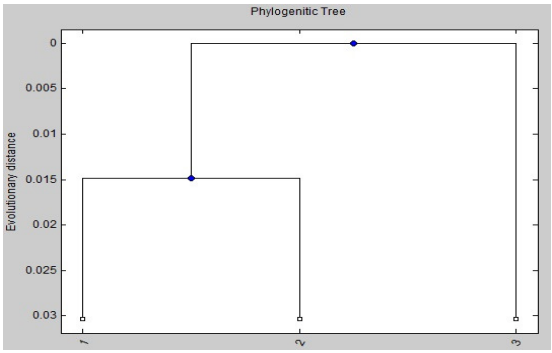

Fig. 10 IPT of input image with respect to faces

I have taken 104 no. of image as dataset which contain 52 original images and 52 composite image collected from internet. Here Sensitivity represents the no. of composite images are correctly classified and specificity represents number of original images correctly classified. After result analysis I have got accuracy of 76.9% images are correctly classified by Metafusion and nearly about 50% by individual SASI ,IM and HOG , IM.

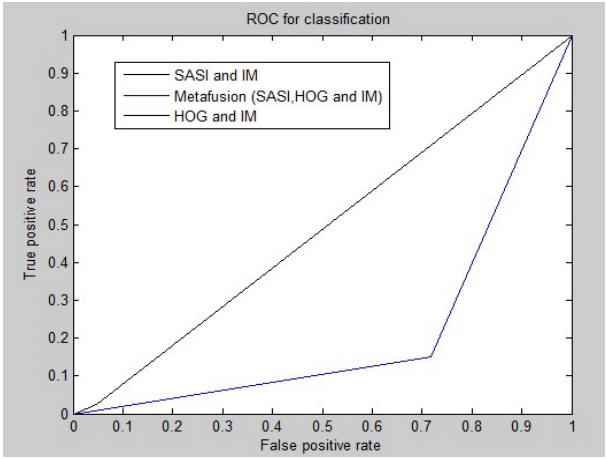

Fig. 11 Accuracy graph

From above graph we can clearly see that by using metafusion technique combine feature of SASI, HOG and IM give better result than SASI, IM and HOG, IM.

6. Conclusions and Future Work

In this paper , machine learning approach is used to exposed image as normal or manipulated .Illuminant color is estimated by using statistical generalized gray edge method and physics –based method as inverse intensity chromaticity color space , join feature are extracted based on texture and gradient from Illuminant Map for all face region . SASI and Hogedge algorithm are complementary to each other hence to form join feature vector late fusion technique named SVM – Meta fusion is used. We consider an image as a forgery if at least one pair of faces in the image is classified as inconsistently illuminated. Advanced illuminant estimator as skin color of faces is incorporated due to challenges in exploiting Illuminant Map and method that operate on illuminant color prone to estimation error, will yield good result. Here skin detection method is incorporated to detect forged image ,so that It will helpful to detect pornography composition.

Image phylogeny tree is constructed by using segmented faces extracted from image. My future work is to construct IPT to show the relationship between n near duplicate images which are created by performing set of transformation on image and post new version of image on internet .

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