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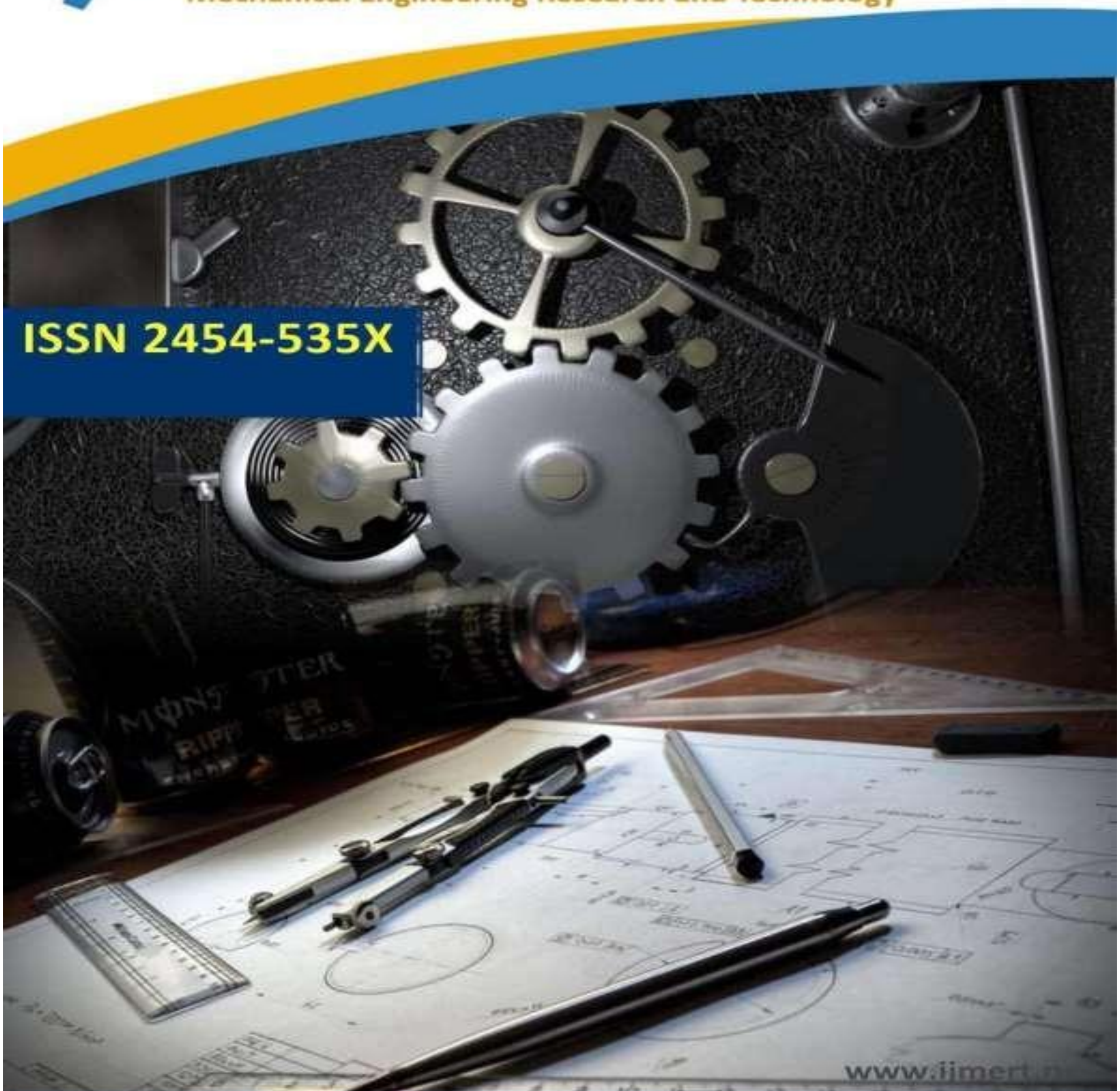

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IMAGE COPY-MOVE FORGERY DETECTION BASEDON SPATIAL DOMAIN

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Abstract— A prominent trend in information deception is the manipulation of digital images. One kind of manipulation is copy-move forgery. Whether active (with prior information of the source picture) or passive (without), image forgery is the study of identifying image altering. Even after the copied area has been rotated in the spatial domain, our proposed approach for recognizing Copy-Move regions is efficient and quick. The suggested approach uses parallel block comparisons to speed up the blocking matching mechanism. The first step in feature extraction is to split the picture into overlapping blocks of a given size. The blocks are grouped into distinct clusters using the k-means clustering algorithm. A similarity measure is computed between each adjacent block to ascertain their degree of similarity after the feature vectors of every cluster block are lexicographically sorted using radix sort. Even after an image has been altered by jpeg compression, rotation, or smoothing conditions, the suggested approach may effectively recognize the duplicated parts, according to the testing findings. When compared to other efforts, the suggested solution cut processing time by as much as 75%. Blind image forensics, picture falsification detection, copy-move forgery, image manipulation, and image tampering are all related terms.

INTRODUCTION

The rapid advancement of photographic technology has made digital image counterfeiting possible. In many areas, including journalism (which shapes public opinion), crime, etc., the detection of digital picture forgeries is an essential problem. It is possible to classify picture forgery detection techniques as either active or passive.

Various approaches using digital watermarks have been put forward in recent years. The active technique relies on previously known information about the source picture, which is often unavailable. To verify the authenticity of the picture, passive or blind procedures should be used. There are three main kinds of picture counterfeiting: copy-move forgery, image compositing (the practice of combining two or more images), and image enhancement (the process of obscuring parts of the image, increasing its brightness, etc.). Copy-Move with rotation modification, or Copy-Rotate-Move (CRM) for short, is the subject of this research. In this method, one section of an image is copied, then rotated and pasted onto another section of the same picture

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(see Fig.1).

Fig. 1. Example of *CM* forgery: (a) Original image and (b) Forgered image.

One approach to finding copied portions is Block Matching, which involves splitting the picture into overlapping blocks of a specified size and then matching each block with every other block in the same image. For the purpose of matching with other blocks, several traits are retrieved to serve as representatives of the blocks. As a consequence of taking the distance threshold into account, the output is matched blocks. Nevertheless, this approach requires a significant amount of time. Improving the block matching complexity may be achieved in a number of different ways. Identifying the areas where the juggler likes to spin, etc., becomes simpler with duplicated parts that have not been modified.

Discrete Cosine Transform (DCT) was used as a discriminative feature by Huang et al. [3], but, it is unable to identify duplicated regions with rotations greater than 5 º. Picture blocks were used as features in the principal component analysis (PCA) by Section I: New Approach
Determining if a picture has duplicated areas—with or without modifications like rotation, reflection, or blurring—is the job of the detection technique. It would be computationally difficult to attempt to investigate every conceivable scenario given that the areas' shapes and sizes are unknown.

a quick clustering method that divides things into K groups according to shared characteristics. For integers, K is a positive value. To sort data into

Popescu et al. [4]. Nevertheless, the aforementioned approach is ineffective when applied to blocks that undergo any geometric modification, including scaling, rotation, etc. In order to gather blocks that were comparable within the same class, G. Lynch et al. [5] used manual grouping.

By using automated block clustering and parallel block comparisons, the suggested approach in this study may identify CRM in the spatial domain and speed up the usual block matching process. Also, it works well with jpeg compression, Gaussian blurring, and reflection, so you can be sure of accurate results.
Section II provides a detailed explanation of the proposed system, and the remainder of the work is structured accordingly. Experimental findings are presented in Section III. The article is concluded in Section IV.

clusters, we minimize the square of the distances between each set of points and the centroid of each cluster. To make K-means run faster, we used D. Arther's Fast K-Means method (FKM) [6], which sidesteps

divisions into sections of varying sizes and shapes. It works better to split a picture into overlapping sections of a constant size.
Figure 2 depicts the suggested approach, which involves dividing the picture into blocks that overlap

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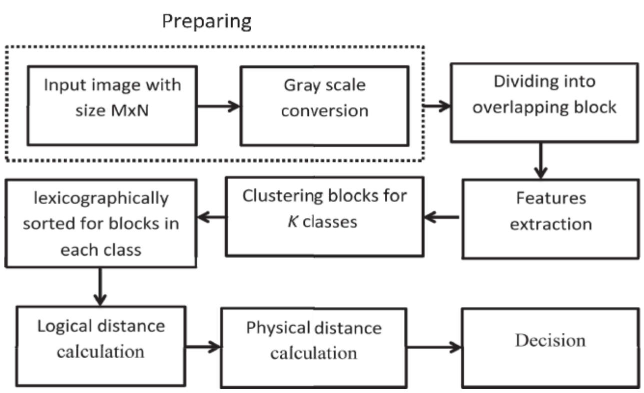
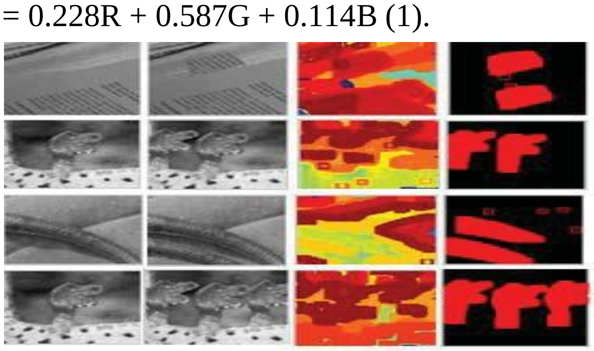
with each other. In order to extract features from each block, we divide it into nested frames and then average them. In the clustering process, these traits are used to categorize blocks that are comparable. Radix sort is used for lexicographic sorting of the feature vectors for each class. If the result of the comparison between any two blocks in close proximity is less than a certain threshold, then we say that the two blocks are comparable. Additionally, in order to decrease false positives, the spatial distance between these blocks is computed. In this part, we will go into further depth about each system process.



wasteful distance computations by using the triangle inequality and maintaining a record of minimum and maximum distances between centers and points. The FKM has been used for clustering in this study. Matrix C stores the feature values from each vector so that the FKM method may be used. The feature vectors of the blocks have been radix-sorted lexicographically for each class [7].It's a reliable sorting algorithm that's quick and doesn't rely on comparisons. An example of digits sorted using radix sort is shown in Figure 5.

Grayscale photographs are the only ones that have been used with the proposed method. For example, if the original picture is in RGB format, it will be converted to a grayscale version using the formula I = 0.228R + 0.587G + 0.114B (1).



the third

Fig. In example 4, we have a block that has been rotated by three fundamental angles: 90 degrees, 180 degrees, and 270 degrees. It is worth mentioning that the block's values remain constant during the block's frame.

Array A, with a size of (B × (num+2)), is used to hold all blocks at the end. Assume b= 9 for the sake of argument; therefore, 7 features would result from a feature vector length of 5 frames averaged plus 2 for the block center.

B.Kernel-based Clustering

To facilitate concurrent comparisons, we clustered blocks into numerous classes using the cluster approach; the K-means algorithm was evaluated.

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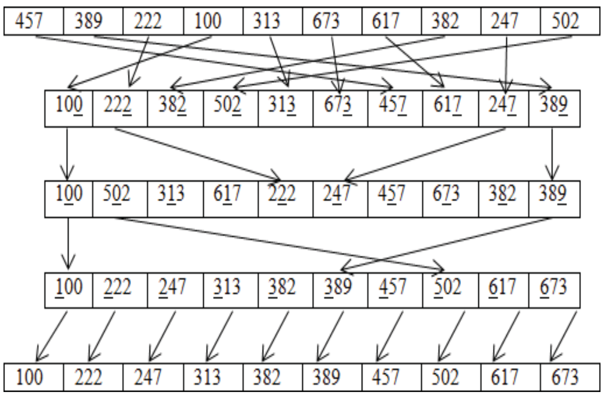

Fig. 5. An example of radix sort.

B. Outcome Visually
The results of identifying manipulated photos without distortion procedures are shown in Figure 6. Each row has four images, one each of the original, manipulated, clustering, and detection findings, which display duplicated areas from left to right. A simple angle detection approach for CRM is proposed. The results of the detection for rotation angles of 90º, 180º, and 270º are shown in Figures 7, 8, and 9, respectively. Figure 10 displays the results of horizontal reflection detection, while Figure 11 displays the results of vertical reflection detection.

Make sure to highlight the areas on the map when the logical distance is less than or equal to a threshold T and the physical distance is larger than or equal to a threshold.

Additionally, opening operation eliminates isolated parts of area smaller than a threshold Ath. The modified black and white picture is then used to highlight the discovered sections that are comparable.
Page 1: Experimental Findings
Here, we lay out the experimental setup and settings, and then we go over the findings to show that our approach is both sensitive and resilient.

i+1

Two blocks are considered to be comparable if dif is less than a threshold T. The elimination of false positives is achieved by testing the physical distance using (5).

diy is equal to the square root of the difference between Aynum+1 and Asnum+1.addition of 2 to the product of (num+2 - num+2)2

i+1

A. Procedure and technique of the experiment
The studies were conducted on a Matlab R2012a with 4 GB of RAM and a 2.30 GHZ CPU. Among the data set's contents were all imagery used in the experiment [8]. A grayscale picture with dimensions of 128×128 pixels was saved in BMP format for all objects. The experiment's parameters were set as follows: T=0.2, Nd=16, Ath=10, and K=4, 10, and 20.

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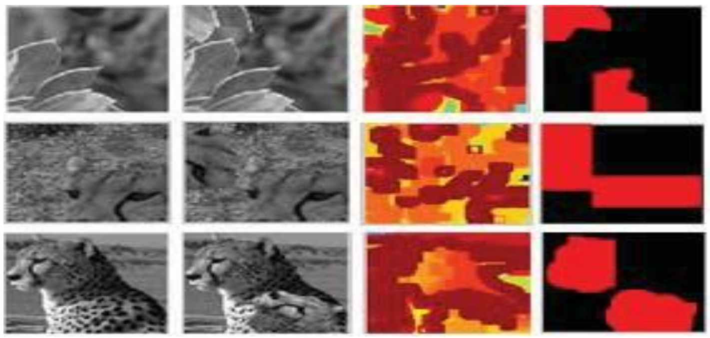
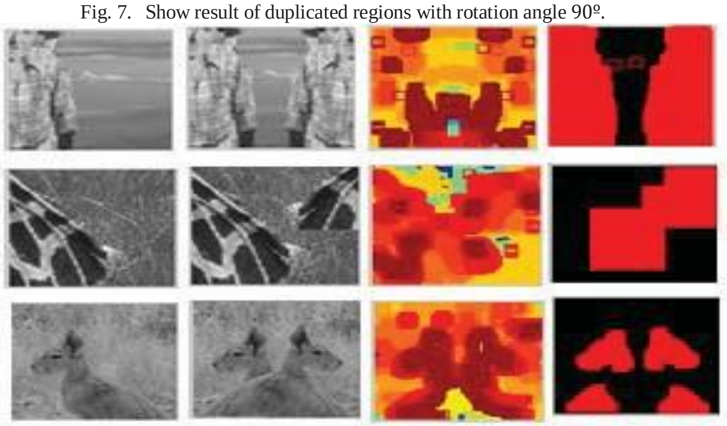


Fig. 7. Show result of duplicated regions with rotation angle 90º.



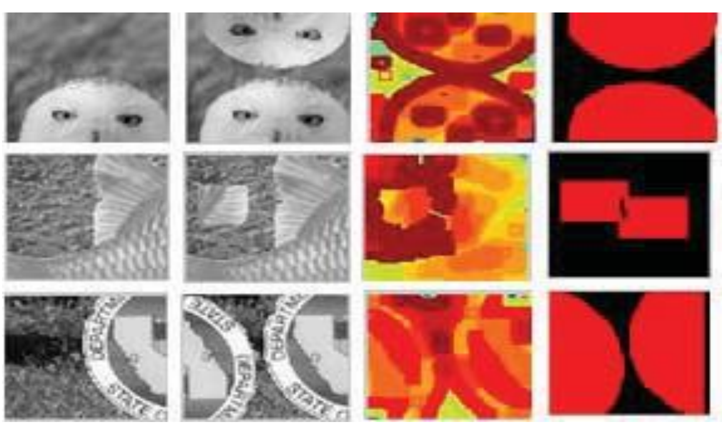


Fig. 8. Show result of duplicated regions with rotation angle 180º.

The proposed method reduces processing time up to 75% of other previous works in Table I. Note that, time decreases when K increases as shown in Fig.12.

Precision and recall has been calculated as the metrics for quantifying the accuracy of forgery detection show in Table II. The precision and recall rates are defined as follows:

Fig. 10. Show result of duplicated regions with horizontal reflection.

$$precision = (Forged\ Blocks \cap Detected\ Blocks)$$

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Fig. 11. Show result of duplicated regions with vertical reflection.

More detected results over tampered images with some modifications shown in Fig.13 that shows in first row original image, detected result with Gaussian blur in second row and in thread row the detected result over JPEG compressed with Q=70.

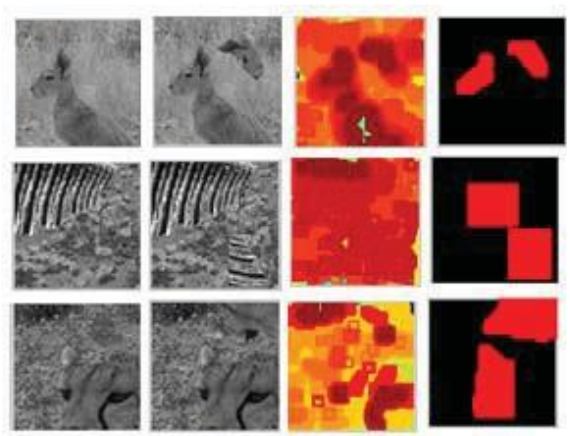

Fig. 9. Show result of duplicated regions with rotation angle 270º.

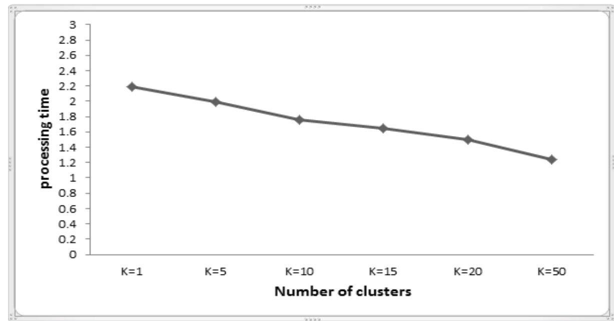

Fig. 12. Show the performance time of different k.

Table III shows the performance rate for different methods. Table IV presents the number of true positives and false positives for different *T* for the results shown in Fig.14. Table V depicts the detection rates for some datasets of copy-move images with some modification.

Fig. 13. Show the result with Gaussian blur (top) and JPEG compression QF=70 (bottom).

TABLE I. THE PERFORMANCE TIME OF DIFFERENT METHODS

Time	Different methods		
	G. Lynch [5]	***Y. Huang [3]***	***Proposed***
	7.68	4.7005	1.5237

TABLE II. THE PRECISION AND RECALL FOR DIFFERENT METHODS

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Rate	Different methods		
	G. Lynch [5]	*Y. Huang [3]*	*Proposed*
Precision	97%	99%	99.9 %
Recall	95%	97.5%	99%

TABLE III. THE PERFORMANCE RATE FOR DIFFERENTMETHODS

Modifications	Different methods		
	G. Lynch [5]	*Y. Huang [3]*	*Proposed*
Without modification	97%	99.9%	99.9%
Rotation	0%	Only less than 5°	99.5%
Gaussian blur	30%	90%	90%
JPEG compression	30%	80%	70%

TABLE IV. TRUE POSITIVE AND FALSE POSITIVE FOR FIG.14.

Threshold	Number of blocks		
	Detection	True Positive	False Positive
0.1	1336	1336 (100%)	0 (0.00%)
0.2	1338	1336 (99.85%)	2 (0.14%)
0.3	1340	1336 (99.70%)	4 (0.29%)
0.4	1343	1336 (99.47%)	7 (0.52%)

Fig. 14. Show the result for different Thresholds: up row shows original image and copy-Rotate-Move image from left to right recpictivley and down row shows result with T=0.1, T=0.2, T=0.3 and T=0.4.

I. CONCLUSIONS AND FUTURE WORK

In this paper, we have proposed a fast and efficient method for CM forgery detection whether without modification and with rotation modify, by using Fast K-means and block frames features. It works in the absence of digital watermarking and does not need any prior information about the tested image. Compare with previous works, our algorithm fast and was more effective. The experiment results show that the proposed method has the ability to detect *CM* and *CRM* forgery in an image faster than other systems by about 75%. In the future, we work in detect Copy-Rotate-Move with any angle, and detect CM with scale modification.

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