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Medical Image Forgery Detection By A Novel Segmentation Method With KPCA

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Abstract

One of the most challenging tasks of recent days is detecting digital image forgery. Effective image processing tools are developed with excellent technology enhancement, making an easy and comfortable process for image forgery. Because of these systems' misusage, the verification of picture is too difficult. Therefore, image forgery detection uses different techniques according to the requirements of detection, efficiency, and type of forgery. This study proposes an efficient novel segmentation method with Kernel Principal Component Analysis (KPCA) for the detection of image forgery. The Normalized cut (NCut) segmentation technique is used initially to segment the forged image. Then, the KPCA method is used to extract the image's features. Finally, image authenticity is decided by comparison of clustering regions according to the threshold. In typical conditions of the image, as changes in brightness, shading diminishment, and limited rotation angles, the copied areas are detected accurately by using the described planned strategy. The performance of the proposed system is analyzed using different medical imaging modalities such as computed tomography, magnetic resonance imaging, x-ray and ultra-sonograms. From the comparative results, it is clear that better performance of image forgery detection is achieved by the described algorithm in terms of accuracy, precision, recall, and specificity than other algorithms.

Keywords

Medical image forgery, Image segmentation, Feature selection, Dimensionality reduction, Normalized cut

Imprint

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I. INTRODUCTION

In modern technologies, effective information is transferred through the images. High resolution digital images are taken from the advanced imaging devices such as smart phones, and those are exchanged among the people. The image is affected or manipulated by the different techniques which are too difficult to observe. The usage of digital images is increased widely in different applications so authenticity plays main role and there is requirement of digital images authenticity and integrity verification [1]. Because of the wide usage of digital images in many fields, there is an increment in forged images technologies. The properties of the images are changed, deleted or added in the images during the forgery without any intimation of it. Therefore, forgery detection of digital images is one of the most researched areas for researchers [2].

Digital image forgery is defined as the process of changing the original image in some particular aspects as resizing, rotation, deleting and adding some noise elements or some geometric transfigurations. Manipulated image authenticity and integrity are verified by using the two techniques of image forensic. These are active forensic method and passive forensic method. In active forensic method authentic information is inserted by using Watermarking [3] and steganography [4] into the image. When the image authenticity is required then recalls the information of prior embedded authentication in order to prove the required image authenticity. But, an image embedding authentication information is very confidential. This embedding information is identified in two conditions one is at the time of creating image and another one is with the help of authorized individuals.

Different mechanisms are using several approaches of image manipulations. Object-level changes in an image are done through the copy-move and splicing techniques, and these are the handling the important portion of the image [5]. By using different tools with the combination of Image retouching techniques, the features of the image are changed. For example, image contrast is enhanced by using the contrast enhancement and based on content of the image, holes in images are stretched through image in-painting. Image colors are changed by using the colorization technique. Then the specific part of the image is identified with some adjustments [6]. Another famous image forgery is cloning (copy/ paste) technique in which some objects or persons in the frame are covered. The cloned part identification in the image is really too difficult with human vision [7]. The cloned part is at any place of the image but, the examination of this image is impracticable. Sometimes an impressive image is designed efficiently by using resize, stretch or rotates the sections. For example, if an image is added to the original image, then there is a requirement of resize the added image according to the original image height, width and particular parameters.

Image modification another mode is splicing of two or more photographs into a frame [8]. The spliced region edges are not identified if this splicing process is done with care. The requirement of authenticity and image integrity preservation are two parameters which handles the process of detecting the forged images. There is requirement of JPEG (*Joint Photographic Experts Group*) compression or intensifying, blurring, rotation and scaling as post-processing operations inclusion before the copied regions pasting in original image. Image clusters of similarity regions are used in the described method. Segmentation technique of NCut is used initially for segmentation of forged image then each region centroids are identified secondly and then KPCA method is used for extracting the features of image for each region.

The remaining sections in this paper are organized as follows: The literature survey of different image forgery techniques are explained in section II. KPCA image forgery detection technique is explained in section III. Different experiments of presenting method are described in the section IV, and finally the conclusion of these results is explained in the section V.

II. LITERATURE SURVEY

A deep learning approach based on simplistic (ten-layered) CNN is introduced by the Rao and Ni et. al. [9] in which the red-green-blue color (RGB) images are automatically utilizes the input to train a hierarchical depiction [9]. Both the splicing and copy-move forgeries are efficiently using this technique. Automatic feature learning is the originality of this method for two forgery types, i.e., splicing and copy-move. The combination of CNN with median filtering forensic technique is presented by the Chen et al. [10] for forgery detection of digital image. CNN network architecture with eight layers is used for the described method and a filter layer is introduced as input layer. Different features are obtained by alternative pooling and convolution layers for supporting the hierarchical learning process and then classification. This technique is first obtained which is a combination of CNN framework with median filtering. For both the cut-pasting and copy-move forgeries, significantly improved results are obtained through the described method which is described by the researchers. Joint Photographic Experts Group (JPEG) compressed images and median filtering from low resolution detected images worked on hand designed features as compared to other famous image forensic tools.

Image global and local contrast enhancement detection uses two different algorithms which were described by the G. Cao, Y. Zhao, R. Ni and X. Li [11]. Unmodified images gray level histogram considerations are used by the previous algorithms which show the smoothness and peak/gap artifacts shows the contrast enhanced images. In JPEG format, digital images are stored and middle/ low quality factor is used for compression of images in real applications. Blocking artifacts are usually generated by the low-quality lossy compression. Therefore, JPEG (lossy) compressed images with middle/low quality contrast enhancement are not detected by the previous approaches. This problem is solved by the proposed algorithm in this research. The contrast enhancement in both high-quality JPEG compressed images and as well as middle/low quality images are detected by the described algorithm. Zero-height gap bin feature is mainly used gray level histogram feature. Cut-and-paste forged image is main application of this forged images detection. Copy-paste forged images are detected with described method by the S. Bravo-Solorio, A. K. Nandi [12]. Rotation, reflection and scaling are the most affected parameters in copy-paste forged images.

Dyadic wavelet transform method is proposed by the N. Muhammad et. al [13]. Signal better compensation and superior reasoning is provided with extra information is restored by the Dyadic wavelet (DyWT) transform. The extraction of segments with high and flat frequency classes uses the DyWT image disintegration. This method determines the minimum Euclidean distance with segment pair as tampered area and copied area. The main disadvantage with this method is uses only the small angle of rotation with better quality images.

The process of possible information recovering from image unmodified form and if any changes are detected then modification operations are focused by the M. C. Stamm and K. J. R. Liu [14]. Contrast enhancement mapping used to change the image and unchanged version histogram of the image is jointly estimated by using the iterative method according to probabilistic model. The histogram entries are identified by the probabilistic model and these entries are more likely to corresponding enhancement artifacts. An accurate estimation is obtained when enhancement is non standard with described algorithm.

The identification of histogram equalization use, global and local contrast enhancement detection uses the different methods which are proposed by the M. C. Stamm and K. J. R. Liu [15] and these methods are used for global inclusion of noise detection for already JPEG-compressed image. High quality JPEG compressed image contrast enhancement is detected by this method. But its disadvantage is middle/low quality JPEG compressed image contrast enhancement is not determined. Cut-and-paste forged images with single source local contrast enhancement are detected by using a separate algorithm.

After preprocessing, the lesion is segmented, and then certain features from the segmented lesion are extracted. Support Vector Machine classifier is used to create a computerized diagnosis for melanoma skin cancer [16]. Segmentation based image processing diagnosis tool is developed. Wavelet transforms are used for the extraction. The tools for integration of segmentation, extraction and classification of images are developed [17]. Image segmentation is highly referred technique for exact separation of image for the accurate diagnosis [18]. The hybrid feature-based ICNN model was proposed and obtained significant performance in CBMIR by means of recall, precision, accuracy, f-score, and specificity compared to other classifiers such as LSTM, DNN, and CNN [19]. Wavelet transform has been used in an attempt has to generate the ECG signal wave forms using MATLAB software then QRS complex were detected and then each complex are used to find the individual peaks like P and Daubechies wavelet has preferred since the scaling functions are similar to the shape of the ECG signal [20].

III. SEGMENTATION METHOD FOR KPCA IMAGE FORGERY DETECTION

The framework of an efficient novel segmentation method for KPCA (kernel principal component analysis) image forgery detection is as shown in below Fig. 1.

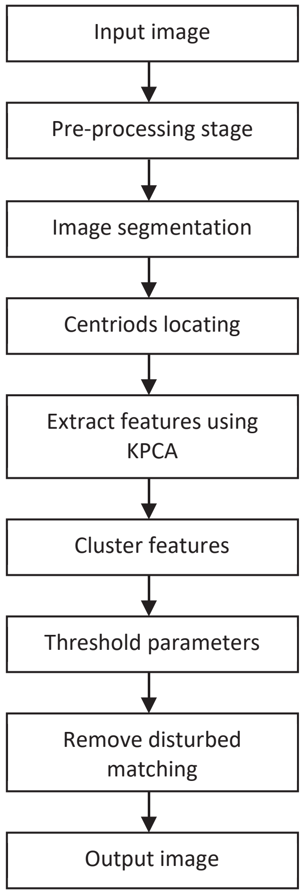

Fig. 1: FRAMEWORK OF IMAGE FORGERY DETECTION

The analysis of described method is as follows: pre-processing stage of input image, Segmentation technique of NCut is used initially for segmentation of forged image then each region centroids are identified secondly and then KPCA (kernel principal component analysis) method is used for extracting the features of image for each region. K-Mean clustering is used for cluster similar features. Then test the matching of each pair of features. Corresponding blocks are same if the pair of features is matching. Corresponding blocks are assumed as copied if pair of features is unmatched. These false and invalid matches are removed with the set of parameters by the definition of algorithm. As a result, forged image last, duplicated region is detected. Each stage explanation is given in the following subsections.

The process of detection starts with image pre-processing which is most important in this process. Resizing the pixel values of input image and raw pixel values rescaling/standardization are involved in the data pre-Processing stage. According to the model design image resizing was performed during the images data set import process. Image pixel values (raw pixel intensities standardization) are measured in between the (0, 1).

The segmentation of input image 'I'of size r is done with the normalized cut (NCut) segmentation. According to spatial and color threshold value image is segmented with a segmentation minimum area and smallest NCut value subject to the choice of image as a weighted graph. According to the below equation weight matrix is calculated as:

$$W_{ij} = e^{\frac{\|F(i)-F(j)\|_2^2}{\sigma_I^2}} * \{\frac{\|X(i)-X(j)\|_2^2}{\sigma_I^2} if \|X(i)-X(j)\|_2^2 < r$$

Where, the spatial values are denoted with X, feature is denoted with F. The specified threshold is referred by the Color values corresponding to point i, j and (sigma). Two discreet eigenvectors are obtained by solving the generalized Eigen system (D – W)y = λDy and the formation of N x N diagonal matrix D as $d_i = (\sum W_{ij})$ with subject to node I. according to the specified minimum threshold value the graph bipartition recursively. Each segment centroid is computed after image segmentation for clustering and feature extraction 7x7 block around the centroids are described.

Image best significance is hold by using centroids in this research compared to other methods. This is because of Euclidean distance effective calculation between two clusters by using the centroids which is also used in calculation of similar clusters. The calculation of Euclidean distance between centroids is uses the connection between centroids. By using NCut technique image is segmented and each segment centroids calculation is done.

Corrupted region as rotated of an image is detected by using KPCA and obtained the best values in terms of accuracy, precision and for small size images computation time is reduced. Features dimensionality is reduced with KPCA. Ignored the low covariance features because of it contained less useful information. The comparison of every region pixel value is not possible in mathematically because of poor advancements or technologies are in post processing functions like color reduction, scaling, rotation and brightness variation. Strength against JPEG compression artifacts are provided for the described technique which handled the scaling and rotation efficiently. The projection of given kth observation of vector data is calculated by:

$$P_K = [p_{k,1}\, p_{k,2} p_{k,3} \cdots p_{k,M}]^T$$

$$p_{k,l} = v_l.\phi(Y_K) = \frac{1}{M}\sum_{i=1}^{M} \alpha_i^1 (\phi'(Y_i)\phi'(Y_K)$$

$$\frac{1}{M}\sum_{i=1}^{M} \alpha_i^1 (K'(Y_i, Y_k))$$

$\phi(Y_i)$ is centered mean feature vector which satisfies $\sum_{i=1}^{M} \phi'(Y_i) = 0$ and p is no. of principal elements where l=1,2,……..,p.

K-Means clustering algorithm is the experiment next step experiment which is also an unsupervised technique after feature extraction. The principle distance between the points is utilized in input point's categorization into various clusters by using the K-means clustering which works as a classifier. Different types of information are clustered by using Random intensities around centroids. As the following equation is used:

$$V = \sum_{i-1}^{k} \sum_{x_j} \epsilon S_i (h(x) - \mu_i)^2$$

Where, clusters are denoted with k. Proposed experiment has clusters value of k=2, S_i (where i = 1, 2, …, k) and μ_i= Centroid of all pixel's x includes the histogram $h(x)\epsilon S_i$. The segmentation map is created with the association of connected pixels and similar clusters at that point as follows:

$$D = arjminj = ||h(X) - \mu_i||^2$$

Algorithms wrong matchings removed with the Threshold which is very important in researched method. n the entire image all identical shift vectors centers are identified and arranged as a category. The center of class (mclass) is calculated from all shift vector centers average in a category and shift vector centers standard deviation is calculated from the dispersion of each vector class (class var). If obtained standard deviation is higher than the threshold then considered the image as forgery case and in which the shift vectors are dispersed.

Misplaced disperse shifts are present in the previous part. But specific shift vector is possible which is considered and concentrated as fake region, wrong matching related blocks are existed. The ultimate goal at this stage is these blocks elimination. Delete the blocks which have any matching neighborhoods. Therefore, the detection of forged images is done along with their matched features.

IV. RESULTS ANALYSIS

The performance and experimental results of the proposed forgery detection method are evaluated in this section. Many medical images are collected from different benchmark databases, such as Derm7pt (1011 dermoscopic images) [21-22], MIAS (322 mammograms) [23], REMBRANDT (200 MRI brain images) [24] and histopathological images (1224 oral cancer images) [25]. All the images are forged using image processing algorithms and tested by the proposed system. The main aim is forgery detection along with improvement in computation time, accuracy, precision, recall rate and specificity of the algorithm. Region duplication forgery identification is accurately identified. Fig. 2 shows sample images used by the proposed system.

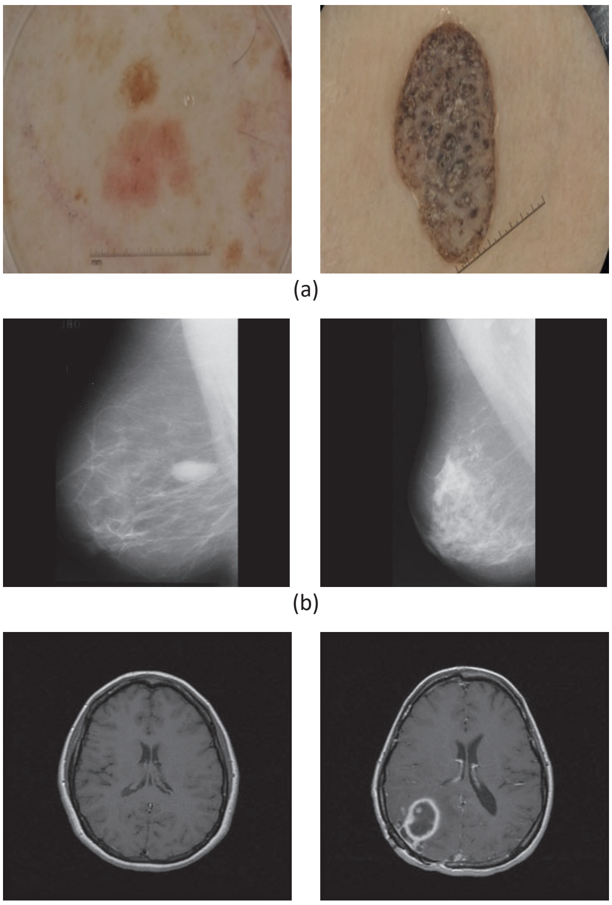

Fig. 2: (a) Derm7pt skin images (b) MIAS mammogram images (c) MRI brain images

Performance parameter is evaluated using the following formulae's:

$$Accuracy = \frac{\text{Ntp}}{(\text{Ntp} + \text{Nfp} + \text{Nfn} + \text{Nfn})}$$

$$\text{Precision} = \frac{Ntp}{(Ntp + Nfp)}$$

$$\text{Recall} = \frac{Ntp}{(Ntp + Ntn)}$$

$$\text{Specificity} = \frac{Ntn}{(Ntn + Nfp)}$$

Where forged and detected as forged total no. of principal components is denoted with Ntp, authenticated and detected as authenticated no. of principal components are denoted with Ntn, authenticated but detected as forged no. of principal components are denoted with Nfp, and forged but detected as authenticated denoted with Nfn.

The result of segmentation with KPCA image forgery detection method was compared with current forgery detection techniques as Deep Learning based Forgery Detection (DL based FD) and Spatial Feature domain-based Forgery Detection (SF based FD) in terms of detection accuracy, precision, recall and F1-score. Table 1 illustrates the comparison results.

Table 1

COMPARISON TABLE FOR DIFFERENT PARAMETERS

Method	Accuracy	Precision	Recall	Specific-ity
DL based FD	92.5	84.5	86.3	85.9
SFD based FD	93.6	89.1	87.8	90.4
KPCA based FD	98.7	94.2	93.4	94.6

The graphical representation of above parameters for considering forgery detection three methods are given below.

From Fig. 3, it is clear that the performance of the presented segmentation with KPCA image forgery detection method achieves the better accuracy than other methods of forgery detection.

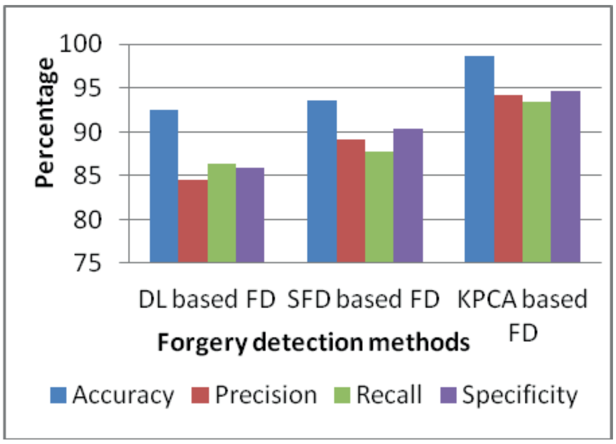

Fig. 3: PERFORMANCE OF DIFFERENT FORGERY DETECTION METHODS

V. CONCLUSION

From several decades, the development of digital images forgery is increased widely. So, there is a requirement of the different algorithms or classifier to detect this copied or forgery content. In this paper, an efficient novel segmentation method for KPCA image forgery detection is described and analyzed. Ncut segmentation technique is used in this method with feature extraction with KPCA. Medical images from three different imaging modalities such as microscopic images, x-ray images and MRI images are used for the evaluation. A comparison with forgery detection techniques, such as DL based FD and SF based FD in terms of precision, accuracy, recall and specificity are demonstrated. It is observed that the segmentation with KPCA image forgery detection method gives better performance. In future, different types of image forgeries are use the described system applications with a great extension.

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