

Pose Invariant Embedding for Deep Person Re-identification

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Abstract

Pedestrian misalignment, which mainly arises from detector errors and pose variations, is a critical problem for a robust person re-identification (re-ID) system. With bad alignment, the background noise will significantly compromise the feature learning and matching process. To address this problem, this paper introduces the pose invariant embedding (PIE) as a pedestrian descriptor. First, in order to align pedestrians to a standard pose, the PoseBox structure is introduced, which is generated through pose estimation followed by affine transformations. Second, to reduce the impact of pose estimation errors and information loss during PoseBox construction, we design a PoseBox fusion (PBF) CNN architecture that takes the original image, the PoseBox, and the pose estimation confidence as input. The proposed PIE descriptor is thus defined as the fully connected layer of the PBF network for the retrieval task. Experiments are conducted on the Market-1501, CUHK03, and VIPeR datasets. We show that PoseBox alone yields decent re-ID accuracy, and that when integrated in the PBF network, the learned PIE descriptor produces competitive performance compared with the state-of-the-art approaches.

1. Introduction

This paper studies the task of person re-identification (re-ID). Given a probe (person of interest) and a gallery, we aim to find in the gallery all the images containing the same person with the probe. We focus on the identification problem, a retrieval task in which each probe has at least one ground truth in the gallery [42]. A number of factors affect the re-ID accuracy, such as detection/tracking errors, variations in illumination, pose, viewpoint, etc.

A critical influencing factor on re-ID accuracy is the misalignment of pedestrians, which can be attributed to two causes. First, pedestrians naturally take on various poses as shown in Fig. 1. Pose variations imply that the position of the body parts within the bounding box is not predictable. For example, it is possible that one’s hands reach above the



Figure 1. Examples of misalignment correction by PoseBox. Row 1: original bounding boxes with detection errors/occlusions. Every consecutive two boxes correspond to a same person. Row 2: corresponding PoseBoxes. We observe that misalignment can be corrected to some extent.

head, or that one is riding a bicycle instead of being upright. The second cause of misalignment is detection error. As illustrated in the second row of Fig. 1, detection errors may lead to severe vertical misalignment.

When pedestrians are poorly aligned, the re-ID accuracy can be compromised. For example, a common practise in re-ID is to partition the bounding box into horizontal stripes [20, 42, 1, 21]. This method works under the assumption of slight vertical misalignment. But when vertical misalignment does happen as in the cases in Row 2 of Fig. 1, one’s head will be matched to the background of a misaligned image. So horizontal stripes may be less effective when severe misalignment happens. In another example, under various pedestrian poses, the background may be incorrectly weighted by the feature extractors and thus affect the following matching accuracy.

To our knowledge, two previous works [8, 7] from the same group explicitly consider the misalignment problem. In both works, the pictorial structure (PS) is used, which shares a similar motivation and construction process with PoseBox, and the retrieval process mainly relies on matching the normalized body parts. While the idea of constructing normalized poses is similar, our work locates body joints using a state-of-the-art CNN based pose estimator, and the components of PoseBox are different from PS as evidenced by large-scale evaluations. Another difference of our work is the matching procedure. While [8, 7] do not

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