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A comprehensive evaluation procedure for copy-move forgery detection methods: results from a systematic review

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Abstract

In the current age, the wide use of digital images has led to the manipulations of content that misrepresent information with malicious goals. This issue demands the requirement of digital image investigation to authenticate the source and certify the trustworthiness of images. One image manipulation technique is called copy-move forgery (CMF), which duplicates one or more regions in an image before it is pasted to another location within the same image. In this paper, a systematic review is

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evaluation levels. At present, CMF detection performance is evaluated either through image-level, pixel-level, or both level evaluations. Image-level evaluation identifies an image either as forged or not while all images in pixel-level evaluation are treated as forged images to localise the CMF regions. The study shows that both image and pixel-level evaluations are dependent and must be incorporated together to ensure a fair evaluation is conducted. A comprehensive evaluation procedure that covers both evaluations is proposed as a guide to future research. The procedure is then examined with seven state-of-the-art CMF detection methods based on keypoint, block, and combination approaches using three available CMF datasets that consist of multiple CMF attacks. The results are measured using multiple F-score values: image scores, pixel scores, and a multiplication of both of these to get the overall percentages of the detection. The results show that the block-based approach is able to obtain the highest percentages of detection in almost all cases of attacks in CMF.

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References

1. Abdalla Y, Iqbal MT, Shehata M (2019)
Convolutional neural network for copy-move
forgery detection. Symmetry (Basel) 11(10):1–17.
[https://doi-
org.ezproxy.um.edu.my/10.3390/sym11101280](https://doi-org.ezproxy.um.edu.my/10.3390/sym11101280)
2. Agarwal R, Verma OP (2020) An efficient copy
move forgery detection using deep learning
feature extraction and matching algorithm.
Multimed Tools Appl 79(11–12):7355–7376.
[https://doi-
org.ezproxy.um.edu.my/10.1007/s11042-019-](https://doi-org.ezproxy.um.edu.my/10.1007/s11042-019-)

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state-of-the-art. Forensic Sci Int 231(1–3):284–295. <https://doi-org.ezproxy.um.edu.my/10.1016/j.forsciint.2013.05.027>

4. Al-Qershi OM, Khoo BE (2018) Evaluation of copy-move forgery detection: datasets and evaluation metrics. Multimed Tools Appl 77(24):31807–31833. <https://doi-org.ezproxy.um.edu.my/10.1007/s11042-018-6201-4>

5. Al-Qershi OM, Khoo BE (2019) Enhanced block-based copy-move forgery detection using k-means clustering. Multidimens Syst Signal Process 30(4):1671–1695. <https://doi-org.ezproxy.um.edu.my/10.1007/s11045-018-0624-y>

6. Amerini I, Ballan L, Caldelli R, Del Bimbo A, Serra G (2011) A SIFT-based forensic method for copy – move attack detection and transformation recovery. IEEE Trans Inf Forensics Secur 6(3):1099–1110

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Commun 28(6):659–669. <https://doi-org.ezproxy.um.edu.my/10.1016/j.image.2013.03.006>

8. Ardizzone E, Bruno A, Mazzola G (2015) Copy – move forgery detection by matching triangles of Keypoints. IEEE Trans Inf Forensics Secur 10(10):2084–2094

9. Bi X, Pun CM, Yuan XC (2016) Multi-level dense descriptor and hierarchical feature matching for copy-move forgery detection. Inf Sci (Ny) 345:226–242. <https://doi-org.ezproxy.um.edu.my/10.1016/j.ins.2016.01.061>

10. Bo X, Junwen W, Guangjie L, Yuewei D (2010) Image copy-move forgery detection based on SURF. In: International conference on multimedia information networking and security, pp 889–892. <https://doi-org.ezproxy.um.edu.my/10.1109/MINES.2010.189>

11. Praveen Selvaraj S, Nandi AK (2011) Automated

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12. Cao Y, Gao T, Fan L, Yang Q (2012) A robust detection algorithm for copy-move forgery in digital images. *Forensic Sci Int* 214(1–3):33–43. <https://doi-org.ezproxy.um.edu.my/10.1016/j.forsciint.2011.07.015>
-

13. Carkir S, Cetin AE (2010) Two-dimensional mellin and mel-cepstrum for image feature extraction. In: *Proceedings of the 25th International Symposium on Computer and Information Sciences*, pp 271–276
-

14. Chen CC, Lu WY, Chou CH (2019) Rotational copy-move forgery detection using SIFT and region growing strategies. *Multimed Tools Appl* 78(13):18293–18308. <https://doi-org.ezproxy.um.edu.my/10.1007/s11042-019-7165-8>
-

15. Christlein V, Riess C, Jordan J, Riess C, Anagnostou E (2018) An evaluation of popular

16. Cozzolino D, Poggi G, Verdoliva L (2014) Copy-Move Forgery Detection Based On Patchmatch. In: IEEE International Conference on Image Processing, pp 5247–5251

17. Cozzolino D, Poggi G, Verdoliva L (2015) Efficient dense-field copy – move forgery detection. IEEE Trans Inf Forensics Secur 10(11):2284–2297

18. Davarzani R, Yaghmaie K, Mozaffari S, Tapak M (2013) Copy-move forgery detection using multiresolution local binary patterns. Forensic Sci Int 231(1–3):61–72. [https://doi-org.ezproxy.um.edu.my/10.1016/j.forsciint.2013.04.023](https://doi.org.ezproxy.um.edu.my/10.1016/j.forsciint.2013.04.023)

19. Dixit R, Naskar R (2017) Review, analysis and parameterisation of techniques for copy-move forgery detection in digital images. IET Image Process 11(9):746–759. <https://doi-org.ezproxy.um.edu.my/10.1049/iet-ipr.2016.0322>

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Multimed Tools Appl 79(27–28):19167–19192.

<https://doi->

[org.ezproxy.um.edu.my/10.1007/s11042-020-](https://doi-org.ezproxy.um.edu.my/10.1007/s11042-020-)

[08751-7](https://doi-org.ezproxy.um.edu.my/10.1007/s11042-020-08751-7)

21. Emam M, Han Q, Niu X (2016) PCET based copy-move forgery detection in images under geometric transforms. Multimed Tools Appl 75(18):11513–11527. <https://doi-org.ezproxy.um.edu.my/10.1007/s11042-015-2872-2>
-

22. Fridrich J, Soukal D, Lukáš J (2003) Detection of copy-move forgery in digital images. Int J Comput Sci Issues 3:652–663. <https://doi-org.ezproxy.um.edu.my/10.1109/PACIIA.2008.240>
-

23. Gani G, Qadir F (2020) A robust copy-move forgery detection technique based on discrete cosine transform and cellular automata. J Inf Secur Appl 54:102510. <https://doi-org.ezproxy.um.edu.my/10.1016/j.jisa.2020.102510>

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15(3):656–665. <https://doi-org.ezproxy.um.edu.my/10.1049/ipr2.12051>

25. Huang H, Guo W, Zhang Y (2008) Detection of copy-move forgery in digital images using SIFT algorithm. In: IEEE Pacific-Asia Workshop on Computational Intelligence and Industrial Application, pp 272–276. <https://doi-org.ezproxy.um.edu.my/10.1109/PACIIA.2008.240>

26. Huang Y, Lu W, Sun W, Long D (2011) Improved DCT-based detection of copy-move forgery in images. *Forensic Sci Int* 206(1–3):178–184. <https://doi-org.ezproxy.um.edu.my/10.1016/j.forsciint.2010.08.001>

27. Jing D, Wei W (2011) CASIA tampered image detection evaluation (TIDE) database. . <http://forensics.idealtest.org/casiav2/>. Accessed 28 Apr 2015

28. Kim S, In-So K (2002) Probabilistic model-based object recognition using local Zemike

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based duplication detection algorithm. In: 3rd Canadian Conference on Computer and Robot Vision (CRV'06), pp 64–64. <https://doi-org.ezproxy.um.edu.my/10.1109/CRV.2006.9>

30. Li Y, Zhou J (2019) Fast and effective image copy-move forgery detection via hierarchical feature point matching. IEEE Trans Inf Forensics Secur 14(5):1307–1322. <https://doi-org.ezproxy.um.edu.my/10.1109/TIFS.2018.2876837>

31. Li J, Li X, Yang B, Sun X (2015) Segmentation-based image copy-move forgery detection scheme. IEEE Trans Inf Forensics Secur. 10(3):507–518. <https://doi-org.ezproxy.um.edu.my/10.1109/TIFS.2014.2381872>

32. Liao X, Yin J, Chen M, Qin Z (2020) Adaptive payload distribution in multiple images steganography based on image texture features. IEEE Trans. Dependable Secur. Comput XX(XX). <https://doi-org.ezproxy.um.edu.my/10.1109/TDSC.2020.30>

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steganography. IEEE Trans Circuits Syst Video Technol 30(3):685–696. <https://doi-org.ezproxy.um.edu.my/10.1109/TCSVT.2019.2896270>

34. Liao X, Li K, Zhu X, Liu KJR (2020) Robust detection of image operator chain with two-stream convolutional neural network. IEEE J Sel Top Signal Process 14(5):955–968. <https://doi-org.ezproxy.um.edu.my/10.1109/JSTSP.2020.3002391>

35. Lynch G, Shih FY, Liao H-YM (2013) An efficient expanding block algorithm for image copy-move forgery detection. Inf Sci (Ny) 239:253–265. <https://doi-org.ezproxy.um.edu.my/10.1016/j.ins.2013.03.028>

36. Mahdian B, Saic S (2007) Detection of copy-move forgery using a method based on blur moment invariants. Forensic Sci Int 171:180–189. <https://doi-org.ezproxy.um.edu.my/10.1016/j.forsciint.2007.08.011>

This website sets only cookies which are necessary for it to function. They are used to enable core functionality such as security, network management and accessibility. These cookies cannot be switched off in our systems. You may disable these by changing your browser settings, but this may affect how the website functions. Please view our privacy policy for further details on how we process your information. Dismiss

transform. J Inf Secur Appl. 52:102481.

<https://doi->

[org.ezproxy.um.edu.my/10.1016/j.jisa.2020.102](https://doi-org.ezproxy.um.edu.my/10.1016/j.jisa.2020.102)

[481](https://doi-481)

38. Mishra P, Mishra N, Sharma S, Patel R (2008)
Region duplication forgery detection technique
based on SURF and HAC. Sci World J
2013(July):2013

39. Muhammad G, Hussain M, Bebis G (2012)
Passive copy move image forgery detection
using Undecimated dyadic wavelet transform.
Digit Investig 9(1):49–57. <https://doi->
[org.ezproxy.um.edu.my/10.1016/j.diin.2012.04.](https://doi-org.ezproxy.um.edu.my/10.1016/j.diin.2012.04.)
[004](https://doi-004)

40. Myna AN, Venkateshmurthy MG, Patil CG
(2008) Detection of region duplication forgery
in digital images using wavelets and log-polar
mapping. In: Proceedings - International
Conference on Computational Intelligence and
Multimedia Applications, ICCIMA 2007, vol 3,
pp 371–377. <https://doi->
[org.ezproxy.um.edu.my/10.1109/ICCIMA.2007.](https://doi-org.ezproxy.um.edu.my/10.1109/ICCIMA.2007.)

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feature. *Multimed Tools Appl.* <https://doi-org.ezproxy.um.edu.my/10.1007/s11042-020-09225-6>

42. Park JY, Kang TA, Moon YH, Eom IK (2020) Copy-move forgery detection using scale invariant. *Symmetry (Basel)*. 12(492):1–16

43. Prakash CS, Panzade PP, Om H, Maheshkar S (2019) Detection of copy-move forgery using AKAZE and SIFT keypoint extraction. *Multimed Tools Appl.* <https://doi-org.ezproxy.um.edu.my/10.1007/s11042-019-7629-x>

44. Pun C, Member S, Yuan X, Bi X (2015) Image forgery detection using adaptive Oversegmentation and feature point matching. *IEEE Trans Inf Forensics Secur.* 10(8):1705–1716

45. Ryu SJ, Lee MJ, Lee HK (2010) Detection of copy-rotate-move forgery using zernike moments. In: 12th international conference, vol 6387, pp 51–65. <https://doi->

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Rotation invariant localization of duplicated image regions based on zernike moments. IEEE Trans Inf Forensics Secur. 8(8):1355–1370.

<https://doi-org.ezproxy.um.edu.my/10.1109/TIFS.2013.2272377>

47. Silva E, Carvalho T, Ferreira A, Rocha A (2015) Going deeper into copy-move forgery detection: exploring image telltales via multi-scale analysis and voting processes. J Vis Commun Image Represent 29:16–32. <https://doi-org.ezproxy.um.edu.my/10.1016/j.jvcir.2015.01.016>
-

48. Somayeh S, Hamid AJ, Wong K, Uliyan D, Dadkhah S (2017) Keypoint based authentication and localization of copy-move forgery In digital image. Malaysian J Comput Sci 30(2):117–133
-

49. Tahaoglu G, Ulutas G, Ustubioglu B, Nabiyev VV (2021) Improved copy move forgery detection method via $L^*a^*b^*$ color space and enhanced localization technique. Multimed

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50. Teerakanok S, Uehara T (2019) Copy-move forgery detection: a state-of-the-art technical review and analysis. IEEE Access 7:40550–40568. <https://doi-org.ezproxy.um.edu.my/10.1109/ACCESS.2019.2907316>

51. Ustubioglu B, Ulutas G, Ulutas M, Nabiyev VV (2016) A new copy move forgery detection technique with automatic threshold determination. AEU - Int J Electron Commun 70(8):1076–1087. <https://doi-org.ezproxy.um.edu.my/10.1016/j.aeue.2016.05.005>

52. Vaishnavi D, Subashini TS (2019) Application of local invariant symmetry features to detect and localize image copy move forgeries. J Inf Secur Appl 44:23–31. <https://doi-org.ezproxy.um.edu.my/10.1016/j.jisa.2018.11.001>

53. Wang XY, Wang C, Wang L, Jiao LX, Yang HY, Niu PP (2020) A fast and high accurate image copy-move forgery detection approach.

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54. Wang Y, Kang X, Chen Y (2020) Robust and accurate detection of image copy-move forgery using PCET-SVD and histogram of block similarity measures. J Inf Secur Appl 54:102536. <https://doi-org.ezproxy.um.edu.my/10.1016/j.jisa.2020.102536>

55. Warif NBA, Wahab AWA, Idris MYI, Ramli R, Salleh R, Shamshirband S, Choo KKR (2016) Copy-move forgery detection: survey, challenges and future directions. J Netw Comput Appl 75:259–278. <https://doi-org.ezproxy.um.edu.my/10.1016/j.jnca.2016.09.008>

56. Warif NBA, Wahab AWA, Idris MYI, Salleh R, Othman F (2017) SIFT-symmetry: a robust detection method for copy-move forgery with reflection attack. J Vis Commun Image Represent 46:219–232. <https://doi-org.ezproxy.um.edu.my/10.1016/j.jvcir.2017.04.004>

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<https://doi-org.ezproxy.um.edu.my/10.1016/j.forsciint.2018.12.004>

58. Yu L, Han Q, Niu X (2016) Feature point-based copy-move forgery detection: covering the non-textured areas. *Multimed Tools Appl* 75(2):1159–1176

59. Zandi M, Mahmoudi-Aznavah A, Talebpour A (2016) Iterative copy-move forgery detection based on a new interest point detector. *IEEE Trans Inf Forensics Secur.* 11(11):1–2512.
<https://doi-org.ezproxy.um.edu.my/10.1109/TIFS.2016.2585118>

60. Zhao J, Guo J (2013) Passive forensics for copy-move image forgery using a method based on DCT and SVD. *Forensic Sci Int* 233(1–3):158–166. <https://doi-org.ezproxy.um.edu.my/10.1016/j.forsciint.2013.09.013>

61. Zhang J, Liu Y, Bao J, Zhu T, Yao Y, Yang H

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62. Zhu Y, Chen C, Yan G, Guo Y, Dong Y (2020) AR-net: adaptive attention and residual refinement network for copy-move forgery detection. IEEE Trans Ind Informatics 16(10):6714–6723. [https://doi-org.ezproxy.um.edu.my/10.1109/TII.2020.2982705](https://doi.org/10.1109/TII.2020.2982705)
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Ethics declarations

Conflict of interest

All authors have no competing interest to declare that are relevant to the content of this article.

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