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Vision based pedestrian detection for advanced driver assistance

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Abstract

In pedestrian detection intricate feature descriptors are used to improve the detection rate at the cost of computational complexity. In this paper, we propose a detector based on simple, robust edgelet features to enhance the detection rate and classifier based on k-means clustering approach to reduce computational complexity. The proposed framework consists of extraction of candidate features of pedestrian detection using edgelet features and use of the cascade structure of k-means clustering for classification enabling high detection accuracy at low false positives. Experimental results show that the proposed method requires less processing time per frame, making it suitable for real-time systems.

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Keywords: K-means classifier; edgelet; pedestrian detection; cascade structure; advanced driver assistance

1. Introduction

Pedestrian detection is one of the most exigent issues in computer vision, and it has diverse practical applications such as advanced driving assistance, autonomous driving, cruise control and surveillance. Over the past decade, the essential role of the computer as well as machine vision modules to realize active safety systems for accident prevention using pedestrian detection is clearly established not only in innovative systems introduced by industry but also in academic research. Pedestrian detection has multiple uses, with the most prominent being advanced driver assistance systems (ADASs). An important facet is to equip vehicles with recognizing capabilities to detect and act on pedestrians in dangerous situations, where the driver would not be able to avoid a collision. A full ADAS with regard to pedestrians would as such not only include detection, but also tracking, orientation, intent analysis, and collision prediction. Pedestrian detection brings many challenges such as changing appearances among pedestrians,

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chaotic backgrounds, scenes with moving pedestrians as well as camera, and need of high speed operation and greater reliability that makes detection issues more complex. Many researchers proposed various methods in order to overcome these issues, but still detection accuracy and speed remains on top priority.

For pedestrian detection, Bo Wu[1] introduced edgelet features. These are shorter segments of the line. The detector is designed based on these edgelet features to detect various body parts. The intermediate results from these body part detectors are pooled together to form a likelihood model which enables pedestrian detection in the complex scenes. The results show that this method shows better pedestrian detection as compared to SIFT and SVM. A combination of Adaboost and SVM is used by Wang[2] that shows better accuracy, using a variety of base classifiers. Experimental results show the efficiency of the proposed algorithm and achieve the accuracy up to 94%. M. Bertozzi[3] shows Pedestrian detection using of far-infrared stereo vision. Such methodology shows limitations in high detection accuracy in the presence of poor lighting conditions. It uses temperate area detection, detection by identifying edges, and computational disparity to improve the detection performance. Final detection is carried out using head morphology and thermal characteristics. This method is able to mitigate false negatives caused due to occlusions but still the question of false positives remains unanswered.

Krotosky[4] shows the pedestrian detection with the help of color and infrared approach. The cross spectral approach is highlighted during multimodal and multi-perspective pedestrian analysis. Liping Yu[5] highlights pedestrian detection based on monocular vision for smart vehicles. Pedestrian detection is based on the two-stage framework. A full body pedestrian detector is built using robust Haar-like features. Adaboost classifier is used to discriminate some pedestrian candidates on the image. Experimental results show the robust performance. The pedestrians in different poses, clothing structure, diverse lighting conditions, and occlusion are detected. Fen XU[6] proposed a pedestrian classifier based on the histogram of oriented gradients as well as support vector machine. They showed that to handle occluded pedestrians, the particle filter based method shows high detection rate. The results of particle filter are better than Kalman-filter based tracking method. Yanwei Pang[7] shows pedestrian detection algorithm can be based on HOG and SVM for high detection accuracy but it suffers from time complexity. A´ kos Utasi[8] used a Bayesian approach on finding pedestrians in stereo image based system using the density of cylindrical objects.

The cascade classifier based on Haarlike features is an algorithm that detects pedestrians at a faster rate. A drawback of this approach[9] is the close link with the appearance of pedestrians and the resulting lack of robustness. A substitute is the solution using HOG and support vector machines (SVMs) [10]. This algorithm is much more robust and detects pedestrians in difficult scenes, but compromising computational speed. The hierarchical SVM classifier[11] and the star cascade[12] cannot be applied to general SVM classifiers because they depend on their specialized classifiers. The HOG-based cascade classifier[13] cannot maintain the detection accuracy of its original classifier because it is an entirely new boosting classifier. The HOG-LBP-based cascade classifier[14] and two CoHOG-based cascade classifiers[15, 16] show equivalent detection accuracy to their original classifiers, but their processing capabilities are simply not sufficient. Human detection algorithm and its applications[18, 19] are discussed in defence application and need of high detection accuracy at low computational cost was stated.

Our approach is based on the edgelet feature based pedestrian detection taking the advantages from Bo Wu[1], providing our model robustness to occlusion and pose variation. Although, Wu had better performance with mostly single human, we train our algorithm to work more efficiently for multiple humans in an image. We also propose the novel k-means cascade framework designed to provide higher detection rate than Wu with few false alarms. This cascade framework has multiple stages and each stage has two level to improve detection rate. As we use edgelet features of the leg and torso along with the head-shoulder unlike Wu, the proposed framework detects pedestrians efficiently. Also, some object classes have lots of within-class variation and key point based descriptors have limited performance in this case. In particular, for humans, it is unclear which key point detector to use. All the standard ones return either points in textured regions or blob like structures. In human detection process, texture is seen mainly on clothing so detections are not repeatable across changes of clothing. Variations in pose tend to confuse the blob based detectors. Thus we use the part-based, multi-feature with trained classifier to locate humans.

The rest of this paper is structured as follows. Section 2 describes edgelet features. These features are used for extraction of candidate features in the pedestrian detection process. Section 3 explains k-means clustering approach used in the proposed framework. Section 4 presents the cascading structure of k-means weak classifiers to enhance