Automatic Driver Assistance System-A Survey on Methods, Performance and Practices

Mahesh Tatyasaheb Chavan[1], Shraddha Satish Bodake[2], Anjali Balaji Barbole[3]

[4]***Professor. Swapnil D. Daphal*** *(Guide), Dept. of Electronics and Telecommunication Engineering, MIT Academy of Engineering Alandi, Maharashtra, India*

---***---

Abstract - *Pedestrian detection is a system which detects number of persons from the image or the live video. It helps the user to take necessary preventive decisions. This paper introduces various types of pedestrian detection techniques based on image processing which includes HOG i.e. Histogram of Oriented Gradients Feature extraction method and SVM i.e. Support Vector machine Classifier to detect the pedestrian, Part Based and feature based pedestrian detection, Histogram of oriented gradients and Local binary pattern. However, as demand of accuracy and speed of detection in real time is increasing, researchers are more focusing to tackle these problems. Therefore, Automatic driver assistance system requires efficient pedestrian detection with highest accuracy and speed of detection to make it intelligent.*

***Key Words*: Histogram of oriented gradient (HOG), Support vector machine (SVM), Jupyter lab**

1. INTRODUCTION

Detecting pedestrian is still a challenging task for automotive vision system due to extreme variability of targets, lighting conditions, and high-speed vehicle motion [1]. 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. Automatic driver assistance system in automobile section uses pedestrian detection to prevent from accidents. These accidents are mainly occurred due to pedestrian mistake or driver mistake. In recent years, with the increasing levels of accidents involving pedestrians, there has been a lot of emphasis placed on the importance of reliable pedestrian detection systems. Automatic driver assistance system uses pedestrian detection to prevent from road fatalities. These road fatalities are mainly occurred due to the mistake of pedestrian or driver. 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. There are few of techniques were proposed 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

2.1 Part based and Feature based pedestrian detection

Part-based detection systems are good to cope well with occlusion as they do not necessarily require the full body to be present to make detection. In addition, many existing systems are disturbed by a high false positive per frame (FPPF), something that a part-based system can reduce if requirements of several body parts to be detected are put in place. These two motivations for part-based detection can be somewhat mutually opposing. By narrowing the classification parameters, the number of false positives is reduced but, likewise, the number of true positives. A tracking algorithm can be introduced to supply missing detection. Antonio Prioletti, Andreas Møgelmose has proposed a part-based pedestrian detection and feature-based tracking for driver assistance by using real-time, robust algorithms, and evaluation. This paper builds on a part based staged detection approach (PPD), which was first put forth in a two-stage part-based pedestrian detection system using monocular vision, providing four major contributions:

1) An analysis of the impact of changes in parameters for this algorithm that goes far beyond what was presented in the initial study.

2) An expansion of the system to a full-fiedged Advanced Driver Assistance System.

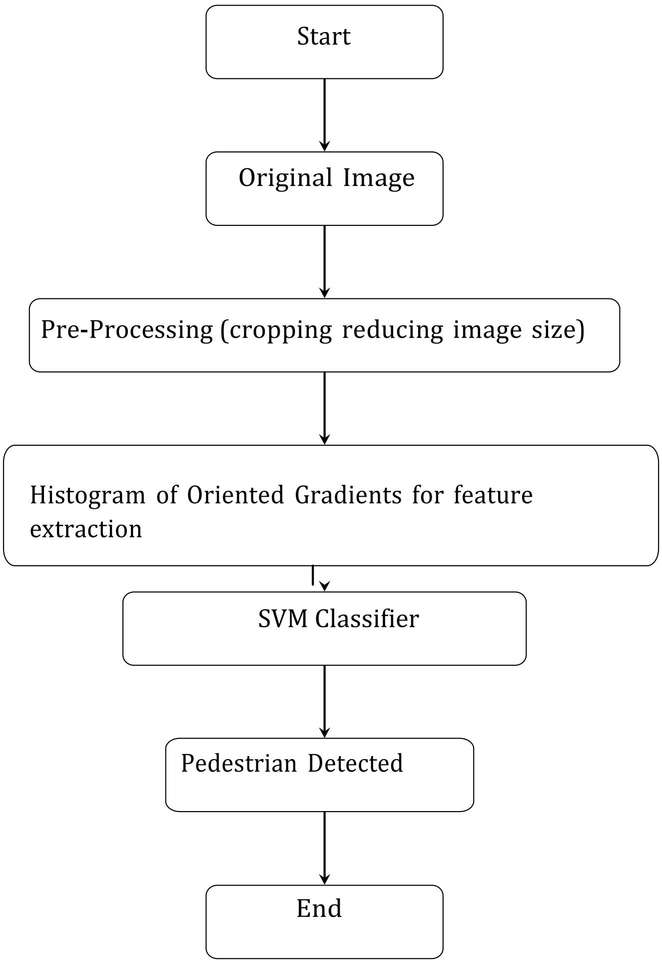
3) The use of more pedestrian-related training and test sets, where the previous paper used general-purpose person data set.

4) Porting of the system to a real prototype vehicle and analysis of critical situations in a real environment, optimizing the system to improve detection and speed performance.

One of the innovations of this system is the use of histogram-of-oriented-gradient (HOG) features in a Part-based Pedestrian Detection. An optimized feature has been adopted to decrease as much as possible the computational time; this helps when testing the system on a real prototype. This paper presents a two-stage system based on the combination of Haar cascade classifier and a novel part-based HOG–SVM and also an innovative features-based pedestrian tracking approach. A Haar detector is used to reduce the region of interest(ROI) at detection stage, providing candidate pedestrians to the HOG detector, which classifies the windows as pedestrians or nonpedestrians at verification stage. To increase the robustness of the system and reduce the number of false positives, a Part-base d Pedestrian Detection is used in the verification stage. The full body, the upper body, and the lower body are each verified using an SVM. These three results are then combined to obtain the final response for the ROI. Two ways were investigated to combine results in the verification stage: 1) A simple majority vote, where at least two of three SVMs must classify the window as a pedestrian; 2) A more advanced way, where another SVM classifies the window based on the estimated function value from an SVM regression performed on each part. Due to the high variability in pedestrian appearance, a robust system with strict thresholds for detection may not detect the same pedestrian in subsequent frames and, thus, reduce the detection rate considerably. To counter this, a stage of feature based tracking was introduced, significantly increasing the number of true positives. One of the great contributions of this paper is a thorough evaluation of the algorithm's parameters. Here, they have described the experiments to determine the best detector, which is then quantitatively and qualitatively tested. DaimlerDB was primarily used, with elements from the INRIA data set in a few tests. Unless otherwise specified, images from the training part of DaimlerDB were used for training i.e. both the detection stage and the part verification stage. In this paper, a pedestrian detector system, running on a prototype vehicle platform, has been presented. The Algorithm generates possible pedestrian candidates from the input image using a Haar cascade classifier. Candidates are then validated through a novel part-based HOG filter. A feature-based tracking system takes the output of the two-stage detector and compares the features of new candidates with those of the past. Matching is performed with the aim of assigning a consistent label to each candidate and of improving the recognition robustness, by filling false negatives filtered by the previous phases. The whole system has been ported to a prototyping framework and integrated on a platform vehicle, for testing and optimization. A significant performance improvement has been obtained by exploiting the CPU multi-core features. As a result, a system working at 20 Hz and offering performance comparable with the state of the art has been obtained. Additional realworld tests have been performed on the platform for finding weaknesses. Although the system is faster compared with the state of the art, its detection performance compares very favorably to the state of the art with a true positive rate of 0.673 at a FPPF of only 0.046 [1]

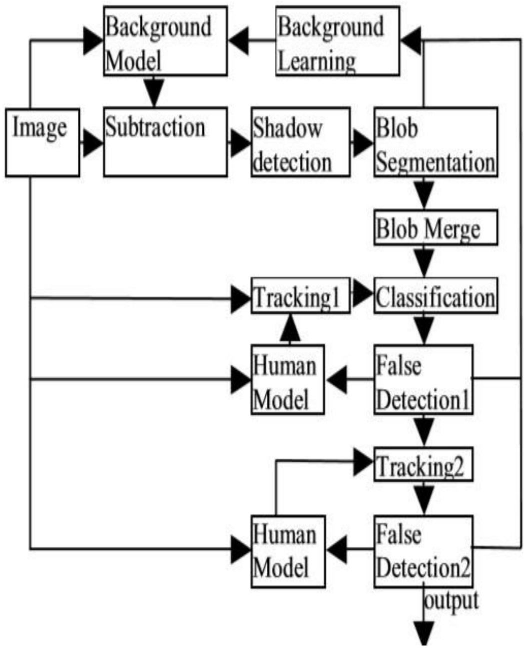
2.2 HOG and SVM based detection

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 formed by combining 4 cells. 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. For the training of the SVM Classifier we need the negative and positive image dataset. There are many datasets of the pedestrians in city or on the road. There are two mainly datasets in which there is well positive and negative images of the pedestrians. first one is MIT data set of the pedestrians which is contains 509 training and 200 testing images of the pedestrians on the cities road and other is INRIA dataset of pedestrians which is contains the 1805 64x128 cropped images of humans. In both datasets the humans are standing positions. For the feature extraction we are using the builtin function of HOGDescriptor from the opencv library of the python. In which human features are extracted by using hog algorithm which is implemented in the hog descriptor. Support Vector Machine is a supervised learning models in machine learning. This classifier is used for the dual class type data sets. When we give the two group data set to the SVM classifier for the training then it will classifies the dataset. [2]



2.3 Real time robust human detection and tracking system

Jianpeng Zhou and Jack Hoang have proposed a Real Time Robust Human Detection and Tracking System with the ability to deal with tough situations. Basically, the system consists of foreground segmentation, human recognition, human tracking and false object detection. The system can learn the false alarm which makes the system more stable and robust through the step of the false object detection. This system can handle most tough situations such as sudden light change, heavy shadow, the objects in background etc. from the test result in varying environments. There are two kinds of techniques for foreground segmentation: optical flow computation and background subtraction. Although the optical flow computation can provide better performance, it is a computationally expensive method and unsuitable for a real time system. To solve the problem of computation consuming, Y.L.Tian and A.Hampapur combine these two techniques together. [3] They firstly use the background subtraction to locate the motion area, and then perform the optical flow computation only on the motion area to filter out false foreground pixels. The background subtraction is popularly used in foreground segmentation. The motion information is extracted by thresholding the difference between the current image and background image. To handle multiple backgrounds, such as water waves and tree shaking, the models such as the mixture of Gaussian [4], Nonparametric Kernel [5], and codebook [6] are provided recently. In this paper, Jianpeng Zhou and Jack Hoang have proposed an improved algorithm of foreground segmentation based basic Gaussian model considering the environments with the sudden light change, shadow and tree shaking. The figure shows the flow of pedestrian detection. [7]



2.4 HOG and LBP

Sliding window technique is used mostly for detection purpose. Xiaoyu Wang et al proposed an idea which is a combination of HOG and Local Binary Pattern (LBP). Local Binary Pattern (LBP) is highly discriminating local descriptor which is invarsiant to monotonic grey level changes, and that makes it a robust feature for image analysis. It consists of two methods. In first method, gradients in the input image are obtained like the original HOG for each pixel. And then histogram is then constructed from the obtained results. In the second method, LBP is calculated from each pixel in the input

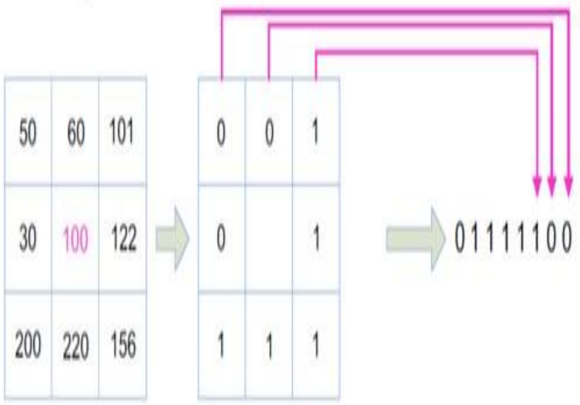


Fig. 1.LBP calculation for every pixel

image. These two methods are then combined to form a HOGLBP feature vector. Daniela Monctezuma et al has proposed a combination of Gabor and HOG features to perform person detection in surveillance applications. At first, the moving object is extracted by the background subtraction technique. Then gabor filter is applied on that extracted object to generate a Gabor image. Thereafter, HOG feature is extracted from the Gabor image to form the feature vector which is used for classification. Li Sun et al proposed the online boosting tracker, fusion of particle filtering, and HOG descriptor for human detection. Here, the current frame of the video will go through the background subtraction first to remove the background and detect whether the human is existing or not. Then this detected result is associated to that of existing trackers from the previous frame. This result from the tracker will be then directed to a flexible particle weighting scheme along with a confidence level value from the HOG descriptor. Hui Xing Jia and Yu Jin Zhang proposed a combination of HOG and Viola's face detection framework for making a human detection system which inherits the speed advantage of Viola's object detection framework and the discriminating power of HOG features on human detection. Each and every bin of the HOG features is treated as a feature instead of taking each block as a building element, in order to replace the HAAR feature in Viola's framework. They have proposed an augmented feature vector, that combines the HOG feature with the cell-structured LBP feature. HOG is unable to perform well when there is background cluttered with noisy edges and Local Binary Pattern is complementary in this aspect. For the construction of the cell-structured LBP, pattern histograms in cells are build. The histograms from the LBP patterns of different cells are concatenated to describe the texture of the current scanning window. They have used the notation LBPu n,r to denote LBP feature that takes n sample points with radius r, and the number of 0-1 transitions is no more than u. For example, the pattern 0010010 is a nonuniform pattern for LBP2, and is a uniform pattern for LBP4 because LBP4 allows four 0-1 transitions. From their point of view, different uniform patterns are counted into different bins and all of the nonuniform patterns are voted into one bin. Figure shows the LBP8,1 feature extraction process. [8]

3. DISCUSSION

A. Illumination Variation

Image quality depends upon the light falling on it and during entire day, multiple light changes are happened. This directly effects on image quality. Sometimes image quality becomes worst that information cannot be retrieved. By updating the background constantly as per the current frames light will gives quit good result. Some pre-processing techniques like blurring of image, Contrast stretching and histogram equalization also gives a good result. Therefore, these techniques are used to remove light changes. Here, overall image quality is increased which results in clearly detecting pedestrian from the image.

B. Variation in Postures and Shapes

Pedestrians have different postures and shapes that creates a problem in detection. Different postures and shapes cause problem in detecting pedestrian and these problems can be eliminated by training the SVM. Numbers of datasets are considered while training the SVM. SVM will predict pedestrians from the image approximately. 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*

TABLE I
COMPARISON OF DIFFERENT METHODS OF PEDESTRIAN DETECTION

Method	Author	Feature	Classifier	Results	Year
LBP-HOG [9]	Cosma, Andrei-Claudiu, Raluca and Nedevschi, Sergiu	HOG, LBP	SVM	FPPI 78%	2013
HOG+SVM Light [10]	Bui, V. Fremont, Boukerroui, P. Letort	HOG	SVM	MR 70%	2013
HOG + Background Subtraction [11]	Z. Jiang, D. Q. Huynh, W. Moran, S. Challa	HOG	Linear SVM	Speed 0.30 s/frame	2013
WSPD (Warp Speed Pedestrian Detection [12]	F. De Smedt, K. Van Beeck, T. Tuytelaars, T. Goedeme	HOG	SVM	25-480 FPS	2013

4. CONCLUSION

Techniques discussed here to detect pedestrian are based on image processing. Most of the techniques used Histogram of oriented gradients feature vector and support vector machine for classification. In the process of pedestrian detection, accuracy and speed of detection are the important parameters to be considered. All the above techniques tried to meet those paraments or requirements. But one has to compromise for either of the parameter i.e. there is an always trade-off between speed and accuracy relationship. There are some constraints such as illumination changes, posture variation of pedestrian always impacts on detection process. For real time application these problems have to consider for pedestrian detection.

5. REFERENCES

[1] A. Prioletti, A. Møgelmose, P. Grisleri, M. M. Trivedi, A. Broggi, and T. B. Moeslund, "Part-based pedestrian detection and featurebased tracking for driver assistance: Real-time, robust algorithms, and evaluation," pp. 1346–1359, Sep. 2013.
[2] N. Dalal and B. Triggs, "Histograms of oriented gradients for human detection," in 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05), vol. 1, June 2005, pp. 886– 893 vol. 1.
[3] Y. Tian and A. Hampapur, "Robust salient motion detection with complex background for real-time video surveillance," in 2005 Seventh IEEE Workshops on
[4] Applications of Computer Vision (WACV/MOTION'05) Volume 1, vol. 2, Jan 2005, pp. 30–35.
[5] C. Stauffer and W. E. L. Grimson, "Adaptive background mixture models for real-time tracking," in Proceedings. 1999 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (Cat. No PR00149), vol. 2, June 1999, pp. 246–252 Vol. 2.
[6] A. Elgammal, R. Duraiswami, D. Harwood, and L. S. Davis, "Background and foreground modeling using nonparametric kernel density estimation for visual surveillance," Proceedings of the IEEE, vol. 90, no. 7, pp. 1151–1163, July 2002.
[7] Kyungnam Kim, T. H. Chalidabhongse, D. Harwood, and L. Davis, "Background modeling and subtraction by codebook construction," in 2004 International Conference on Image Processing, 2004. ICIP '04., vol. 5, Oct 2004, pp. 3061–3064 Vol. 5.
[8] Jianpeng Zhou and Jack Hoang, "Real time robust human detection and tracking system," in 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05) - Workshops, Sep. 2005, pp. 149–149.
[9] X. Wang, T. Han, and S. Yan, "An hog-lbp human detector with partial occlusion handling," 11 2009, pp. 32 – 39.
[10] A.-C. Cosma, R. Brehar, and S. Nedevschi, "Pedestrians detection using a cascade of lbp and hog classifiers," 09 2013, pp. 69–75.
[11] M. Bui, V. Fremont, D. Boukerroui, and P. Letort, "People detection in´ heavy machines applications," in 2013 IEEE Conference on Cybernetics and Intelligent Systems (CIS), Nov 2013, pp. 18–23.
[12] Z. Jiang, D. Q. Huynh, W. Moran, and S. Challa, "Combining background subtraction and temporal persistency in pedestrian detection from static videos,"

in 2013 IEEE International Conference on Image Processing, Sep. 2013, pp. 4141–4145.

[13] F. De Smedt, K. Van Beeck, T. Tuytelaars, and T. Goedeme, "Pedestrian´ detection at warp speed: Exceeding 500 detections per second," in 2013 IEEE Conference on Computer Vision and Pattern Recognition Workshops, June 2013, pp. 622–628.