Person re-identification in video surveillance systems by feature replacement of occluded parts of human figures

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Abstract

The algorithm for re-identifying people in intelligent video surveillance systems is proposed. It is based on the construction of a compound neural network descriptor and replacing features of occluded parts of a human figure. Composite descriptors are generated for all images in a gallery and recorded in a table. They characterize the global and local features of each person, considering his individual parts' visibility. Detection and selection of areas of interest for the formation of local descriptors is carried out based on detecting key points of the human body. If a person is partially occluded by other people or objects, then the corresponding region is classified as invisible, and the compound descriptor of respective component will be invalid and equal to zero. For images whose feature vector has zero components, the feature table is ranked according to the cosine similarity metric for each visible local fragment. Based on the feature table rankings, the k-nearest neighbors are determined and the k1-best are selected from them. The corresponding k_1-nearest neighbors' component average value of the feature vector is used to replace the zero descriptor components. The feature table is then

updated for the generated vectors and ranking is performed according to the query using the cosine similarity metric. ResNet-50 and DenseNet-121 were used as backbone CNNs for feature extraction, and testing was performed using Market-1501, DukeMTMC-ReID, Occluded-Duke, MSMT17, and PolReID1077 datasets.

Data availability

No datasets were generated or analysed during the current study.

References

1. Chen H, Ihnatsyeva SA, Bohush RP, Ablameyko SV (2023) Person re-identification in video surveillance systems using deep learning: analysis of the existing methods. Autom Remote Control 5:497–5282. https://doi.org/10.1134/S0005117923050041

   Article **Google Scholar**

2. Zhong Z, Zheng L, Kang G et al (2020) Random erasing data augmentation. AAAI Conf Artif Intell. 34(07): 13001–13008. https://doi.org/10.1609/aaai.v34i07.7000

3. Wang G, Yang S, Liu H et al (2020) High-order information matters: learning relation and topology for occluded person re-identification. In: 2020 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), pp 6448–6457. https://doi.org/10.1109/CVPR42600.2020.00648

4. Yang J, Zhang J, Yu F et al (2021) Learning to know where to see: a visibility-aware approach for occluded person re-identification. In: 2021 IEEE/CVF International Conference on Computer Vision (ICCV), pp 11865–11874. https://doi.org/10.1109/ICCV48922.2021.01167

5. Fang H, Xie S, Tai Y, Lu C (2017) RMPE: regional Multi-person Pose Estimation. In: 2017 IEEE International Conference on Computer Vision (ICCV), pp 2353–2362. https://doi.org/10.1109/ICCV.2017.256

6. Chen LC, Papandreou G, Schroff F, Adam H (2017) Rethinking atrous Convolution for semantic image segmentation. ArXiv Abs. /1706.05587https://doi.org/10.48550/arXiv.1706.05587

   Article **Google Scholar**

7. Yang Q, Wang P, Fang Z, Lu Q (2020) Focus on the visible regions: semantic-guided alignment model for occluded person re-identification. Sensors 20(16):4431. https://doi.org/10.3390/s20164431

   Article **Google Scholar**

8. Yao Z, Wu X, Xiong Z, Ma Y (2019) A dynamic part-attention model for person re-identification. Sensors 19(9): 2080. https://doi.org/10.3390/s19092080

9. Sun Y, Zheng L, Yang Y et al (2018) Beyond part models: person retrieval with refined part pooling (and A strong convolutional Baseline). Comput Vis – ECCV 2018 Lecture Notes Comput Sci 11208:501–518

   Google Scholar

10. Miao J, Wu Y, Liu P et al (2019) Pose-guided feature alignment for occluded person re-identification. In: 2019 IEEE/CVF International Conference on Computer Vision (ICCV), pp 542–551. https://doi.org/10.1109/ICCV.2019.00063

11. Miao J, Wu Y, Yang Y (2022) Identifying visible parts via pose Estimation for occluded person re-Identification. IEEE Trans Neural Netw Learn Syst 33(9):4624–4634. https://doi.org/10.1109/TNNLS.2021.3059515

    Article **Google Scholar**

12. Kalayeh MM, Basaran E, Gokmen M et al (2018) Human semantic parsing for person re-identification. In: 2018 IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp 1062–1071. https://doi.org/10.1109/CVPR.2018.00117

13. Chen Y, Zhu X, Gong S et al (2017) Person re-identification by deep learning multi-scale representations. In: 2017 IEEE International Conference on Computer Vision Workshops (ICCVW), pp 2590–2600. https://doi.org/10.1109/ICCVW.2017.304

14. Lin Y, Zheng L, Zheng Z, etal et al (2019) Improving person re-identification by attribute and identity learning. ArXiv abs/170307220. https://doi.org/10.1016/j.patcog.2019.06.006

15. Liao S, Shao L (2022) Graph sampling based deep metric learning for generalizable person re-identification. arXiv:2104.01546. https://doi.org/10.48550/arXiv.2104.01546

16. Tan H, Liu X, Yin B, Li X (2023) MHSA-Net: multihead self-attention network for occluded person re-identification. IEEE Trans Neural Networks Learn Syst 34(11):8210–8224. https://doi.org/10.1109/TNNLS.2022.3144163

Article **Google Scholar**

17. Mamedov T, Konushin A, Konushin V (2024) ReMix: Training generalized person re-identification on a mixture of data. arXiv:2410.21938. https://doi.org/2410.21938

18. Li W, Zhao R, Xiao T, Wang X (2014) DeepReID: Deep Filter Pairing Neural Network for Person Re-identification. In: 2014 IEEE Conference on Computer Vision and Pattern Recognition, pp 152–159. https://doi.org/10.1109/CVPR.2014.27

19. Zheng L, Shen L, Tian L (2015) Scalable Person Reidentification: A Benchmark. In: 2015 IEEE International Conference on Computer Vision (ICCV), pp 1116–1124. https://doi.org/10.1109/ICCV.2015.133

20. Ristani E, Solera F, Zou RS et al (2016) Multi-camera Track ArXiv abs. Performance Measures and a Data Set for Multi-target/1609.01775. https://doi.org/10.48550/arXiv.1609.01775

21. Wei L, Zhang S, Gao W, Tian Q (2018) Person transfer GAN to bridge domain gap for person re-identification. In: 2018 IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp 79–88. https://doi.org/10.1109/CVPR.2018.00016

22. Fu D, Chen D, Bao J et al (2021) Unsupervised pre-training for person re-identification. In: 2021 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), pp 14745–14754. https://doi.org/10.1109/CVPR46437.2021.01451

23. Zheng Z (2017) Person__reID__baseline__pytorch. https://github.com/layumi/Person__reID__baseline__pytorch. Accessed 23 Dec 2024

24. Huang Y, Wu Q, Zhong Y, Zhang Z (2021) Clothing status awareness for long-term person re-idenification. In: 2021 IEEE/CVF International Conference on Computer Vision, pp 11895–11904. https://doi.org/10.1109/ICCV48922.2021.01168

25. Wang G, Lai J, Huang P, Xie X (2019) Spatial-temporal person re-identification. Proc AAAI Conf Artif Intell 33(01):8933–8940. https://doi.org/10.1609/aaai.v33i01.33018933

Article Google Scholar

26. Choi S, Kim T, Jeong M et al (2021) Meta batch-instance normalization for generalizable person re-identification. In: 2021 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), pp 3424–3434. https://doi.org/10.1109/CVPR46437.2021.00343

27. Chen P, Dai P, Liu J et al (2021) Dual distribution alignment network for generalizable person re-identification. Proc AAAI Conf Artif Intell 35(2):1054–1062. https://doi.org/10.1609/AAAI.V35I2.16190

28. Zhao C, Chen K, Wei Z et al (2019) Multilevel triplet deep learning model for person re-identification. Pattern Recognit Lett 117:161–168. https://doi.org/10.1016/j.patrec.2018.04.029

Article Google Scholar

29. Yao Y, Jiang X, Fujita H, Fang Z (2022) A sparse graph wavelet convolution neural network for video-based person re-identification. Pattern Recogn 129(16):108708. https://doi.org/10.1016/j.patcog.2022.108708

Article Google Scholar

30. Ye S, Bohush R, Chen H et al (2023) Data augmentation and fine tuning of Convolution neural network during training for person Re-identification in video surveillance system. Opt Memory Neural Netw 4(32):233–246. https://doi.org/10.3103/S1060992X23040124

Article Google Scholar

31. Dataset PolReID1077 https://github.com/SvetlanaIgn/PolReID1077. Accessed 23 Dec 2024

32. Wong KY (2022) Yolo7. https://github.com/WongKinYiu/yolov7/tree/pose. Accessed 23 Dec 2024

33. Li W, Wang X (2013) Locally aligned feature transforms across views. IEEE Conference on Computer Vision and Pattern Recognition, Portland, OR, USA. pp 3594–3601. https://doi.org/10.1109/CVPR.2013.461

34. Song G, Leng B, Liu Y et al (2018) Region-based quality estimation network for large-scale person re-identification. Thirty-Second AAAI Conf Artif Intell (AAAI-18) 32(1):7347–7354. https://doi.org/10.1609/aaai.v32i1.12305

Article **Google Scholar**

35. Zheng L, Bie Z, Sun Y et al (2016) MARS: a video benchmark for large-scale person re-identification. ECCV 2016. Lecture Notes in Computer Science. 9910:863–884. https://doi.org/10.1007/978-3-319-46466-4_52

36. Ye M, Shen J, Lin G et al (2021) Deep learning for person re-identification: a survey and outlook. IEEE Trans Pattern Anal Mach Intell 44(6):2872–2893. https://doi.org/10.1109/TPAMI.2021.3054775

Article **Google Scholar**

37. Bohush R, Ihnatsyeva S, Ablameyko S (2022) Person re-identification accuracy improvement by training a CNN with the new large joint dataset and re-rank. Mach Graphics Vis 31(1/4):93–109. https://doi.org/10.22630/MGV.2022.31.1.5

Article **Google Scholar**

38. Chen M, Wang Z, Zheng F (2021) Benchmarks for corruption invariant person reidentification. ArXiv abs/211100880. https://doi.org/10.48550/arXiv.2111.00880

39. Luo H, Gu YZ, Liao XY et al (2019) Bag of tricks and a strong baseline for deep person re-identification. In: IEEE/CVF Conference on Computer Vision and Pattern Recognition

Workshops (CVPRW). pp 1487–1495. https://doi.org/10.1109/CVPRW.2019.00190

40. Li Y, Yang Z, Chen Y et al (2022) Occluded person Re-Identification method based on multiscale features and human feature reconstruction. IEEE Access 10:98584–98592. https://doi.org/10.1109/ACCESS.2022.3203706

Article **Google Scholar**

41. Kim M, Cho M, Lee H et al (2022) Occluded person re-identification via relational adaptive feature correction learning. ICASSP 2022–2022 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), pp 2719–2723. https://doi.org/10.1109/ICASSP43922.2022.9746734

42. Wang P, Ding C, Shao Z et al (2022) Quality-Aware part models for occluded person re-Identification. IEEE Trans Multimedia 25:3154–3165. https://doi.org/10.1109/TMM.2022.3156282

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Contributions

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Ethics declarations

Conflict of interest

The authors declare no competing interests.

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- **Image augmentation**