KI WISSEN
Automotive AI Powered by Knowledge

1.7 Knowledge Aware Pedestrian Detection

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Abstract

Accurate pedestrian detection is an important aspect in autonomous and smart vehicles for ensuring safety and efficiency. In recent times, Deep Neural Networks (DNNs) have showcased remarkable prowess in object detection, especially for pedestrians. Despite these phenomenal feats, DNNs can only utilize information present in historical data and cannot utilize any explicit information that may also contain valuable information. To overcome this limitation, we propose a knowledge-fusion framework tailored for the pedestrian detection problem. The primary objective is to empower DNNs by seamlessly integrating explicitly defined information into their learning process. This explicit information may encompass domain-specific knowledge, rules, or features that are not inherently present or difficult to extract from historical data.

Knowledge Identification and Definition

Identification and definition of explicit knowledge that is relevant and integrable with DNNs is crucial. Typically, knowledge base consists of predefined rules or algorithms that are not learned in the training process. The knowledge base will take the same input as DNNs, however, its features are explicitly defined and are not learned. In our proposed approach, we aim to pinpoint areas within an image where the likelihood of pedestrians being present is high. To obtain this explicit information, we utilize Coarse- and Fine-grained Attention Network (CFANet) [1]. CFANet is utilized to obtain Pedestrian Probability Distribution (PPD), which assigns a probability score to each individual pixel in the image. This nuanced assessment provides a coarse estimate of probable regions within an image where pedestrians are likely to be present.

Figure 1: Pedestrian Probability Distribution over the image

Methodology

- Obtain explicit information
  - *Calculate PPDs for the input image using CFANet*
- Fusion of knowledge- and data-driven approach
  - *Intermediate Fusion: PPDs are fused with the latent feature maps*
  - *Late Fusion: PPDs are also fused at the inference layer*
- Learn combined features based on explicit (PPDs) and implicit (DNN latent features) information
- Inference on test set

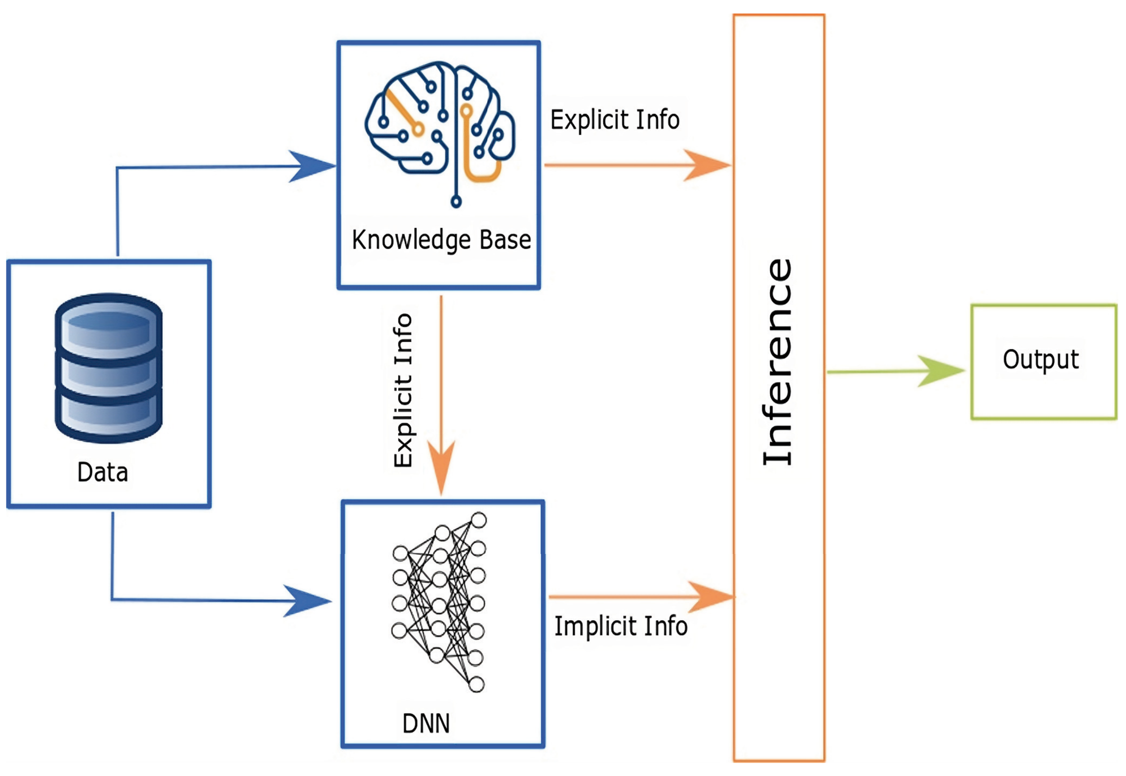

Figure 2: Overview of knowledge-aware pedestrian detection framework

Evaluation Metric

Log-average miss rate over false positive (MR^{-2}), calculated by taking geometric mean of miss rates at 9 equally spaced thresholds in the log space.

Results

- City Persons Dataset

Model	Reasonable	Small	Heavy
Baseline (F2DNet [2])	9.37	11.88	35.91
Baseline with knowledge	**8.95**	**10.24**	**34.90**

- Caltech Dataset

Model	Reasonable	Small	Heavy
Baseline (F2DNet [2])	2.50	2.78	41.39
Baseline with knowledge	**2.15**	**2.44**	**38.45**

Key Highlights

- Improved performance
- Faster convergence

References

[1] Liangzi Rong., Et al. Coarse- and Fine-Grained Attention Network With Background-Aware Loss for Crowd Density Map Estimation (2021)
[2] Abdul Hannan Khan., Et al. F2DNet: Fast Focal Detection Network for Pedestrian Detection (2022)

Detection

Partners

Continental, BOSCH, Valeo, [at], AVL, BTC embedded systems, Capgemini engineering, e:fs, DFKI, DLR, fortiss, Fraunhofer IAIS, Fraunhofer FOKUS, FZI, Universität des Saarlandes, bast

External partners

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