

## 摘要

随着越来越多的大型摄像头网络被部署到各个公共场所中，人们越来越关注计算机视觉中监控视频技术领域的研究与发展。而人体目标再识别正是监控视频技术领域的核心课题之一。即给出某个摄像头下的人体图像，查询该人在其它摄像头下的图像和位置。此研究有助于实现跨摄像头人体行为分析和事件检测，从而使计算机完成对公共场所的智能安全监控。

由于多摄像头下的行人图像存在光照变化强烈、分辨率较低、姿态差异明显、易被遮挡等问题，人体目标再识别研究面临着巨大的挑战。为了处理上述问题，传统研究主要集中在两方面：1) 设计和提取局部不变特征来表达人体的视觉信息。然而，局部不变特征对视角变化、姿态差异等因素缺乏足够的鲁棒性。2) 学习判别式距离度量，从而减小同一人不同图像特征之间的距离。此类算法对两两摄像头下的行人图像学习一个距离度量矩阵，效率低下，难以处理多摄像头网络中的人体目标再识别问题。本文针对上述问题进行了研究，利用人体属性特征在多摄像头下的不变性以及不同属性间共生性与互斥性特点，提出了一系列创新算法：

- 基于判别式隐空间属性建模的人体目标再识别算法，使用原型隐空间映射技术和判别式学习方法，有效的融合了底层图像特征、属性特征和代表属性相关性的原型隐空间特征；
- 基于嵌入式低秩属性相关性的多任务人体目标再识别算法，所得到的嵌入式低秩属性相关性矩阵，可以对预测不准确的属性特征进行改进和恢复，从而得到更准确的属性特征；
- 基于半监督深度属性学习的人体目标再识别算法，使用半监督的深度学习框架，对有限的具有属性标注的训练集进行数据增强，通过深度学习更好的发掘人体属性特征。

总之，本文专注于基于人体属性和属性相关性学习的人体目标再识别研究，提出的算法在多个公共数据集上的性能达到了国际领先水平。本文的算法推动了基于属性特征的人体目标再识别研究，并有望对跨摄像头跟踪，检索以及事件检测和识别提供技术支持。

**关键词：**人体目标再识别，属性特征融合，属性相关性学习



# Multi-Camera Person Re-identification Using Multi-Attribute Embedding

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## ABSTRACT

As more and more large camera networks have been deployed in public spaces, people are paying increasing attention to the research and development of surveillance video technology in the computer vision field. Person re-identification is one of the core subjects of surveillance video technology. With person re-identification, we can use a person's image from a certain camera to query the image(s) and position(s) of this person in images captured by other surveillance cameras. This research helps to implement cross-camera human behavior analysis and event detection so that computers can monitor various public places in an intelligent manner.

However, multi-camera person re-identification is faced with great challenges caused by various factors, such as drastic illumination changes, pose variation, low resolution, and frequent blockings. Traditional studies attempt to solve these problems in two ways: (1) designing and extracting local invariant features to represent the visual appearance of a person. However, local invariant features are not sufficiently robust to viewpoint variation, pose changes, etc. (2) reducing the distance between features of the same person in different images by learning a discriminative distance metric. Such algorithms learn a distance metric matrix for person images under each camera pair and thus are inefficient for handling the person re-identification problem in a multi-camera network.

Based on the analysis of these problems, this work has proposed a series of novel algorithms by exploiting the invariance of human attribute features under multiple cameras as well as the coexistence and mutual exclusion of certain attributes:

- A person re-identification algorithm based on discriminative latent space attribute modeling. Prototype latent space mapping technology and discriminative learning method are used to effectively integrate low-level image features, attribute features and prototype latent space features representing attribute correlation.
- Multi-Task Learning with Low Rank Attribute Embedding (MTL-LORAE) for person

re-identification. The resulting embedding low-rank attribute correlation matrix is able to improve and recover poorly predicted attribute features so as to provide more accurate attribute features.

- A person re-identification algorithm based on semi-supervised deep attribute learning. A semi-supervised deep learning framework is used to perform data augmentation on a limited number of attribute-labeled training sets so that deep learning can better discover human attribute features.

In summary, this work focuses on applying human attribute features and attribute correlation to person re-identification. The proposed algorithms have achieved comparable results with the state-of-the-art on multiple public datasets. Our algorithms have contributed to attribute-feature-based person re-identification research and will hopefully provide technical support for cross-camera tracking, retrieval, and event detection and recognition.

**KEYWORDS:** Person Re-identification, Attribute Embedding, Attribute Correlations Learning