A Review on Histogram of Oriented Gradient

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Abstract—Pedestrian detection systems are receiving increasing attention in both industry and academia with the rapid development of autonomous automobiles which employ artificial intelligence.This article describes the approaches to Histogram of Oriented Gradient and support vector machine, focusing on studying the HOG feature and application, detailing the process of HOG feature extracted and the design of classifiers in pedestrian detection.

I. INTRODUCTION

Real-time human detection from videos is one of the most active areas in computer vision due to its widespread applications such as intelligent surveillance and home security in [1], personal protection and kidnapping detection in [2], automatic detection of crimes in [3] and human computer interfaces in [4]. The successful progress towards design of autonomous vehicles such as autonomous cars [5,6], self-driven rider less bicycles [7], autonomous robots [8] and drones [9,10] have spearheaded research in the area of pedestrian detection. Pedestrian detection using HOG and neural networks is reported in [11], pedestrian detection for advance driver assistance system using HOG and Adaboost is reported in [12], pedestrian detection using Bayesian and Edgelet detectors in [13], using local binary patterns (LBP) in [14], using Motion and Appearance patterns in [15], using Shapelet features in [16] and using Deep Networks in [17].

II. DESIGN OF PROPOSED PEDESTRIAN DETECTION SYSTEM

In this section, the design of proposed real-time pedestrian detection system is explained with feature extraction and classifier being the two main stages of the system

A. HOG Feature Extraction

The sequence of steps followed to obtain these HOG features from an input image, considering an input image of size 256 x 256 pixels. The input image is divided into 256 cells with a cell size of 16 x 16 pixels and each cell is divided into four sub-cells as with a sub-cell size of 8 x 8 pixels.

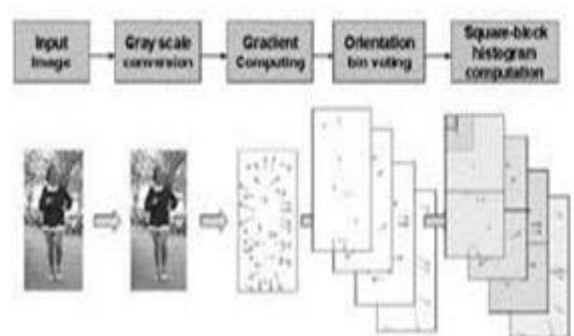
The gradients Gx and Gy of a particular pixel location is computed using 1D masks in X and Y direction as:

$Gx = Mx \bullet Ix$

$Gy = My \bullet Iy$

where$Mx = [-1\ 0\ 1]$ and $My = [-1\ 0\ 1]T$ are the masks used on Ix in X-direction and Iy in Y-direction respectively. The gradient magnitude, Gmag and orientation angle, Gdir are computed.

The gradient vector for each pixel location in the sub-cells are drawn using Gmag and Gdir values The gradient vectors in each sub-cell are normalized to obtain a key descriptor as shown. Similarly, key descriptors are computed from each cell to obtain HOG features of input image.



B. SVM Classifier

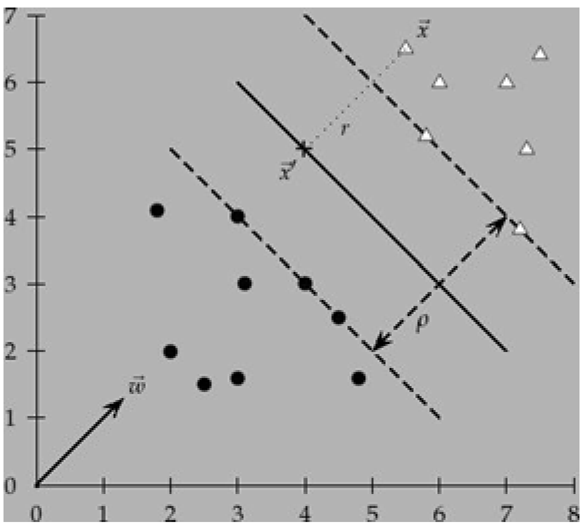
Support vector machine (SVM) is a new method of machine learning based on statistic learning theory proposed by Vapnik et, the goal of which is to find the optimal classification surface [21].
SVM is considered to be the simplest and fastest classifier for both linear as well as non-linear

Classification problems [18]. SVM learning aims at finding a good hyperplane in a higher dimensional feature space, that best separates two classes as shown in Fig. 5. The equation of SVM hyper plane that classifies two classes is given as

$$Y(z) = \sum_{sv=1}^{NSV} \alpha_{sv} y_{sv} \left(\Phi^{T}(x_{sv})\,\Phi(z)\right) + b$$
$$= \sum_{sv=1}^{NSV} \alpha_{sv} y_{sv}\, K(x_{sv}, z) + b,$$

where, z is the test data, K(xsv , z) is the kernel function, NSV denotes the number of support vectors, xsv is the input, is the target output and is the Lagrange multiplier associated with each training data.

Fig. 2 optimal classification surface in the linearly separable case [21].



III. EXPERIMENTAL RESULTS

The performance of proposed system is evaluated by carrying out various experiments using images collected online, using images from INRIA Person Dataset [20] and using real-time inputs. The photo collage of samples considered for training from two classes, background and pedestrians for images obtained online. The performance of proposed pedestrian detection system using images obtained online and real-time input images, which is again a photo collage of few results obtained, wherein a blue box denotes the identification of apedestrian in an image. The performance result of proposed system is reported in Table I for all the experiments carried out using different datasets. It is observed that a maximum accuracy of 98.31% is INRIA datasets, which is a mixture of cropped images of pedestrians and backgrounds. Pedestrian detection accuracy of 96.35% is obtained on testing the system using full scenery images provided in the INRIA database. It is observed during experimentation that the proposed real-time pedestrian detection system gave 93.22% accuracy based on the distance between pedestrian and camera, whereas 100% accuracy is obtained, the moment pedestrian comes closer towards the camera. This suffices the requirement of pedestrian detection for autonomous vehicles.

IV. CONCLUSION

In this paper, design of a real-time pedestrian detection system for autonomous vehicles is proposed and its performance is evaluated by carrying out various experiments using offline images, images from standard dataset and real- time input. The system is capable of detecting pedestrians with an accuracy of 98.31% and it is observed that the non-detected pedestrians are also detected, once they come closer to the camera, thus achieving 100% recognition accuracy.

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