Partially Obscured Human Detection Based on Component Detectors Using Multiple Feature Descriptors

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Abstract. This paper presents a human detection system based on component detector using multiple feature descriptors. The contribution presents two issues for dealing with the problem of partially obscured human. First, it presents the extension of feature descriptors using multiple scales based Histograms of Oriented Gradients (HOG) and parallelogram based Haar-like feature (PHF) for improving the accuracy of the system. By using multiple scales based HOG, an extensive feature space allows obtaining high-discriminated features. Otherwise, the PHF is adaptive limb shapes of human in fast computing feature. Second, learning system using boosting classifications based approach is used for training and detecting the partially obscured human. The advantage of boosting is constructing a strong classification by combining a set of weak classifiers. However, the performance of boosting depends on the kernel of weak classifier. Therefore, the hybrid algorithms based on AdaBoost and SVM using the proposed feature descriptors is one of solutions for robust human detection.

Keywords: Boosting machines, parallelogram based Haar-like feature, multiple scale block based HOG features, support vector machine.

1 Introduction

In recent years, human detection systems using vision sensors have been become key task for a variety of applications, which have potential influence in modern intelligence systems knowledge integration and management in autonomous systems[1, 2]. However, there are many challenges in the detection procedures such as various articulate poses, appearances, illumination conditions and complex backgrounds of outdoor scenes, and occlusion in crowded scenes. Up to day, several successful methods for object detection have been proposed. The state of the art of human detection was presented by Dollar *et al.* in [3]. The standard approach investigated Haar-like features using the classification SVM for object detection [4]. However, the performance of Haar-like features is limited in human detection applications [5, 6] due to it is sensitive to a high variety of human appearances, complex backgrounds, and illuminative dynamic in outdoor environments. Other authors proposed the Histograms of Oriented Gradients descriptor (HOG) [7-9] to deal with that problem. In the case of occlusion problem, the combining HOG and Local Binary Pattern (LBP) for feature descriptor is presented in [10]. In that system,

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the authors accumulated both HOG and LBP to construct feature vectors, which are fed to the SVM in both the training and detection stages. Experimental results indicated that the system was capable of handling partial occlusion. In another approach, Schewartz *et al.* [11] proposed the method for integrating whole body detection with face detection to reduce the false positive rate. However, the camera pose is not always opposite with the human, therefore the face is not always appearance. In terms of learning algorithms used in object detection, SVM and boosting methods are the most popular algorithms which have been successfully applied to classification problems.

This paper focuses on partially obscured human detection in crowded scenes with two major contributions. First, two kinds of extension feature descriptors are presented, multiple scale block based Histograms of Oriented Gradients feature (MHOG) and parallelogram based Haar-like feature (PHF) for improving accuracy of system. The "integral image" method for each feature type is also proposed, which allows fast computing. Second contribution focuses on efficient detection approach using an interpolation of SVM and boosting technique for constructing a strong classification based on set of weak classifiers.

2 Feature Description

This section presents two kinds of feature descriptors. The MHOG feature is used for description the full body, human components of head and torso. The PHF feature is proposed to describe components of arms and legs. To making coherency in argument, the feature descriptors are briefly presented in this section.

2.1 PHF Feature Descriptor

This subsection presents a new feature descriptor, which extended the Haar-like feature. The PHF feature represents the difference of intensities between adjacent parallelogram regions, see also Fig. 1. The original Haar-like features [12] used "integral image" method based on a cumulative sum of intensities within rectangular regions, which supports fast computing feature with only eight accesses with any size of regions. However, the restriction is that features within rectangle regions, so it is not adaptive to various poses of human. The PHF descriptor is based on modified Haar-like features that significantly enrich the basic set, which is suitable to detect skew shape components, e.g., pose of the legs, arms of human.

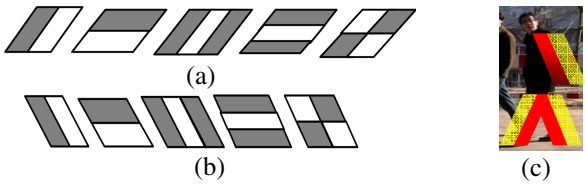

Fig. 1. Proposed parallelogram based Haar-like feature: (a-b) some prototypes, (c) features represent for the limbs of human