Copy-Move Forgery Detection Technique For Forensic Analysis in Digital Images Using DWT And Phase Correlation

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Abstract: *Digital images are the main sources of information sharing in this modern life. There are numerous applications of digital images that include but not limited to the news reporting, medical imaging, insurance claims and news reporting. But with the advancement in technology, the credibility of the images become a major concern. CMF (Copy move Forgery) is one of the significant forgeryattacks in which a region of the same image is copied and pasted to develop a forged image. In this research, the DWT technique with the Phase Correlation methodis implemented. First, we converted the input RGB image to grayscale image then we have applied DWT, after that the image was divided into overlapped blocks. After this, we used Phase Correlation technique to sort all the blocks. The result of the study shows that the proposed technique is effective to detect the forged image with enhanced accuracy.*
Keywords: *digital imaging, copy-move forgery, correlation, DWT*

I. Introduction

Digital imaging is the creation of photographic images of having different natures such as the actual image of the object or the interior structure of the object. This term is defined as the scanning, printing, and display of such images [1]. With the advancement of digital imaging, the life of human being is totally transformed. They use cameras and webcams, printers and scanners and the images are created using the different software and print of the images is made with the help of printers [2]. There is classification of digital imaging into various types and is used for different purposes. It is classified on the basis of electromagnetic radiation and the waves, these waves help to capture the picture or the video [3]. Digital imaging can do this by using different kinds of objects like digital cameras, in the hospitals and labs. It can be used by taking x-rays which are further used to identify the internal shape inside the human body; gamma rays are used for PET. For medical practitioners sound digital imaging allows the ultrasonography Digital imaging is a technology that enables one to take digital images for image editing [4]. With the advancement in the technology, everybody has their personal laptops, desktops in order to handle the photographic software because computer systems are more powerful to run these type of applications such as digital imaging [5]. Nowadays the internet usage is very common for everyone and sharing their photos with each other is common as well. This technology helps them to edit, viewing and sharing photos and graphics. Nowadays by using the social networking sites like Facebook, Instagram, and others sites everyone can share their photos and graphics whether they are amateur or professionals. This technology creates advanced things in the mind of every individual [6].

II. Digital Image Processing

Digital image processing is a subfield of signal and systems that focuses on the images specifically. This is the process of manipulating digital images with the help of a digital computer [7]. With the help of algorithms digital image processing manipulates the digital images. The creation of images, processing images, communicating and displaying images are included in the manipulation of the images. Image processing algorithm for digital image processing can be used for converting the signals from an image sensor into digital images, to extract the size, number of objects and scale from the scene, to improve the clarity of the scene, to compress the images and prepare images for the display or printing purpose,etc. [8].The Adobe Photoshop is commonly used software for processing the images is; this software allows individual to compress, resize and crop images as required by the individual. Today digital image processing has become very popular process which has various applications in many number of fields like computer vision, digital video processing, face detection, biometric verification, remote sensing, signature recognition and character recognition,etc. [9]. Basically, all digital image-processing operations can be divided into four categories that are:
1. Image Rectification,
2. Image Enhancement and

3. Information Extraction.
4. Image Restoration,

Where, the first operation deals with processing of raw image data that are initial to correct for geometric distortion, the second one deals to regulate the data radiometrically and also deals with the elimination of noise present in the data. The enhancement procedures are performed on the image in order to display the data for subsequent visual interpretation effectively. The information extraction operations have the purpose of replacing visual analysis of the image data with quantitative techniques so that it will be possible to identify the features in a scene automatically.
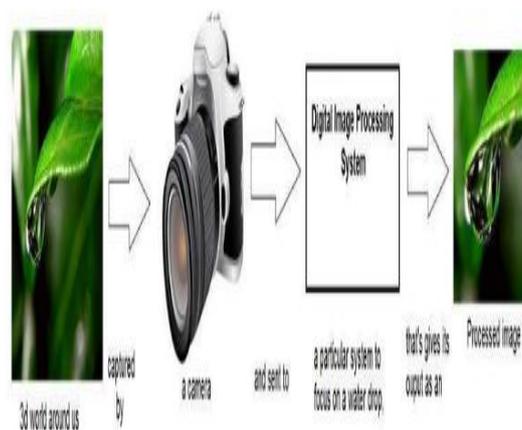

Figure 1: Digital Image Processing [10].

Nowadays digital images are finding utility in various fields like medical field, educational institutes, and has also become common source of sharing information in social media. Now we can easily make use of this technology on our phones through camera and can easily share the images as well [11]. There are various other benefits of digital image processing like CT scan , ultrasound and also in field of research [12].
There are also certain limitations of digital imaging despite of its high quality production to the people. The limitations are like when the image got blur the so we have to restore image, in the dark room quality of image is not proper so filtration is required[13]. Sometimes it difficult to divide image into segments like high resolution image contains high density pixel, but at times digital image processing is unable to do this, due to incapable of setting intensity and edge of the film. [14].

III. Copy-Move Forgery

Copy-Move Forgery is one of most important tool that is commonly used in manipulations of images, in which some parts of the image are copied from the image and pasted onto the same image for hiding unwanted portions of the image or to mask a scene that is unwanted. It is very easy to temper the digital images because various image editing software are easily available. Copy move forgery is one of the most common type of image tampering [2]. As there is a rapid advancement in digital image processing software, there is a extensive advancement of progressive tools and techniques for copy-move forgery. This copy-move forgery is done for hiding an object or a part maliciously. To shield the omitted object from the image, textual areas like grass, cloudy sky are good, because with the background they can be easily blended up [6]. Due to this blending, it is difficult for human eye to identify the blend. The tampered image is saved in the loss JPEG format so that detection of forgery of the image becomes difficult in order to make forgery strong.

Therefore, to identify the copy-move forgery, the division of image into blocks is needed for detection, and a feature vector is tranferred to every block which is needful that has the low dimension for comparison. Thus, the number of blocks and characteristics' dimensions are thet important factor that affects the complexity of the computation [10].
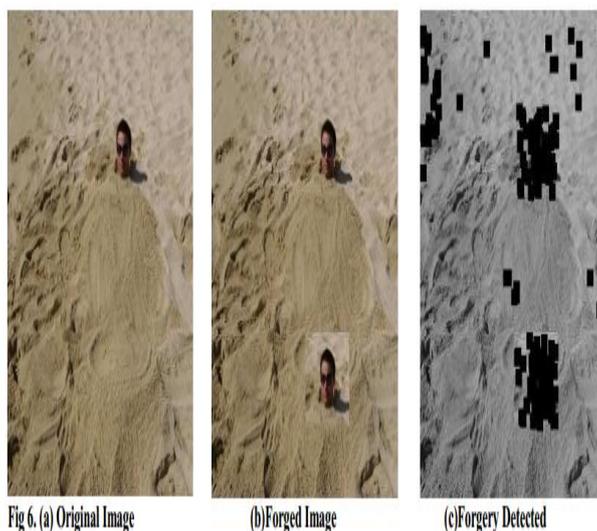
Fig 6. (a) Original Image   (b)Forged Image   (c)Forgery Detected

Figure 2: Copy-Move Forgery [3]

3.1 Different Techniques Of Copy-Move Forgery Detection
There are different types of techniques that are used for detecting the copy-move forgery in the image. These techniques are as follows:

A. Exhaustive Search
This method consists of comparing the image with every cyclic shifted version of the same image to indentify the copy-move forgery. But, this approach is computationally very expensive and may require (MN) 2 steps for an image of size MxN.

B. Autocorrelation Approach
The approach that is used by this method is that detection here is done based on autocorrelation. Due to the autocorrelation peaks are introduced in the original and copied segments for the shifts that matches the copied-moved sections. Thus these peaks are used for copy-move forgery detection. Because, most of the power of natural mages lies in their lowfrequencies bands, thus if the autocorrelation is determined directly for the image itself, it would result in large peaks at the corners of image and their neighborhoodsas well. Therefore, autocorrelation should not be determined directly from the image but can be done from its version that is high pass filtered. There are several high-pass filters like Marr edge detector, Sobel edge detector, Laplacian edge detector, and noise extracted. The demerit of this approach is that it is effective for large duplicated regions of the image.

C. Block-Matching Procedure
There are two block matching procedures those are an exact match and robust match. In the exact match, those parts of the image are detected that match exactly where as in robust match, the concept is very similar to the exact match except that order and matching of the pixel representation of the blocks is not done in this method, but their robust representation is done for the blocks that comprises of quantized DCT coefficients.

D. Key Point-based methods
This method comprises of a SIFT (Scale Invariant Feature Transform) algorithm that can be used for detailed detection. This algorithm is robust in contradiction of post processing. This method determines SIFT key points and matches these key points with one another to detect forgeries. If the result is in the form of matched SIFT points, then the image is considered as copy-move forgeries. This matching procedure is computed for every key point by classifying its nearest neighbor. When this method needs to detect forgeries in the high scale images, this method faces some problems. Therefore BBF (Best-Bin-First) search method is used for matching. In BBF technique, classification is done by greatest related vectors with a maximum prospect and minimum computation. After that one tempered image is taken into account and repeated the detection for the threshold that is dissimilar. There is one more algorithm for detection that is speeded up Robust Features (SURF) algorithm. This algorithm uses Hessian matrix identifying and defining the key points and then allocates the placement. Then the SURF descriptors are used for matching. The threshold is used to increase the robustness and avoids false indentifications.

IV. Methodology

In our work, the technique for the detection of the copy move forgery was implemented. The method applied in this is the Wavelet Transformation process. The work was done for both the DWT (Discrete Wavelet Transformation), and SWT (Stationary Wavelet Transformation) approaches. Wavelet Transform is considered as one of the excellent tools which have the ability to determine the location of areas having the high and the low frequencies. Wavelet Transforms is not similar to the FT (Fourier Transform) technique. There is a lot of difference between these two approaches. The FT (Fourier Transform) provides only the information regarding the frequency only, but in the Wavelet Transform, it provides the information for the frequency as well as of the temporal or the spatial information. The overall implementation of the work was done in the MATLAB Software.

4.1 DWT (Discrete Wavelet Transformation)

DWT is the technique which can help in reducing the size of the image at each level. The primary purpose of the Wavelet transform is to decompose a signal into a fixed basic function. These features are known as wavelet. Mother Wavelet is defined as the wavelets which are obtained from a single model wavelet by shifting and dilation. DWT divides the signal into low and high-frequency parts. The low frequency contains the raw information of the signal, and the high-frequency part consists of the information regarding the edge components.
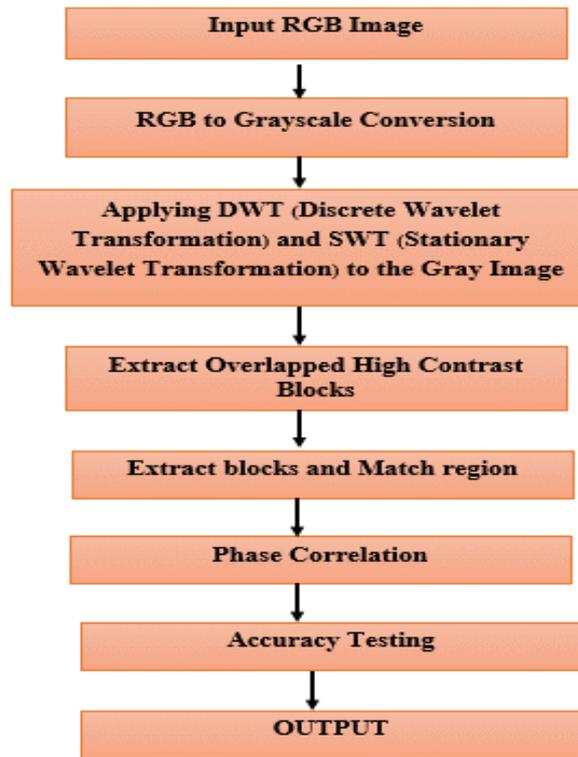
4.2 SWT (Stationary Wavelet Transformation)

SWT helps in modifying the low and the high pass filters at each level of decomposition, and it also helps in eliminating the down sampling. SWT costs little higher as compared to the DWT method. In our work, the accuracy of the DWT method is more as compared to the SWT technique.

4.3 Steps of Methodology

1. The CoMoFoD Database of the Images is considered for our. First, the input image was read, and the conversion of the input image from RGB (Red-Green-Blue) to Grayscale was done.
2. The DWT (Discrete Wavelet Transformation) and SWT (Stationary Wavelet Transformation) approaches are applied to the input Image. Using DWT, the image got decomposed into four sub bands; these bands are LL, LH, HL, and HH. The most of the data is focused on the LL sub band, which is considered as the estimation of the image also. The size of the picture got reduced to every level by the DWT transformation.
3. After applying the SWT and DWT Approaches, the extraction of the high contrast blocks was done. Calculations of the contrast for each block was done. Ignore the blocks in which the contrast is less than the specified value of the threshold.
4. Matrix sorting is the next step after extracting the high contrast blocks.
5. Calculation of the phase correlation was done. In this, the phase correlation was calculated for the block corresponding to the recent row with the blocks to the above and below of that row.
6. Then, extraction of blocks and the matching of the region was done.
7. After this, various output parameters were calculated for this work. The output parameters that werecomputed in this are as following:
1. False Positive
2. True Positive
3. False Negative
4. True Negative
5. True Positive Rate
6. False Positive Rate
7. Sensitivity
8. Specificity
9. Accuracy

4.4Flowchart

Input RGB Image

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RGB to Grayscale Conversion

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Applying DWT (Discrete Wavelet Transformation) and SWT (Stationary Wavelet Transformation) to the Gray Image

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Extract Overlapped High Contrast Blocks

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Extract blocks and Match region

↓

Phase Correlation

↓

Accuracy Testing

↓

OUTPUT

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4.5 Now let us see the formulas for all the Parameters
1. True Positive (TP) is defined as the test result is one which detects the condition when the condition is present.
2. False Positive (FP) is defined as thetrial result is one that detects the condition when the condition is absent.
3. True Negative (TN) is defined as the test result is one that does not detect when there is no presence of the condition.
4. False Negative (FN) is defined as the trial result is one that does not detect the condition when there is the existence of the state.

1. True Positive Rate (TP Rate) $= \frac{TP}{(TP+FN)}$ (1)
2. True Negative Rate (TN Rate) $= \frac{TN}{(TN+FP)}$ (2)
3. Sensitivity $= \frac{TPTP}{(\quad+FN)} * 100$ (3)
4. Specificity $= \frac{TNTN}{(\quad+FP)} * 100$ (4)
5. Accuracy $= \frac{TPTP}{+FP} * 100$ (5)

V.   Result And Discussion
5.1 Results using SWT using our raw image

1)   Original Image

2) Tampered Image

3) Final Forged Detected Output

5.2 Results using DWT using our raw image

1) Original Image

2) Tampered Image

3) Forged Image

4) Final Output

5.3 Resultant Values using SWT and DWT

S.NO	Parameters	Resultant Values using SWT	Resultant Values using DWT
1.	Size of Input Image	(387*506)	(400*200)
2.	Total Number of Blocks	189620	5208
3.	Remaining Blocks after excluding the low contrast blocks	43792	1936
4.	Elapsed Time	23.71 Seconds	222.31 seconds
5.	TPrate	1.0000	1
6.	FPrate	0.0031	2.8000e-04
7.	Sensitivity	99.9985	100
8.	Specificity	99.6859	99.9720
9.	Accuracy	99.84	99.9860

5.4 Comparison of the results with the previous work [28]

In the previous work, they have used the Stationary Wavelet Transform (SWT),but we have used both Discrete Wavelet Transformation (DWT) as well as Stationary Wavelet Transform (SWT) approaches.

In their work, first they used the SWT technique, and after that, they extracted various blocks feature and then matching the blocks. If the duplicate block found then, they produced practical results. But in our case, we have implemented the DWT technique with the Phase Correlation method. In our methodology primarily,first, we have converted the input RGB image to grayscale image then we have applied DWT, after that the image was divided into overlapped blocks. After this, we have used the Phase Correlation technique to sort all the blocks. During this process, we have found some duplicate blocks. Our most significant purpose of our method is to reduce the complexity time and to reduce the overall complexity of the model. Another idea of our approach is that it works very well for the noisy images also.We have also compared the result of our work with their work. In this, the forged image was considered same as per their research,and the results of this are as following:

1) Tampered Image

2) Final Output Forged Detected Image

3) Output Values

S.NO	Parameters	Values
1.	Size of Input Image	(141x140)
2.	Total Number of Blocks	17822
3.	Remaining Blocks after excluding the low contrast blocks	3345
4.	Elapsed Time	5.03 seconds
5.	TPrate	0.9999
6.	FPrate	0.0046
7.	Sensitivity	99.9946
8.	Specificity	99.54441
9.	Accuracy	99.7690

Comparing the results with their work, the accuracy our work is 99.75 %. But they are getting the accuracy as 97.8 % for the above image shown and by using SWT (Stationary Wavelet Transform) Approach. The central part of our work is that it is working very well for the Noisy images but in their work, they are not dealing with the pictures having the Noise content.

VI. Conclusion
Digital image processing makes use of different algorithms to manipulate digital images. Manipulation of images may include the creation, processing, communicating and displaying of images. But in spite of numerous secure digital image processing algorithms, the problem of copy move forgery is increasing day by day. As the digital images are used in various applications where original images need to be secured as it is.

Therefore, in this research, we proposed algorithms to detect the forged images. The result of the proposed algorithms shows high accuracy in detecting the forged image.

References

[1]. T. Mahmood, T. Nawaz, Z. Mehmood, Z. Khan, M. Shah, R. Ashraf. "Forensic Analysis of Copy-Move Forgery in Digital Images Using the Stationary Wavelets." The Sixth International Conference on Innovative Computing Technology,August 2016.

[2]. S. Kumar, P. K. Das, Shally. "Copy-Move Forgery Detection in Digital Images: Progress and Challenges." International Journal of Computer Science and Engineering, Vol. 3, No. 2, Feb 2011.

[3]. A.B. Singh, S. DebBarma, Kh. M. Singh. "Review of Copy-Move Forgery Detection of Images using Discrete Cosine Transform." International Journal of Computer Applications, Volume 84, No 15, December 2013

[4]. Manjeshbn, Madhu. "Enhancing Image Copy-Move Forgery Detection using Particle Swarm Optimization Techniques." International Journal of Advanced Networking & Applications (IJANA), 2016.

[5]. S. Q. Saleh, M. Hussain, G. Muhammad, and G. Bebis. "Evaluation of Image Forgery Detection Using Multi-scale Weber Local Descriptors." ISVC, 2013.

[6]. J. Tang, J. Yao, R. Rangayyan, Y. Yang."Introduction to the Issue on Digital Image Processing Techniques for Oncology" IEEE, Vol. 3, February 2009.

[7]. S. Wenchang, Z. Fei, Q. Bo, L. Bin. "Improving Image Copy-Move Forgery Detection with Particle Swarm Optimization Technique." 2016.

[8]. R. Sekhar, A. S. Chithra"Recent Block-based Methods of Copy-Move Forgery Detection in Digital Images." International Journal of Computer Applications, Volume 89, No 8, March 2014.

[9]. N. Singhal and S. Gandhani. "Analysis of Copy-move Forgery Image Forensics: A Review." International Journal of Signal Processing, Image Processing, and Pattern Recognition, Vol.8, No.7 (2015).

[10]. "Create Innovative Digital Image Processing Project output - Video Dailymotion,"Dailymotion, 2017. [Online]. Available:http://www.dailymotion.com/video/x38agcb_create-innovative-digital-image-processing-project-output_school. [Accessed: 19- May- 2017].

[11]. G. Mohammad, M. Hussain, K. Khawaji "A Review Blind copy move image forgery detection using dyadic undecimated wavelet transform" IEEE., March 2017.

[12]. M. Soni, A. Khare, S. Jain. "A Survay of Digital Image Processing and its problems" International Journal of Scientific and Research Publications, Vol. 4, Issue 2, February 2014, pp.1-6, 2014.

[13]. M. Hussain, S. Qasem, G. Bebis, G Muhamad, H. Aboalsamh, H. Mahkour. "Evaluation of Image Forgery Detection Using Multi-scale Weber Local Descriptors." International Journal on Artificial Intelligence Tools, Vol. XX, No. X, 2014.

[14]. S. Dewangan. "Importance and Application of Digital Image Processing" IJCSET, Vol.7, July 2016, pp. 316-320, 2016.