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Pedestrian Detection for Automotive Night Vision

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Abstract: The sudden appearance of a pedestrian is a major concern for the driver particularly during the night as it could lead to an accident at night due to poor human eyesight. A pedestrian detector for vehicle night vision is added to solve the problem.In this device a NIR (Near Infrared) camera is used to take pictures of a night scene. Since there are large variations in the pedestrian poses in the intra-class, a tree-structured classifier is proposed here to handle the problem by training it with different image subsets and different sizes.This paper discusses the combination and validation of the Haar-Cascade and HOG-SVM (Histogram of Oriented Gradients Support Vector Machine).Haar-Cascade is equipped to identify the entire human body that excludes most non-pedestrian regions.A component based SVM classifier with HOG features is used to refine the pedestrians after identification. The pedestrian's upper and lower body part HOG features are used for partly based validation of observed bounding boxes.A full body validation scheme is also implemented using HOG-SVM when particular part is not validated by any validation based on the part.

Keywords: FIR,Haar-Cascade,NIR, Pedestrian Detection, SVM.

INTRODUCTION

Pedestrian detection is one of the most difficult and critical tasks in the field of computer vision. It has been commonly used in autonomous vehicles such as robotics, security.A lot of research has been done on the detection of pedestrians in recent years, but in the intelligent vehicle systems with cluttered backgrounds and varying light conditions in moving world, the role of pedestrian detection is still challenging. Night vision systems use two types of sensing technologies: 1) Near-Infrared (NIR) imaging systems,and 2) Far-Infrared (FIR) imaging systems.The main aspects in both types of night-vision systems are pedestrian detection capability, commercial appeal and collision avoidance effectiveness[1].A Far Infrared Imaging system works on an object's sensing temperature, but at the time of the summer, the ambient temperature is nearly equal to the body temperature which does not allow a pedestrian to distinguish from its surroundings.In winter seasons, people generally wear heavy cloths that don't allow the camera to sense temperature. A pedestrian is very difficult to detect in these types of situations but an NIR system is highly environmental resistant.NIR imaging systems have many more advantages when compared with FIR imaging systems in terms of image quality, commercial aspects and other visual information[2].

Most of the pedestrian detection techniques are established with a standard visible camera under day light conditions. Chances of injuries are greater at night as compared with daytime.Vision-based cameras are used in surveillance applications where traditional background subtraction methods are used for the generation of Region of Interest (ROI) that fail because it is a moving background. Normal vision cameras cannot capture all the necessary information during the night, since the background is cluttering and texture less.In order to overcome these types of situations, comprehensive night time pedestrian detection work is carried out focused on near infrared images due to their merits than far-off infrared images.It describes a night time pedestrian detection system with a cascaded classification and a part-based validation process in a near infrared environment approach.Pedestrian classification efficiency is implemented and analysed with the help of a Haar cascade detector and part-based validation using HOGSVM.The pedestrian detection systems based on part build a reliable validation of pedestrians compared to the other systems[3].

SYSTEM OVERVIEW

The first phase of the system deals with the detection of pedestrians using a scanning window with a Haar cascade detector, which eliminates most non-pedestrians and the second phase, makes the system more robust by validating the detected pedestrians with HOG-SVM detector based on part[4].The overall view of the pedestrian detection system is shown in Figure 1.

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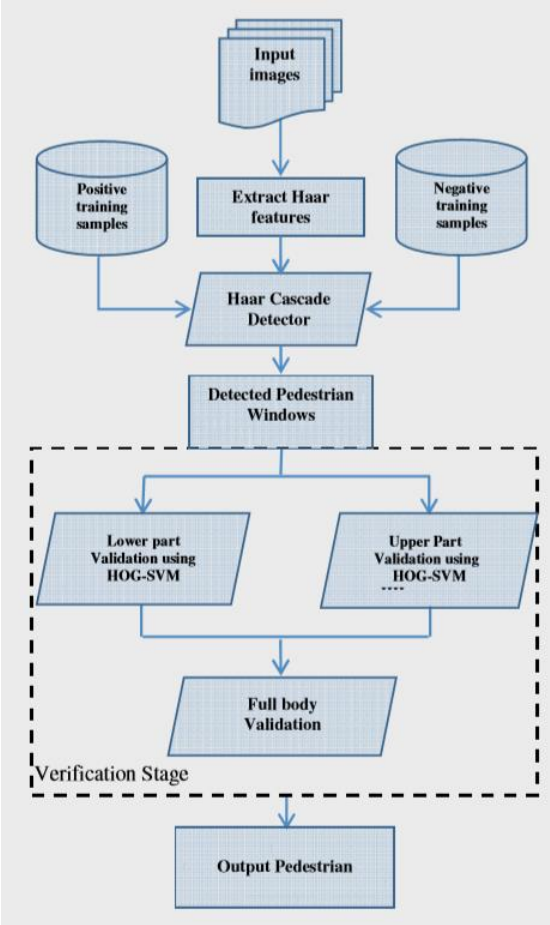

Figure 1: Structure of the Pedestrian Detection System with Detection Stage and Part Based Validation Stage.

1. *Detection Stage:*

The machine scans each window of the input image at this point and extracts Haar characteristics from that particular window, which is then used to compare with the cascade classifier. For training a classifier with Haar features of positive and negative samples are using for boosting algorithm.The cascade classifier structure makes the system fast enough by filtering the majority of non-pedestrian regions in the input image.The Haar-based detection function is used for rough input image classification that focuses on non-pedestrian rejection and defines the pedestrian regions with bounding box.The cascade classifier structure makes the system fast enough by filtering the majority of non-pedestrian regions in the input image[5].

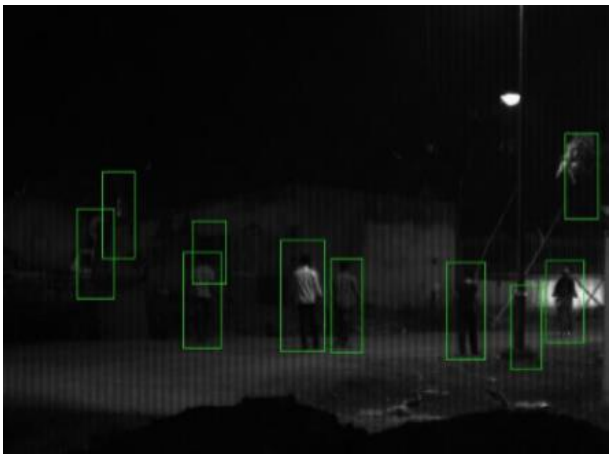

Figure 2: Output of the Haar Cascade Detection Stage

In many object detection modules, such as vehicle, face and pedestrian detection, Haar features extracted from intensity images are used because they record the fine details of the object and have a fast algorithm.Figure 2 shows the performance of a Haar Cascade Detector with pedestrian bonding package.The false alarm rate is higher but most non-pedestrian regions are excluded.Pedestrian detected detector stage output is processed with a part-based validation module to reduce the false alarm rate[6].

2. *Part Based Validation:*

This module verifies by making parts of each bounding box of the preceding level. Here for verification each pedestrian is divided into upper and lower parts of the body. This system uses the HOG feature to detect the pieces.The HOG feature set significantly outperforms pedestrian detection. HOG has more influence in pedestrian detection systems in recent years due to its robust orientation set of features.The HOG features of these components are extracted and compared to the pre-trained SVM Classifier. SVM is a type of classifier which can be trained to distinguish two distinct sets by positive and negative features.SVM is a popular classifier in combination with HOG[7].

3. *Overall Verification:*

The device tests the HOG-SVM performance based on the component (Figure 3).If the upper and lower body parts of the bounding box are correctly checked then at the end of the second stage the output pedestrian box appears. Then, if any part of the pedestrian is validated correctly in the previous stage, it checks for full body

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validation.If both upper and lower body parts do not confirm, then system considers as a non-pedestrian or false alarm and removes it in that stage[8].

Figure 3: Overall Verification Stage

4. *Adaptive Pre-processing:*

Characteristics of night vision image are histogram concentration at low pixel values on dark sky and high headlights on vehicles or night lights.The most significant point of this paper is to improve the comparison of the section on histogram with low intensity because the histogram of the pedestrian rarely observed is focused on the section of low intensity level (Figure 4).Contrast enhancement must be achieved after Otsu's segmentation algorithm to improve the contrast of the pedestrians[9].

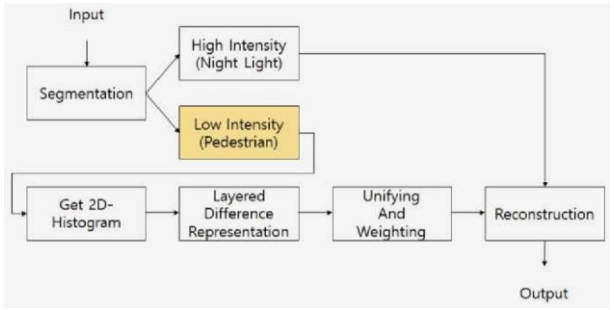

Figure 4: Adaptive Contrast Enhancement Workflow Proposed By LDR Method.

PERFORMANCE EVALUATION

The algorithm has a high false alarm rate when detected by Haar Cascade Detector only. Compared with other schemes, the missing chances of true positive are comparatively fewer.The false alarm rate is significantly reduced when a part based HOG-SVM detector is tested on the device. Whenever the two individual Haar cascade and HOG-SVM systems are tested, the false alarm rate is greater as compared with the methodology proposed[10]. Figure 5 shows the performance evaluation of individual system HOG and Haar detectors. Figure 6 shows the final performance evaluations before and after part based validation.

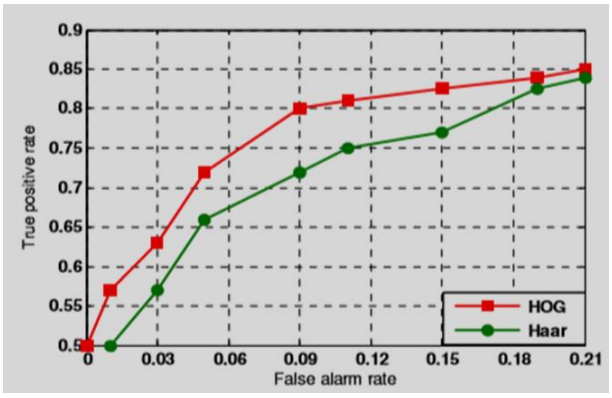

Figure 5: Performance Evaluation of Individual Systems HOG and Haar Detectors

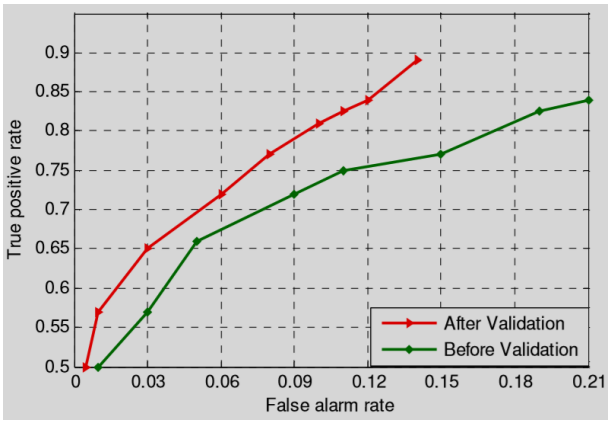

Figure 6: Final Performance Evaluations Before and After Part Based Validation

CONCLUSION

A robust algorithm that uses near infrared images to distinguish pedestrians in night and to recognize and verify pedestrians, it incorporates both Haar features and HOG features in Cascade.While detecting pedestrians and eliminating non-pedestrians using Haar features in the first stage, false alarm rates are higher in cluttering background situations, but in the second stage, combining HOG-SVM with part-based detection makes the system robust by reducing false alarm rates.Vision-

based cameras are used in surveillance applications where traditional background subtraction methods are used for the generation of Region of Interest (ROI) that fail because it is a moving background.A pedestrian is very difficult to detect in these types of situations but an NIR system is highly environmental resistant.NIR imaging systems have many more advantages when compared with FIR imaging systems in terms of image quality, commercial aspects and other visual information.Pedestrian classification efficiency is implemented and analysed with the help of a Haar cascade detector and part-based validation using HOGSVM.The pedestrian detection systems based on part build a reliable validation of pedestrians compared to the other systems.

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