Study On Various Forgery Detection Techniques In Digital Image Phoney

R.Nalini
Department of Computer Science
Assistant Professor, Government First Grade College, K.R.Puram, Bangalore-36

Abstract- *Image forgery is the manipulation of digital images to conceal meaningful information or object in the image. Among different image forgery techniques, copy-move forgery is one of the frequently used image forgery approach. This paper surveys on different types of techniques to perform efficient way for forgery detection.DWT, PCA, DCT, SVD techniques are used to detect image forgery. Both the original and tampered images are taken as input. The study analyses the existing methods and suggests an efficient method for image forgery detection.*

Keywords: DCT, Digital Tampering, DWT, PCA, SVD.

I. INTRODUCTION

Copy-Move forgery[5] is performed with the intention to make an object “disappear” from the image by covering it with a small block copied from another part of the same image its important properties, such as noise, color palette and texture, will be compatible with the rest of the image and thus will be more difficult to distinguish and detect these parts Since the key characteristics of Copy-Move forgery is that the copied part and the pasted part are in the same image, method to detect this forgery is exhaustive search, but it is computationally complex and more time is needed for Detection [16]. Most of the forgery detection techniques are categorized into two major domains: intrusive/non-blind and non-intrusive/blind [6].

Intrusive method which is also known as a non-blind method requires some digital information to be embedded in the original image when it is generated, and thus it has a limited scope. Some of the examples of these methods are watermarking and using digital signature of the camera and not all the digital devices can provide this feature [6]. On the other hand, non-intrusive method which is also known as a blind method does not require any embedded information. The DWT and PCA techniques are used to reduce the amount of computation in duplicated regions. To further reduce the amount of computation, this paper proposes wavelet based approach where the usage of wavelet transform for compression of tampered images have been tested and phase correlation is used as similarity checking criterion for identifying duplicity of overlapping blocks formed from the tampered images[16].

The multi resolution analysis feature of DWT has been explored. Compared with other approaches DWT is preferred for their reduced computational complexity [1]. In, DCT it takes more time to detect the forged region.PCD uses the same principle of the DCT but it has drawback that it affecting the efficiency of the algorithm because the blocks are directly extracted from the original image, resulting in a large number of blocks.SVD also takes lot of time for their computation.

Copy-move forgery is a type of image forgery in which a part of image is copied and pasted to another part in the same original image [16].

Original image Forged image

Fig.1a Fig.1b

Fig.1a shows the original image of the object, fig.1b shows the copied image where the label is copied from the bowl to tumbler.

This can be done for Two Purpose
1. To hide or conceal an important object.
2. To show more than one object.

Adobe Photoshop cloning tool will be used to clone the object in the original image. Some of the approaches used in copy-move forgery detection:

1. Discrete Cosine Transform
2. Principal Component Analysis
3. Independent Component Analysis
4. Singular Value Decomposition
5. Discrete Wavelet Transform

II. PROPOSED TECHNIQUES

1. Discrete Cosine Transform
2.

DCT is widely used in image compression and is widely accepted in the multimedia standards[7]. It transform block of image into its corresponding transformed array of DCT coefficients [20].The transformed array is encoded into a bit-stream using two approaches:

- Zonal coding
- Threshold coding
-

Zonal coding-It is based on the premise that the transformed coefficients having very high variances that carry signal and should be retained, less variances can be truncated.

Threshold coding-It is based on the premise that the transformed coefficients of largest magnitude make the most significant contribution to the reconstructed block quality.

Step 1. Take 2 images. Divide it into the fixed size blocks such as, M*N grayscale image first split up into overlapping blocks of B*B pixels:
Bij(x, y) = f (x + j, y + i)
Where, x,y∈{0,…..B-1}
i∈{1,…M-B+1}
j∈{1,…. N- B+1}
We able to obtain N blocks of overlapped sub blocks from suspicious image:

N blocks=(M-B+1)X(N-B+1) …..(1)

Step 2. For each block DCT is applied, after that DCT coefficients matrix with same size as the block is exploited which can represent the corresponding block.

Step 3. Assume the size of the block Bi is 8*8, the coefficient matrix is also 8*8.The nature of DCT that the energy only focuses on the low frequency coefficients. If the image block undergoes DCT transform, we can use four parts energy to represent the whole image while without losing any important information. For this basic motivation, we use a circle block to represent the coefficients matrix and divide it into four parts: C1, C2, C3, and C4.

.

To obtain the matching features, denote v1, v2, v3, v4 as the feature of c1, c2, c3, c4. We can get *Vi* (*i*=1,2,3,4) though equation:

$vi\_\sum_{c_{area}} f(x,y)$(f(x,y)$\epsilon$C_areai,i=1,2,3,4)

Vi = mean of coefficients value corresponding to each Ci.

After that 4 features are gotten, which can be combined to feature vector with the size of 1*4 denote as:
V=[v1,v2,v3,v4]……………..(2)

Step 4. The feature vector are extracted and arranged to a matrix:

$$A=\begin{bmatrix} v1 & . \\ . & . \\ v(M-B+1) & (N-B+1) \end{bmatrix}$$

A is then lexicographically sorted. Meantime, take all left corner's coordinate of each bock which represented by circle block.

Sorted set is defined as $\hat{A}$ Based on $\hat{A}$ Euclidean distance m_match = (Ai,Aij) between adjacent pairs of $\hat{A}$ is calculated using following equation:

m_match(Ai,Aij) $=\sqrt{\sum_{k=1}^{4}(vi^k - vi + j^k)^2}$<similarity threshold……………(3)

we calculate the actual distance between two similar blocks as follows:

mdistance

(Vi,Vi+j) $=\sqrt{(xi - xi + j^2) +}\,(yi - yi + j)^2$ >distance threshold……………..(4)

Step 5. Morphological operation is used and output the final result.

Experimental results

Fig.2a

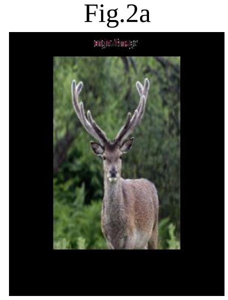


Fig.2b

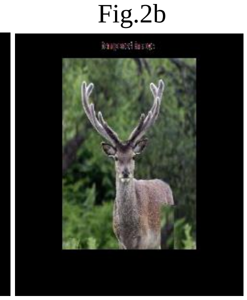


Fig.2c

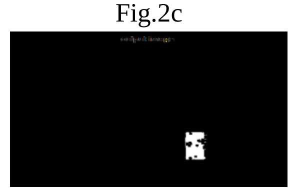


Fig.2a shows the original image of a deer. In Fig.2b shows the copied image, where the detected results can be shown in Fig.2c.

Advantages

1. The use of DCT to detect forgery is better for jpeg images than using a predefined method PCA.
2. Make the program more efficient.
3. Since the PCA does not detect the
forgeries for jpeg image efficiently, we apply DCT so that we detect forgery on jpeg image too.
4. Truncation of the PCA basis typically reduces the dimension from 64 to 32. This technique works by first applying a principal component analysis (PCA) on small fixed size image blocks to yield a reduced dimension representation.

Limitations

1. Truncation of higher spectral coefficients results in BLURRING.
2. Coarse quantization of some of the low spectral coefficients introduces GRAININESS in smooth portion.
3. It can iterate upto 2nd level decomposition.

III. PRINCIPAL COMPONENT ANALYSIS

A similar detection method is used, in which the image blocks are reduced in dimensions [2,18].

1. The Colored input forged image has high dimensionality so converted as M×N dimensional gray scale image. The high frequency image matrix A is considered for further processing. The eigen value problem is to determine the nontrivial solutions of the equation
$Ax = \lambda x$…………………(1)
where A is high frequency matrix, x is a length of n column vector, and λ is a scalar. The n values of λ that satisfy the equation are the eigenvalues, and the corresponding values of x are the right eigenvectors.

2.For eigenvector [*c*,*d*] TP, the direction U of the dominant eigenvector is defined by

$U = \tan^{-1}(c/d)$ where $0^o <= U <= 90^o$…. (2)

Gram matrix are then projected on to the ordered eigen vectors.

3.The grammians is used to determine the controllability and observability of state-space models and for model reduction. The controllability grammian is defined by

$W_c = \int_0^\infty {}^e A\tau\ BB\ T\ {}^e Ar\tau d\tau$ ………....(3)
and the observability grammian by

$W_o = \int_0^\infty {}^e Ar\tau\ CCT\ {}^e A\tau\ d\tau$ …………(4)
The discrete-time counterparts are

$W_c = \sum^\infty Ak\ BBT[AT]k$ …………...(5)

$W0 = \sum^\infty [AT]kCCT\ Ak$…………...(6)

Centered tested gram matrix obtained from (1), (2), (3), (4) & (5) are sorted lexicographically. Pairs of coordinates are listed as a matrix. Offset are found which removes or keeps values from the beginning or end of a vector and outputs the result in a vector of user-specified length such a high frequency offsets gives the duplicated region[16].

Experimental output

Original image Copy image

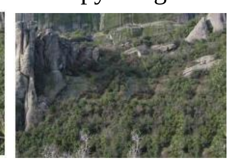


Fig.3a Fig.3b

Final classification using PCA

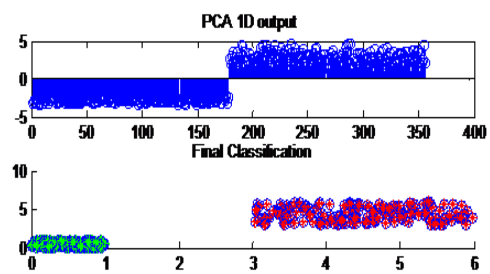


Fig.3c
Fig.3c shows the classification of PCA.

Fig.3d
After Projecting the Frequency Offset On to Image/Forgery Part it looks like fig.3d

Limitations

1. It does not support tampered image.
2. Not support noise component or color palette.

IV. SINGULAR VALUE DE COMPOSITION

SVD is used to detect and locate duplication regions in tampered images. Instead of exhaustive searching, a fast searching method of k-d tree is also used to make feature matching. The proposed algorithm has low computational complexity and is more robust to post image processing, such as scaling, rotation, noise contamination, Gaussian blurring, lossy JPEG compression etc[18].

The detection process consists of two major steps:
(1). Image features extracting;
(2). Block similarity matching.

Image Features Extraction

Using singular value decomposition, the proposed method achieves extract unique feature vectors of image blocks by decreasing the dimension of blocks features space. Let *A* be an image matrix with A∈R (NxM), its SVD is expressed in the following form: $A=U\Lambda V^T$

Where U∈R (NxN), V∈R (MxM), both U and V are orthogonal matrices. $\Lambda \in R^{N \times M}$ is an NxM diagonal with the form:

$$\Lambda = \begin{bmatrix} \Sigma_r & 0 \\ 0 & 0 \end{bmatrix}$$

Where Σ_r is a square diagonal matrix in $R^{r\times r}$, Σ_r= diag(σ_1, σ_2,……. σ_r) is the rank A that is equal to the number of non negative singular values.

3.2 Block Similarity Matching

After objects or regions are represented as r-dimensional SV feature vectors u and v, where $\mathbf{u} = (u_1, u_2, \ldots, u_r)^T$ and $\mathbf{v} = (v_1, v_2, \ldots, v_r)^T$ the Euclidean distance D(u, v) is used as similarity measure between these vectors:

$$D(\mathbf{u}, \mathbf{v}) = (\sum_{i=1}^{r} (\mathbf{u}(i) - \mathbf{v}(i))^2)^{1/2}$$

In blocks features recognition, the similarity matching is efficiently used to identify the similar blocks in one image. A simple exhaustive search computes the distance from the block to all others. This approach is very inefficient and its computational cost is O(N). To improve the efficiency of finding neighboring blocks, some hierarchical structures have been proposed.

The k-d tree is a commonly used structure for searching nearest neighbors. The k-d tree preprocesses data into a data structure allowing us to make efficient range queries. It is a binary tree that stores points of a k-dimensional space in the leaves.

The basic ideas is that first divide an image into small overlapped blocks, then compare the similarity of these blocks and finally identify possible duplicated regions.

Step 1:

1.First partition an image into small overlapping blocks. Determine a window with BxB size and slid it over the whole image by one pixel each time from upper left to bottom right corner.
2.The block size BxB is assumed to be smaller than the size of duplicated regions to be detected.
3.The total number of overlapping blocks for an image of M×N pixel is (M-B+ 1)(N-B+1)[18].

Step 2:

For each block, apply SVD by using the equation given below

$$A = U\Lambda V^T$$

Extract a singular values feature vector from

$$\Lambda = \begin{bmatrix} \Sigma_r & 0 \\ 0 & 0 \end{bmatrix}$$

Then, sort all feature vectors in a matrix A containing (M-B+1)(N-B+1) rows.

Step 3:

Block Similarity Matching
1.First, transform features in each block into a k-d tree and search similar blocks for each query from formula

$$D(\mathbf{u}, \mathbf{v}) = (\sum_{i=1}^{r} (\mathbf{u}(i) - \mathbf{v}(i))^2)^{1/2}$$

2.Determine desired similar relation between two blocks with threshold ρ. If D(U,V) ≤ ρ perform a further verification. For two given blocks, assume block1 with coordinates (*i*, *j*)and block2 with coordinates (*k*,*l*) are labeled suspected duplication regions.
If $C_{12} \geq s$
$C_{12=}$ max {abs(i-k),abs(j-l)}
Where C12 is an offset of coordinates between block 1and block 2.
3.The threshold s is the maximum offset between duplicated regions. In order to increase robust for eliminating existed

pseudo-matching, the distance ratio of the closest to the second closest neighbors which is defined as below:

$$R = \frac{\min_D}{\mathrm{secmin}_D}$$

4.Matches are accepted only if R less than or equal to ω, where ω is the threshold. The ratio R eliminates 90% of the false matches while discarding less than 5% of the correct matches but the accuracy of match can be enhanced.

Step 4:
Identifying Tampered Regions
1.The matched blocks satisfying thresholds are first marked as suspected regions. Then the connected regions composed of these blocks are just duplicated regions.
2.The tampered detection results can be visualized by a region map which shows the
duplicated regions if necessary and thus the forged portion of the image is detected.

Experimental Result

Fig.4a Fig.4b

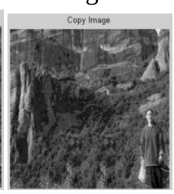


Fig.4a shows the gray scale conversion of original image.
Fig.4b shows the gray scale conversion of copied image.

Fig.4c

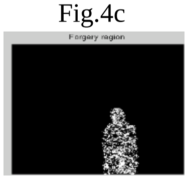


Fig.4c shows the detection result of the forged part.

Advantages

1.SVD is used on fixed-size blocks of low-frequency component in wavelet sub-band to yield a reduced dimension representation.
2.Improve detection efficiency.

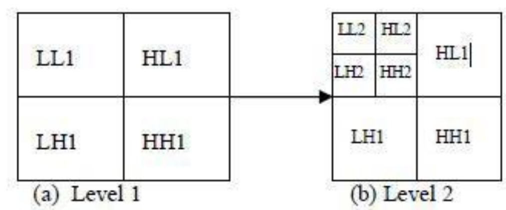
Limitations

1. Computational time is high.
2. Computationally complex.
3. Noised images are not detected properly.
4. Not produce output to the damaged image.

V. DISCRETE WAVELET TRANSFORM

The Discrete Wavelet Transform is basically used to reduce the size of the image at each level, e.g., a square image of size $2^i \times 2^i$ pixels at level L reduces to size $2^{i/2} \times 2^{i/2}$ pixels at next level L+1.The image is decomposed into four sub images, at each level. The sub images are labeled LL,LH, HL and HH. LL corresponds to the coarse level coefficients or the approximation image. This image is used for further decomposition[21].

Among these methods DWT is mostly preferred for the following reason, "in their algorithms blocks are directly extracted from original image resulting in large number of blocks, thus affecting the efficiency of the detection algorithm"[11].



Original image Tampered image

Fig.5(a) Fig.5(b)

Forged image

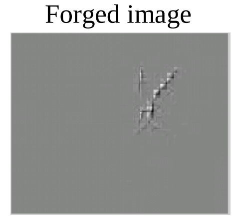


Fig.5(c)

Fig.5c shows the copied region in wavelet form by comparing the original and tampered images in fig.5a and fig.5b.

Detection of Reference and Match Blocks
1. Read the image selected by the user as input.
2. If the input image is not a gray scale image then convert it into a gray scale image.
3. Apply wavelet transform up to specified level "L" to the gray image.
4. For each overlapping b × b block in the LL_L image

4.1. Form a matrix A of dimension b^2 columns and (M-b+1) × (N-b+1) rows by extracting the resulting pixel values by rows into a row of A.
4.2. Form another matrix B same as A with two additional columns for storing top-left co-ordinates.
5. End
6. Ignore blocks where contrast is minimum.
7. Sort matrix A lexicographically.
8. For each row of A
8.1.Compute the phase correlation for the block corresponding to above and below the current rows.
8.2. If the computed maximum phase correlation value exceeds a preset threshold value, then store the top left coordinates of the corresponding reference block and the matching block from B matrix in a new row of a matrix.
9. End

Comparison of Reference and Match Blocks

1. For LL_{L-1} level in the image pyramid
1.1. For each row of the matrix
1.1.1. Form a reference region by padding 'm' pixels on all the sides of the b × b reference block.
1.1.2. Form a matching region by padding 'm' pixels on all the sides of the b × b matching block.
1.1.3. For each b × b overlapping of the reference region.
1.1.3.1. Find corresponding match in matching region based on Phase correlation but search process has to be opted for selected part of matching region.
1.1.3.2. If the computed maximum phase correlation value exceeds a present
threshold value, then the top left coordinates of the corresponding reference block and the matching block are stored in a new row of a matrix.
1.2. End
2. End
3. For LL_{L-2} level to original image in the image pyramid
3.1. For each row of the matrix
3.1.1. Form a reference region by padding 'm' pixels on all the sides of the
b × b reference block.
3.1.2. Form a matching region by padding 'm' pixels on all the sides of the
b × b matching block.
3.1.3. Compare them using Phase Correlation.
3.1.4. If the computed maximum phase correlation value exceeds a present threshold value, then store the top left coordinates of the corresponding reference block and the matching block in a new row of a matrix.
3.2. End
4. End

5. Plot the blocks as copied and pasted regions on the given input image.

4.1 Phase Correlation

The ratio R between two images "img1" and "img2" is calculated as follows.

$$R = \frac{F(img1) \times conj(F(img2))}{\|F(img1) \times conj(F(img2))\|}$$

where "F" is the Fourier Transform, and "conj" is the complex conjugate the inverse Fourier Transform of "R" is the phase correlation ρ.

Experimental Result

Fig. 6(a)

Fig.6(b)

Fig.6(c)

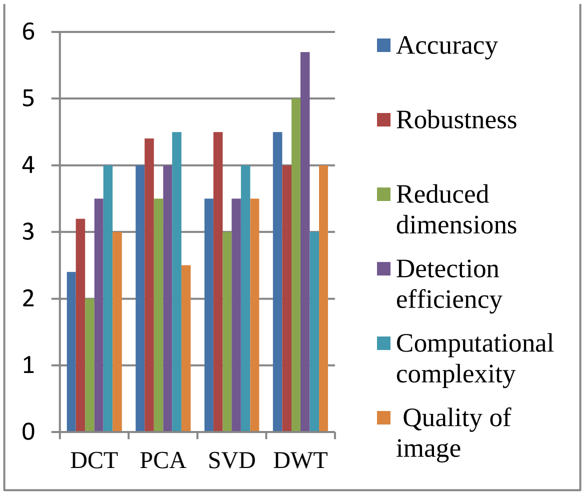
Fig.6a shows the original image, fig.6b shows the tampered image, fig.6c shows the detected result of the forged part

Advantages

- DWT reduces dimension of the image.
- Drastically reduces the time.
- Increases accuracy.
- Produced output to the tampered image
- Economically viable.
- Phase correlation uses the block to find the forged region.
- Modular interactive tools, including ROI selections, histograms, and distance measurements
- ICC color management
- Multidimensional image processing
- Image-sequence and video display
- COM import and export

VI. CONCLUSION

For detecting the forged image various copy methods are proposed. In that, most commonly used techniques are SVD, DCT, PCA. Time complexity, Truncation of higher spectral coefficients results in BLURRING, Coarse quantization of some of the low spectral coefficients introduces GRAININESS in smooth portion are some of the drawbacks of proposed method. To overcome the disadvantages the DWT method has been used. In this project, "Discrete Wavelet Transform-Phase Correlation Analysis" has been used to increase the accuracy and to reduce the time complexity. Comparison of all the method can be shown in figure 7.



REFERENCES

[1] Akhilesh kumar yadav, deenbandhu singh, vivek kumar(2014) 'Image Copy Move Forgery Detection using Block Representing Method', International Journal of Soft Computing and Engineering (IJSCE), Volume-4, Issue-2,pp.43-59.

[2] Alin C Popescu and Hany Farid (2011) ' Exposing Digital Forgeries by Detecting Duplicated Image Regions',International Journal of Digital processing,Volume-4, pp. 23-27.

[3] Fridrich.J, Soukal.D, and Lukas.J(2013) , 'Detection of copy move forgery in digital images', Proceedings of the Digital Forensic Research Workshop, volume 5, Issue 4,pp. 43-47.

[4] Guohui LiI, Qiong WuI, Dan TuI, Shao/ie SunI(2007) 'A Sorted Neighborhood approach for Detecting Duplicated regions in Image Forgeries based on DWT and SVD' , volume 4,pp.1750-1753.

[5] Harpreet Kaur, Kamaljit Kaur (2015), 'A brief survey of different techniques for detecting copy move forgery', International Journal of Advanced Research in Computer Science and Software Engineering, Volume 5, Issue 4, pp.875-882.

[6] Mohammad Farukh Hashmi, Aaditya R. Hambarde, Avinash G. Keskar(2013) 'Copy Move Forgery Detection using DWT and SIFT Features' International Conference on Intelligent Systems Design and Applications, pp.188-193.

[7] Murali.S,GovindrajB.Chittapur,PrabhakaraH.S,Basavaraj S.Anami(2012) 'Comparison and Analysis of photo image forgery detection techniques' International Journal on Computational Sciences & Applications (IJCSA) Volume 2, No.6,pp. 45-56.

[8] Najah Muhammad, Muhammad Hussain, Ghulam Muhammad, George Bebis(2011), 'Copy-move forgery detection using Dyadic wavelet Transform', Eighth International Conference Computer Graphics, Imaging and Visualization, pp. 30-35.

[9] Pradyumna Deshpande , Prashasti Kanikar(2012), 'Pixel Based Digital Image Forgery Detection Techniques' International Journal of Engineering Research and Applications, Vol. 2, Issue 3, pp. 539-543.

[10] Prathibha.O.M, Swathikumari.N.S, Sushma.P (2012), 'Image forgery detection using Dyadic Wavelet Transform', International Journal of Electronics Signals and Systems (IJESS) ISSN: 2231- 5969, Vol-2, pp. 41-43.

[11] Preeti Yadav, Yogesh Rathore(2012) 'Detection of Copy-Move Forgery of Images Using Discrete Wavelet Transform'. International Journal on Computer Science and Engineering (IJCSE), Vol. 4,pp. 565-570

[12] Rohini.A.Maind, Alka Khade, D.K.Chitre (2014) 'Forgery (Copy-Move) Detection in Digital Images using block method' International Journal of Collaborative Research in Engineering Sciences Volume I Issue 2, pp.1-4.

[13] Rajalakshmi.J, SureshKumar.K, Vetrikanimozh.A,(2015) 'Tamper Detection with Reduced Time Complexity Using Hybrid Techniques', International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 1, Issue 2 pp. 64-68.

[14] Rajapriya.S,Nima Judith Vinmathi.S (2014), 'Detection of Digital Image Forgeries by Illuminant Color Estimation and Classification' International Journal of Innovative Research in Computer and Communication Engineering Vol.2, Special Issue 1,pp. 248-254

[15] Rama seshagiri rao channapragada, Anil srimanth mantha, Munaga v.n.k. prasad (2012)'Study of contemporary digital watermarking techniques' IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 6,pp. 45-50.

[16] Saiqa Khan,Arun Kulkarni(2010), Reduced Time Complexity for Detection of Copy-Move Forgery Using Discrete Wavelet Transform,International Journal of Computer Applications, Volume 6– No.7.

[17] Shital R.Kopulkar, Borse M.S, Radnyeesha R.Sadaphule (2015), 'Detect Digital Image Forgeries using Color Intensity' International Journal of Engineering Science Invention ISSN,Volume 4 Issue , PP.22-26

[18] Shivakumar B.L,Santhosh Baboo .S(2010), 'Detecting copy-move forgery in digital images: A survey and Analysis of current methods' Global Journal of Computer Science and Technology Vol. 10 Issue 7 pp. 61-65.

[19] Shivanjali Kashyap (2015) , 'Digital Watermarking Techniques and Various Attacks Study for Copyright Protection', International Journal of Advanced Research in

Computer Science and Software Engineering,Volume 5, Issue 3, pp. 737-745.

[20] Tanuja K. Sarode, Naveen Vaswani(2014), ‘Copy-move forgery detection using Orthogonal wavelet transforms’, International Journal of Computer Applications (0975 – 8887) Volume 88 – No.8, pp. 41-45.

[21] Yang Wang, Kaitlvn Gurule, Jacqueline Wise, Jun Zhaeng(2012), ‘Wavelet based region duplication forgery detection’ Ninth International Conference on Information Technology- New Generations, pp. 30-35.