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A Survey on Machine Learning Techniques for Vehicle Classification, Helmet Detection, and Number Plate Recognition

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Abstract:
Background*: Object tracking in video surveillance is of great interest for many researchers, which is an important application and emerging research area in machine learning and image processing. Detecting object is a process to find the presence of objects with a bounding box and categories or forms of the placed objects in a picture. This paper provides a review on tracking techniques, their categorization into different types and focuses on important and useful tracking techniques. We review general strategies under literature survey on different techniques and finally state the analysis of possible research directions.*
Key Word*: Machine Learning; Object Detection; OpenCV; Vehicle Detection*

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I. Introduction

The main goal of this work is to develop automatic vehicle detection and classification systems to automatically detect and track objects of interest from video screens and estimate the speed of vehicles without sensors. Object detection is a challenging, technological, and practically useful problem in the field of computer vision that allows us to identify and locate an object in a video or image. Object detection deals with distinguishing the presence of assorted individual objects in an exceeding video. In the proposed software program, initially, it captures the first frame via webcam. This framework will be treated as the first framework. The movement will be obtained by calculating the phase difference between the first frame and the new frame. The refined structure will be called the Threshold framework. Then by using other complex image processing methods such as Shadow Removal, Dilation, Contouring, etc. in the threshold framework, larger objects are captured. This project involves speed estimation of the vehicle which is done using the image processing technique.

II. Literature Survey

Wei Hou *et al.* [1] proposed a technique that used the moving object library and the data structure in the computer vision library to construct a vehicle video analysis system for the detection and tracking of cars on the road. CAMSHIFT algorithm was used to solve the problem of target deformation and partial occlusion. Gaussian Background model was used to obtain background. That experiments had verified that for vehicle detection, the threshold of 20 is the best value.

Apeksha P Kulkarni *et al.* [2] proposed the technique that efficiently managed to distinguish the vehicles from the surrounding environmental variability and improve the low-resolution videos through the Histogram equalization technique to maintain uniformity of videos in terms of resolution and also in removal of noise from videos. Accuracy gained for detected vehicles by that approach is 97.39% and for a vehicle, tracking is 98.26%.

Valanukonda Lakshmi Padmini *et al.* [3] proposed the technique that used a machine learning-based approach to identify helmet usage among motorcyclists. Object detection-based algorithm is trained to identify motorcycles and their helmet. With an 87.6% model accuracy rate, this research work has proposed a solution to enhance the driving safety measurements, which in turn deploys a time-efficient approach to handle the traffic regulations.

The efficient approach for Unattended Object Detection by Contour Formation utilizing Background Subtraction was proposed by Neelam Dwivedi et al. [4]. The proposed approach uses background subtraction for object detection with the ability to change the background frame if the detected object is found non-

suspicious/harmless. Average Correct Object Detection Rate, average Object Success Rate, and average False Alarm Rate of the static and dynamic background are 70.83%, 67.25 %, and 35.41% respectively.

Suraiya Parveen *et al.* [5] proposed a simple and efficient motion detection system that supports the user to interact with the machine andmade it possible to access and extract informationfrom the internet on a PC. This proposed model is useful due to its effective and user-friendly nature. In this case, a basic interface is established for the customer to select the important area to be researched, i.e. the region of interest, and then image processing techniques are applied to the photos to calculate vehicle count and classify the vehicles using machine learning algorithms.

KEYOU GUO1 *et al.* [6] used multi-scale feature fusion for a real-time vehicle object detection method. In that, the learning rate-adaptive adjustment algorithm was used to replace the traditional and fixed learning rate, and it is applied to the model training process to generate a vehicle multi-object detector. The experimental results showed that the detection time of the enhanced SSD detector is 55.6 MS, with a better detection speed than other traditional detection algorithms under the same resolution.

A. Manju, *et al.* [7] used Background separation and Haar cascades to detect an object. Haar cascade algorithm was used and the detection rate was increased in this framework. The experimental analysis in this framework can achieve a higher object detection rate from videos with a low false-positive rate, compared to the other system.

Shriharsha S. Venia *et al.* [8] proposed a system to distinguish, track and check vehicles utilizing a vision-based system. That framework could be utilized for detection, counting, and following of the vehicles and then characterize the recognized vehicles from a given input video. This system demonstrates that vehicle counting and classification model for roadways can get over 93% exactness and 25 FPS speed on the vehicle detection, counting, and classification of the tracked vehicles.

For highway surveillance video situations, Huansheng Song et al. [9] suggested an object detection and tracking approach. The extraction of the highway's road surface area provided a more effective ROI area in this case. Based on the annotated highway vehicle object dataset, the YOLOv3 object identification technique was utilized to create an end-to-end highway vehicle detection model.

Fahad A Khan *et al.* [10] developed a machine system to detect motorcyclists without helmets as well as to detect and recognize characters of the number plate. They used deep learning-based convolutional neural networks. Transfer learning [12], is used on the CNN model, Yolov3-tiny Darknet trained in advance on the COCO dataset. This information has encouraged acquiring high precision in order.

III. Conclusion from Literature Survey

1. Most of this surveillance uses humans to monitor the activities that are happening in the area of interest. However, using humans in surveillance has its disadvantage to overcome that limitation researchers are working in automated visual surveillance systems.
2. A major technique used to improve the detection of vehicles is the use of a background subtraction algorithm.
3. Vehicle detection and classification has been an area of application of machine learning and image processing which is being researched extensively by its importance due to the increasing number of vehicles, traffic rule defaulters, and accidents.

IV. Proposed Methodology

The system has been developed in three stages. The first stage involved the detection of a vehicle. The second stage involved machine training using the OpenCV library to track the vehicle. The third stage involved speed estimation of vehicles. A video from the camera is used as input. Each frame goes through an object detection process to get a moving object.

I. **Pre-processing** – Stream of frames are extracted from the input video. Gaussian filter is used to remove noise and reduce details. Each frame is pre-processed to adjust the contrast and to remove the noise.

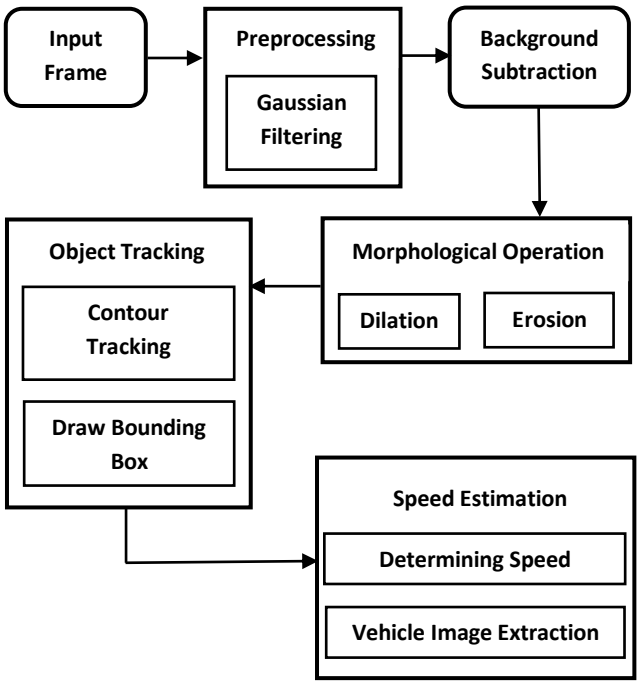

Figure 1 Block diagram of the proposed methodology

II. **Background Subtraction** - After pre-processing, foreground objects are extracted by using the background subtraction method. In this method, the pixel difference between the current frame and the background frame is calculated. In OpenCV, the BackgroundSubtractor object is used to form the foreground mask.

III. **Morphological Operation** - In cases like noise removal, erosion is followed by dilation. The morphologyEx() of the method of the class Imgproc is used to perform these operations. Erosion removes white noises, but it also shrinks objects. Dilate is used to increase the object area.

IV. **Object Tracking** - The detector identifies the vehicles in a given frame of video and returns a list of bounding boxes around the vehicle to the tracker. Contours help in shape analysis, finding the size of the object of interest, and object detection. OpenCV has a findContour() function that helps in extracting the contours from the image. The vehicle detection process is based on the process of feature detection. The features which are extracted are tracked over sequential frames. The tracker uses the bounding boxes to track the vehicles in subsequent frames.

V. **Speed Estimation** - The speed of a vehicle can be estimated when a tracked vehicle covers a segment of the road. The time difference between the position of a vehicle is calculated. The timer starts when the vehicle enters the region of interest, and the timer ends when the vehicle exits the region of interest. Thus, from the distance and travel time of the detected vehicle, the speed of that vehicle is determined. By using contour detection image of a vehicle that drives above the speed limit is extracted.

V. Conclusion

Simple and efficient motion detection and speed estimation system is proposed in this research work. This paper presents the techniques to achieve improvement and outperformance in the vehicle detection and speed estimation process. The proposed approach uses background subtraction and contour detection to identify vehicles. This project is able to estimate the speed of vehicles and save vehicle data. The presented research represents the determination of vehicle speed employing an image processing technique. In speed estimation, the time difference between the position of a vehicle in a region of interest is calculated. Multiple vehicles and their speed can be detected. Vehicle image is extracted using contour detection. The classification of the object in computer vision is a widely used system in research as well as real-time applications.

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