ISSN (e): 2250 – 3005 || Volume, 07 || Issue, 10|| October – 2017 ||
International Journal of Computational Engineering Research (IJCER)

Comparative Analysis of Image Decomposition and Feature Matching Techniques for Copy Move Forgery Detection

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ABSTRACT
With the advancement of technology and easy availability of image editing tools it has become very easy to temper or manipulate the digital images in order to hide some information in image. Image forgery detection at present is among the hot research fields of image processing. Copy move forgery is the technique people are frequently making use of it. In this paper there is comparative analysis of techniques for image enhancement and feature matching which are fundamental steps in various algorithms which are used for copy move forgery detection.
Keywords: SWT (Stationary Wavelet Transform), DWT (Discrete Wavlet Transform), Conventional block matching, phase correlation, block feature matching, SIFT (Scale Invariant Feature Transform), DCT (Discrete Cosine Transform)

Date of Submission: 18-08-2017 Date of acceptance: 04-11-2017

I. INTRODUCTION

These days digital images are playing important role in areas like forensic investigation insurance processing, medical imaging, journalism and many other fields. But the basic requirement is the authenticity of these images. As the technology has become advanced and various fast computing sources are available ,it has become easy to manipulate or forge the digital images. There are various forgery techniques, of these techniques copy move forgery is frequently used by the people[1]. Many types of methods have been suggested to detect this type of forgery. In all these methods the image enhancement or we can say image decomposition and feature matching are necessary actions in the various algorithms used in the detection of copy move forgery detection.

There are various existing techniques for image enhancement like WZP-CS ,in this a high resolution image is generated using wavelet domain zero padding and then a number of low resolution images are created by spatial shifting , wavelet transforming and discarding the high frequency bands ,then final high resolution image is reconstructed by realigning and averaging these intermediated high resolution images[2]. The second technique is DT-CWT Dual tree CWT is used to decompose an input image into different sub band images, then high frequency sub bands and input image are interpolated, followed by combining all these images to generate a new high resolution image[2]. The third technique is SWT it also decompose image into sub bands in which three are detailed sub band and one is approximation sub band[4]. The SWT is redundant scheme as the output of each level of SWT contains same number of samples as input.[5]. The fourth technique is DWT, it decomposes the image into four sub bands. After decomposition interpolation is applied on these four sub bands. The low resolution image is obtained by low pass filtering[3]. In this paper the detailed comparative analysis of SWT and DWT has given.

There are various proposed techniques for feature matching in which the prominent are like DCT coefficient (Discrete Cosine Transform). Discrete Cosine Transform (DCT) representation as robust factor in feature in extraction of features.In DCT detection of duplicated regions was based on matching the quantized DCT coefficients of image blocks which are overlapped. The parameter Q is used for calculation of quantization. The higher value of the Q-factor produces finer quantization, the more similarity in blocks in order to be identified as matched blocks. Lower the value of Q-factor leads more matching blocks thereby producing more false matches[7]. The second one SIFT (Scale invariant feature transform) , Hailing Huang [8] applied SIFT feature. The SIFT algorithm extracts distinct features of local image these are invariant when the image is scaled or rotated and are also robust to changes in noise, illumination, distortion [9]. The Major drawback that SIFT has is having problem with small block size [8]. The third one is conventional block matching the frame or image is divided into blocks. The block-matching procedure extracts features from each block and then find the duplicated blocks based on the similarity they have in their features. Like conventional methods, if all blocks are taken into consideration in the matching procedure, it will create computational problem[10]. The fourth one is phase correlation method though it is block based but in this method phase correlation is found out between the blocks and based on this phase correlation the similarity of features is decided.

II. COMPARITIVE ANALYIS OF SWT AND DWT

SWT is redundant scheme, it decompose the image into various distinct sub bands which are Low-Low sub band(LL), Low-High sub band(LH), High-Low sub band(HL), High-High sub band(HH). The number of samples in output of SWT is same as that in input, thus there is redundancy of N for N levels.[6] In this technique bi-cubic interpolation is used. In SWT high frequency sub bands and interpolated high frequency sub bands have same size thus we can add them.[3] In this technique low resolution image is obtained by low pass filtering of high resolution image. This technique is commonly used in in decomposing the image which further helps the researcher in there algorithms which are used for finding duplicated regions in image. The various steps of SWT are:

1. The image is divided into three detailed and one approximation sub band ,the LL is approximation sub band the rest three are detailed sub bands.[4]
2. Average of approximate parts of image is taken.[4]
3. Finally approximation coefficients are replaced, and high resolution image is obtained using inverse SWT.[6]

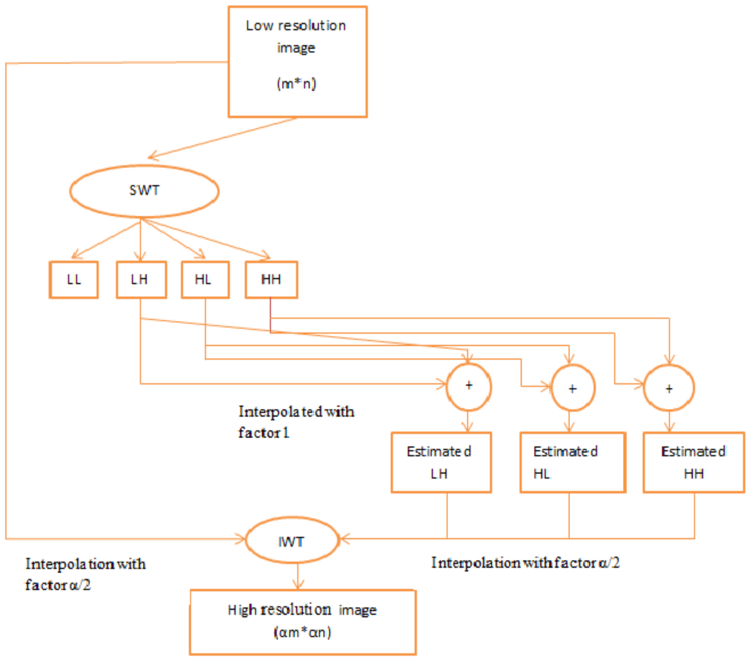

Figure 1: SWT based algorithm[3]

In DWT the image is decomposed into same manner as it is done in SWT , following are the sub bands are Low-Low sub band(LL), Low-High sub band(LH), High-Low sub band(HL), High-High sub band(HH).These components of images are then interpolated by bicubic interpolation[6]. The LL sub band is the low resolution if initial image. The steps are:[6]

1. The interpolation of low resolution image is done with half of the interpolation factor 'α/2',it helps in interpolation of higher frequency bands and thus improve image quality.
2. The higher frequency sub bands are interpolated by factor α.
3. In the end inverse DWT gives us final high resolution image.

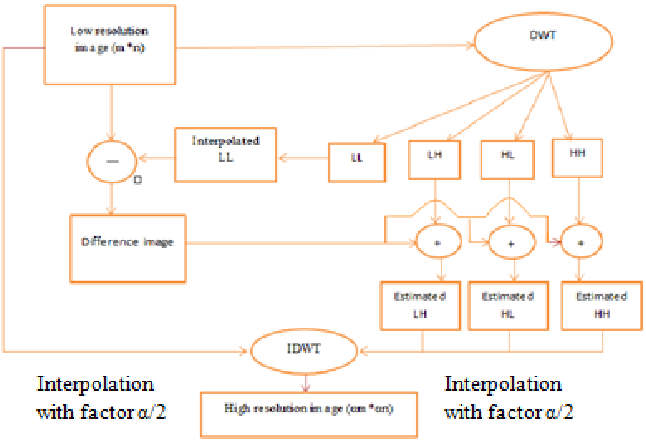

Figure 2: DWT based algorithm [3]

Table 1: Comparison of SWT and DWT

Techniques	Advantages	Disadvantages
SWT	Redundant scheme	Image gets distorted
DWT	Gives sharp image	High frequency components are lost

III. COMPARITIVE ANALYSIS OF CONVENTIONAL BLOCK MATCHING AND PHASE CORRELATION

Conventional Block Matching follows block by block matching principle. The LL band DWT transformed image is divided into blocks which are overlapped. In this scheme, square blocks are used for convenience and shifting of one pixel is done to obtain overlapping blocks overlapping only by one pixel it taken into account so that to avoid chances of missing similar regions. The idea of block-matching procedure is to extract similar features. At the first stage non overlapping blocks are taken into account, similarity measure is applied on it then they are lexicographically sorted out. After that overlapping blocks are taken and on them similarity measure is applied [10].

The method follows: [10]

1. Overlapping blocks of size b*b are created with shifting of one pixel, the number of overlapping blocks for each layer are

$$N = (G - b + 1) * (H - b + 1)$$

2. Then overlapping block is transformed into row matrix of size

$$N_{over} * b^2$$

3. Then non overlapping blocks are extracted for block size b*b

$$N_{nonover} = (G/b) * (H/b)$$

   These elements are sorted lexicographically.
4. The correlation coefficient of non overlapping blocks is calculated C_{IJ} where i=1 and j=(i+1) for pair of rows
5. Then threshold value of correlation coefficient (C_T) is chosen.
6. Distance is calculated of each participated row

$$d(P,Q) = \left({}^{1}/_{b^2}\right) \sum_{i-1}^{b^2} |P_i - Q_i| / P_i$$

P and Q represents rows after this C_D = threshold value of distance between two rows is selected. A pair of rows with average value of three distances less than $C_D$is considered as block undergone forgery.

In phase correlation wavelet transform is applied firstly to the image in order to decompose it i.e., $LL1$ sub band. Then the $LL1$subband are further divided into sub-images and then phase correlation is applied to compute the spatial offset (Δx,Δy) between the regions which are copy moved. There is an easy location of Copy-Move regions by pixel-matching, i.e., the input image is shifted according to the offset and then the difference is calculated between the image and its shifted version. Then the MMO (Mathematical Morphological Operations) are used in order to take away the isolated points so as to achieve the improved location [11].

The steps are as follows:[11]

1. Shift an image $f_1(x,y)$ by $(\Delta x,\Delta y)$ thus we get the shifted image that is

$$f_2(x,y) = f_1(x-\Delta x, y-\Delta y)$$

2. Apply Fourier transform

$$F_1(u,v) \text{and} F_2(u,v)$$
$$F_2(u,v) = F_1(u,v)e^{-j(u\Delta x+v\Delta y)}$$

3. The normalized cross power spectrum of $F_1(u,v)$ and $F_2(u,v)$ is

$$d(P,Q) = \left(\frac{1}{b^2}\right)\sum_{i=1}^{b^2} |P_i - Q_i|/P_i$$

4. Calculate p(x, y) which inverse Fourier transform of P (u, v) and extract the peak, i.e, max (p(x, y))
5. Fix a threshold T_p there exists max (p(x, y)) $>T_p$, which depicts image is a Copy-Move image then move to next step, else end the algorithm.
6. Get the spatial offset $(\Delta x', \Delta y')$ according to the spatial location of the peak in p(x, y); calculate the offset $(\Delta x, \Delta y)$ using the offset $(\Delta x', \Delta y')$ and the sub-image spatial location.
7. Calculate $f''(x, y)$
8. Calculate $f_\Delta(x, y)$
9. Mark the zero areas in $f_\Delta(x, y)$. If the regions marked are adjacent, they can be called as Copy-Move regions, if marked points are isolated; with the help of mathematical morphology they are removed.

Table 2: Comparison of Conventionalblock matching and Phase correlation

Techniques	Advantages	Disadvantages
Conventional block matching	There is low overhead in this method	Method has complexity and computation time is high
Phase correlation	Method has lower entropy	It is not very efficient when copy move parts are more and more spatially located

IV. CONCLUSION

In this paper the comparative analysis of image decomposition or we can also say image enhancement techniques and also the comparative analysis of feature matching techniques has revived. The analysis shows that DWT is less complex than SWT. Thus being less complex and produce less distortion can be more beneficial for image decomposition. For feature matching phase correlation can be better method for copy move forgery detection regions as it is more efficient and has lower entropy. As compared to other feature matching techinques it gives us less false detection rate.

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International Journal of Computational Engineering Research (IJCER) is UGC approved Journal with Sl. No. 4627, Journal no. 47631.

Rupinder Kaur Comparative Analysis of Image Decomposition and Feature Matching Techniques for Copy Move Forgery Detection." International Journal of Computational Engineering Research (IJCER), vol. 7, no. 10, 2017, pp. 40-43.