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A Review on Pedestrian Detection Techniques

Roshan Baba Kawade

Department of Electronics and Telecommunication, Government College of Engineering, Amravati, Maharashtra, India

Abstract: ***Pedestrian detection is a process in which number of person are detected from the image or the live video. This information send to user in the forms of sound or video alarm. It helps user in taking necessary preventive decision. Pedestrian detection process comes under security and safety aspect. As, security and safety is prime concern in today's digital world, it has gaining more concentration. It is being a very popular topic for research. This paper introduces various pedestrian detection techniques based on image processing and its various problems in detail. With variation in illumination, postures and clothing of pedestrian, detection process is a really difficult and challenging task. However, as demand of accuracy and speed of detection in real time is increasing, researchers are more focusing to tackle these problems. Efficient pedestrian detection with highest accuracy and speed of detection is required.***

Keywords: Histogram of oriented gradient (HOG), Support vector machine (SVM), Advanced driver assistance system (ADAS)

1. Introduction

Pedestrian detection is a popular technique in video surveillance and automobile field. In today's digital world, it is mandatory for improving security and safety in every field. Human activity detection and storing information is required in area like banks, ATM machines, shopping malls, jewelry shops and most of the other places where suspicious activity might be happened. These areas are fully covered with CCTV cameras. It helps in improving overall protection.

ADAS system in automobile section uses pedestrian detection to prevent from accidents. These accidents are mainly occurred due to pedestrian mistake or driver mistake. Population growth also impacts on traffic condition worsening and such accident scenarios. These accidents result in serious fatalities and injuries for long time. So, prevention of such accidents is needed today. Statistics on road side accidents show that maximum accidents are happening due to pedestrians. Pedestrian detection plays major role in avoiding these accidents by alerting driver. So,it results in gaining concentration on pedestrian detection in automobile field.

There are few of techniques wereproposed earlier for pedestrian detection. These algorithms are having its individual advantages and disadvantages. These techniques are based on boosting up the processing speed and accuracy. Section II provides various algorithms for pedestrian detection. Section III discusses few challenges in detection process. Section IV gives conclusion.

2. Literature Review

1) Motion based detection

In this method, motion is found out from successive frames. If a prominent motion from person is observed, then it confirms that a pedestrian is present there. This algorithm has been developed at '*University of Liege*' to analyze the shape of these silhouettes (Pattern and shape) in order to detect human. This method also captures motion from non-pedestrian object. Also, it requires stable background in order to detect complete motion (Extracting foreground). In real time, it generates more false detections. Changing illuminations in day-night scenarios also effect on overall detection. This technique is applicable in surveillance field where background is stable.

2) HOG and SVM based detection:

This technique is proposed by Navneet Dalal and Bill Triggs in 2005. It highly applicable in pedestrian detection and object detection. HOG is a powerful feature descriptor uses in shape detection. It contains histogram of oriented gradient of every pixel in image. It divides image into number of overlapping blocks. These blocks are formedby combining 4 cells. [1] These features are given to train the SVM called offline training of SVM. SVM is the machine learning technique. It is a discriminative classifier formally defined by a separating hyperplane. Hyperplane is a boundary line for classification of positives and negatives. Positives and negatives examples are needed for pre-training the SVM. After the training, SVM will be implemented in real time classification.

3) Improvement in HOG extraction:

Qiangzhu et al had proposed an algorithm to use a larger set of blocks with different sizes, locations and aspect ratios as compared with original HOG extraction. [3] This is because the use of fixed size blocks is not enough for effective operation of the early stage of the HOG extraction. Next, they use the adaboost algorithm to choose the most suitable blocks for detection. These blocks are only considered in final HOG features.AdaBoost is a classifier used in object detection.

Ning He et al proposed a method which applies integrated scale space theory with HOG feature extraction called Scale Space Histogram of Oriented Gradients (SS-HOG). [4] It extracts features of image in different scales. As, different scales gives different information, this used here to improve accuracy of detection. To extract the SS-HOGs features, the first step is to choose different value of scale parameters and give a multiple scale space representation of the original image. Next, each representation of image with different scale parameter is computed with HOG to obtain the HOG feature vector. These features are given to the SVM classifications.

Original HOG and SVM based detection is time consuming and not suitable for real time application. So, Yibo Cui et al proposed a design in which they have neglected irrelevant pixels in object contour. [5] This will decrease the dimension of feature descriptorfor simplifying and speeding up the classification process of SVM classifier. Human body part gives maximum information. So, with considering these features only will increase detection process.

Adaboost classifier is used in face recognition. It is based on Haar features detection. Some researcher has combined Adaboost classifier with SVM classifier for increasing detection accuracy. Chenhui Zhou proposed a combination of histogram of oriented gradients with main and partial features. [6] In their method, firstly the image is undergone with Haar features and Adaboost in order to extract the head and shoulder of human. Next, the extracted head and shoulder will undergo process of HOG extraction and the features extracted will be used to train the Adaboost again. This approach gives higher speed of detection, as the number of gradients that needed to be calculated is reduced greatly.

Guangyuan Zhang et al gives another method which optimizes the use of HOG feature and SVM classifier. [7] They have calculated gradient value of each pixel of the image. Next, the input image is not resized but width to height ratio limited to 1:2.Each input image is divided by cells of 8 x 16 pixels.while pixels per cell are (width/8) x (height/16). All blocks have been normalized and combined to get final feature set. It used for final SVM classification. This technique is also sped up detection with integral image technique.

Combination of co-occurrence method with the HOG feature was presented by T. Watnabe et al. This exploits the co-occurrence frequency of the oriented gradients between the pixel-pairs in image, which is called as co-occurrence HOG. [8] Each pixel-pair are assigned with a variation value, which represents the spatial relationship of two points. Finally, it gets feature set with co-occurance HOG.

Daimeng Wei et al proposed a method which improved HOG feature by combining additional enhanced feature to obtain more information from the image. [9] This method is known as Enhanced Histogram of Oriented Gradient. Firstly, the image computed into a gradient image. This gradient image will be downscaled into nine correspondence images. Now, HOG descriptor will be extracted from these images. This provided spatial information which is added to the original HOG proposed by Dalal & Triggs. Finally, the original HOG features and the newly extracted features will be combined to form the Enhanced HOG features.

4) Combining other features with HOG features:

Combining other informative features with HOG features always improve accuracy level in detection. As, it provides more information for classification. Few of the researchers have tested some combinations for pedestrian detection.

For detection purpose sliding window technique is used prominently. Xiaoyu Wang et al proposed an idea of combining HOG and Local Binary Pattern (LBP). [10] Local Binary Pattern (LBP) is a highly discriminative local descriptor which is invariance to monotonic grey level changes, making it a robust feature for image analysis. It consists of two methods. In first, gradient of each pixel in the input image is obtained like the original HOG.An integral histogram is then constructed from the results. In the second module, LBP is computed from each pixel in the input image. Both method has combined to form HOG-LBP feature vector.

Daniela Monctezuma et al proposed a combination of Gabor and HOG features called HOGG to perform person detection in a surveillance application. [11] Firstly, the moving object is extracted by using background subtraction technique. Gabor filters is applied on the extracted object to generate a Gabor image. HOG feature is then extracted from the Gabor image to form the feature vector for classification.

Li Sun et al propose the fusion of particle filtering, online boosting tracker and HOG descriptor for human detection. [12] Firstly, the current frame of the video will undergo background subtraction to remove the background and detect any existing human. The detection result is then associated to the existing trackers from the previous frame. The result from the tracker will be directed to a flexible particle weighting scheme together with a confidence level value from the HOG descriptor.

Hui-xing Jia & Yu-Jin Zhang proposed a combination of HOG and Viola's face detection framework to form a human detection system which inherits speed advantage of Viola's object detection framework and the discriminative power of HOG features on human detection. [13] Each bin of HOG features is treated as a feature rather than taking each block as a building element, in order to replace the HAAR feature in Viola's framework.

5) Part based detection

Researchers has faced all kind of issues which caused inaccurate detection to occur, mostly caused by occlusion, as human happen to appear with different clothing. One way to overcome the occlusion problem is by doing part-based detection. This technique searches for some prominent shapes of the human's body part. Prominent shapes of pedestrian are head and shoulder.

In the Xiaoyu Wang et al proposed method which can easily handle partial occlusion. [10] They used two kinds of detectors, the global detector for the whole scanning window and a part detector for local regions. An occlusion likelihood map is constructed by using the response of the HOG feature in the global detector. Once an occlusion is detected, the part-based detector of the system will be triggered and applied over the un-occluded region.

3. Discussion

Pedestrian detection faces various problems. Illumination changes, variation in posture of pedestrians, variation in clothing and shapes of pedestrians are the common problems it has.

A. Illumination Changes

During entire day, multiple illumination changes are happened. This directly effects on image quality. Sometimes image quality becomes worse that information cannot be retrieved. This problem always occurs while working on an image. Constantly updating Background as per the current frames illumination will gives quit good result. Some pre-processing techniques like blurring of image, Contrast stretching and histogram equalization also gives a good result. These techniques are commonly used to remove an illumination changes. In this method, overall image quality is increased. This results in clearly finding pedestrian from the image.

B. Variation in Postures, Clothing and Shapes

Pedestrian are having different postures, clothing and shapes. This creates a problem in detection. For example, different colors clothing, different Attire and different shapes. This makes condition very much complex for detection of pedestrian. These problems can be eliminated by adequately training the SVM. There are no any limitations on number of data to be given for training the SVM. So, different colors clothing, different postures and different shapes images data are given to train the SVM. After that SVM will approximately predicts pedestrians from the image. Large numbers of datasets are considered while training the SVM.

Pedestrian detection using HOG and SVM detects multiple false positives. Non-maximum suppression will help in eliminating these false positives but not completely. So, certain pre-processing is needed to perform.

1) Increase numbers of positives and negatives with different postures and appearances of pedestrian images.
2) Increase scaling of image so, more accurate result will be obtained. It helps in detect multi-scaled pedestrian from the image. This called image pyramid.
3) Pre- processes over the detecting image like gamma correction, blur and filter should be performed before going to the SVM. It helps in overcoming different environmental conditions.

4. Conclusion

All the techniques discussed here are based on image processing. Most of it used HOG feature vectors and SVM for classification. In pedestrian detection, accuracy and speed are the main required concern. All the above algorithms tried to match with these both requirements. But there is an alwaystrade-off between speed and accuracy relationship. Some other features like illumination changes, posture and attires variation of pedestrians always impacts on detection process. These problems have to consider predominately for pedestrian detection in real time applications.

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