Survey paper on different techniques of vehicle tracking, counting and classification

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***Abstract*: In this study we describe and compare various video image processing techniques of vehicle tracking, counting and classification. This study can be very much useful to do comparative analysis of various image video processing methods used to track and count vehicles. We propose a literature survey based on our study and a comparison table is provided for comparative analysis of methods that we studied.**

***Index Terms*: R-CNN, YOLOv3, Single shot Multi-box detector (SSD), Image processing**

I. INTRODUCTION

Intelligent Transportation System (ITS) makes use of various video processing techniques to detect and classify vehicles to provide them as output of surveillance cameras. Considering the massive growth in number of vehicles in recent years it is tedious job to monitor and maintain traffic related information accurately. Vehicle tracking and classification have vast applications in various fields including traffic congestion control, incident detection, crowd monitoring, civil engineering, vehicle toll systems etc. Accurate counting and tracking of vehicles with less processing time can improve the health of traffic monitoring system with great extent.
The main challenges faced while detecting vehicles from input video frame are:

I. Occlusion of objects can cause repetitive or no detection of vehicle leading to wrong results.
II. In most of the techniques, shadows of vehicles are not considered due to which wrong results may be produced.
III. Surveillance cameras cannot operate in heavy weather conditions hence limited opportunities are available.
IV. Background is not uniform throughout the video and may be subject to light intensities available.
V. Different surveillance cameras produce images with different resolutions.

In this study we describe and compare various vehicle counting, tracking and classification methods which try to solve above problems. Our study will help researchers to get a summary of work done in the proposed domain so far so as to speed up his/her research work.

II. LITERATURE SURVEY

[1] With the help of Unmanned Aerial Vehicle (UAV) made a comparison between the two CNN algorithms faster RCNN and YOLOv3. The two algorithms were compared based on precision, recall, F1 score, quality and processing time. Experimental comparison was done using images taken by an UAV flown above Prince Sultan University campus and from an open source dataset available in Git-hub [2]. This paper concluded that both algorithms are comparable in precision, but YOLO v3 outperforms faster R-CNN in sensitivity and is more capable to extract all the cars in the image with 99.07% accuracy. Concerning the processing time for one image detection, YOLOv3 outperforms Faster R-CNN. This paper demonstrates that YOLOv3 can be used for traffic monitoring in UAV imagery.

[3] Calculate the number of vehicles passing on the road based on the detection of vehicles that cross a virtual line. Mainly focuses on congestion problem in urban areas. Background subtraction is implemented using k Nearest Neighbor method. This technique gave a success rate exceeding 95%.

[4] Based upon whether vehicle is travelling with speed or if there is traffic congestion virtual loops or detection lines are used for vehicle counting. Lamplight suppression, night time checking and shadow elimination improves the efficiency of the system. Traffic congestion algorithm is very useful to get traffic related data in many applications. Rather than applying single algorithm for every condition (day time, night time, amount of traffic congestion etc.) this method, based on the scenario uses different methods/techniques to detect and count vehicles.

[5] Various techniques used in vehicle counting in intelligent transportation system (ITS) fails to recognize the occlusion of vehicles and may produce wrong results. This method uses connected component analysis and CNN to identify cross lane vehicles and to produce exact results with increased accuracy. Virtual coils are used for counting of vehicles from various traffic videos provided.

[6] Single Shot Multi-box (SSD) along with virtual coil is used to track, detect and count moving vehicles. Tracking algorithm is used to first track vehicle, vehicle count is then maintained using virtual coil. Even though some part of the object is blocked, the object can still be detected with the help of SSD.SSD incorporates motion detection and classification tasks into a single framework. Open source dataset KIITI is used along with manual annotation image.

[7] Vehicle detection from various input video frame is done using a faster Region based Convolutional Neural Network(R-CNN) network which gives increased accuracy and reduced processing time. Fast R-CNN is type of CNNs which solves the drawbacks of R-CNN by applying a CNN on the main image to produce a convolutional feature map. Residual network ResNet-50 is used to train DNN. Cars Dataset provided by Stanford University is selected to train and test data in this work. This method provides almost real time vehicle detection. Video frames from video based intelligent transportation system are used for the purpose of vehicle detection.

[8] Compares two commonly used techniques for object detection- Support Vector Machine (SVM) and Single Shot Multi-box Detector (SSD).Experimental analysis is performed on images from different cameras with different resolutions(640 x 480, 1280 x 720, 1920 x 1090).Performance of two methods is compared based on precision, Recall and F1 score. This paper concludes that SSD is better than SVM but there is a trade-off for CPU, RAM and processing time for SSD.

[9] Vehicle detection and classification is performed by first using background subtraction to detect moving vehicle then to obtain the clear identification of vehicle newly proposed iterative morphological operators are used for removal of shadows if any and finally earlier moments are used to classify vehicles based on descriptor vector formed.

[10] Proposed approach consists of six stages: background subtraction, vehicle segmentation, shadow detection, vehicle tracking, vehicle classification and vehicle counting. It deals with problems faced in object detection- occlusion of objects and shadowy conditions. Simple approach that can be applied to count, track and classify an object.

[11] Detection and classification of vehicles is achieved using counter classifier- based on various video processing methods like object detection, edge detection, frame differentiation and the Kalman filter. Implementation is performed using C++ programming language. The classification test error was about 5 percent and detection test error was about 4 percent.

[12] In this paper, a low cost infrared based system is used for counting and classification of vehicles. The infrared system contains a pair of transmitter and receiver, each mounted on either side of the lane, forming a magnetic loop between them. The Infrared pulse is transmitted and captured within a particular time span at the receiver end. When a vehicle passes by, distortion is formed between the transmitter and receiver. The vehicle is classified on the basis of distortion created on the induction loop in number of sensors arranged in vertical levels and comparing the distortion model with the database. Vehicle counts can be derived on the basis of arrival and departure of a vehicle. Communication between the sensors and devices is managed by a micro-controller.

[13] A new method called faster-SSD is proposed which has better outcomes than the previous methods of object detection and classification. Virtual loops are used to count vehicles. The vehicle detection accuracy is 99.3% and classification accuracy is greater than 98.9%.Vehicle counting method is based on center point of vehicle. The proposed model can run on different platforms and deals with the problem of object occlusion faced while object detection.

III. TABLE OF COMPARISON

Author/s	***Year of publish***	***Approach***	***Description***	***Limitations***
Bilel Benjdira, Taha Khursheed , Anis Koubaa , Adel Ammar , Kais Ouni,	2019	Comparison of the two CNN algorithms faster RCNN and YOLOv3 based on UAV.	This paper concluded that YOLOv3 can be used for traffic monitoring in UAV imagery.	Drones are used for UAV which needs additional costing and maintenance.
Ali Tourani, Sajjad Soroori, Asadollah Shahbahrami, Saeed Khazaee and Alireza Akoushideh	2019	Faster R -CNN with ResNet-50.	Vehicle detection from still images using R-CNN for increased accuracy and reduced execution time	Not complete real time approach. The experimental analysis was not done on real surveillance camera videos.
Andr´es Heredia and Gabriel Barros-Gavilanes	2019	Comparison of SVM and SSD for classification of vehicles	Demonstrates that SSD is better than traditional algorithms like SVM.	Other algorithms of vehicle classification are not taken into consideration.
Qiaoqian Chen, Na Huang, Jieming Zhou, Zhao Tan	2018	SSD (Single Shot Multi-box detector)	SSD along with virtual coil is used to track, detection and counting of moving vehicles.	Vehicles travelling along different trajectories overlapping each other and considered as a single vehicle in certain frames.

Salma Bouaich, Mohamed Adnane Mahraz, Jamal Riffi, Hamid Tairi	2018	K nearest neighbour.	Calculate the number of vehicles passing on the road based on the detection of vehicles that cross a virtual line.	Counting of vehicles is not possible in all environmental conditions due to use of CCTV cameras.
Lili Chen, Zhengdao Zhang , Li Peng,	2018	Faster Single Shot Multibox Detector	New faster SSD model is proposed for vehicle detection and vehicle counting is based on virtual coils by considering centre point of vehicle.	This method can run on a platform of limited computation.
Abirami Ramanathan, Min Chen	2017	Simultaneous Partition and Class Parameter Estimation (SPCPE)	Provides a method to deal with object occlusion and shadowy conditions problem in vehicle tracking, counting and classification	Limited scope in vehicle detection and classification.
Siham Aqel , Abdeslam Hmimid , My Abdelouahed Sabri and Abdellah Aarab	2017	Background Subtraction, morphological operators, invariant earlier moments	A new approach is provided for detection and classification of vehicles to solve traffic problem.	Occlusion problem of vehicles is not solved in some cases.
Fei Liu, Zhiyuan Zeng, Rong Jiang	2017	Virtual loop and detection line method, block wise background update.	Based upon the scenario, the system chooses to the suitable algorithm.	System is inefficient in heavy weather conditions.
Ali Tourani , Asadollah Shahbahrami	2015	Counter-classifier, Kalman filter algorithm	Vehicle counting based on digital image processing	Counting of objects is not taken into consideration
Jilong Zheng, Yaowei Wang, Wei Zeng	2015	connected component analysis (CCA) and CNN	Vehicle cross lane cases can be identified efficiently using this method.	Various lightning conditions and weather Conditions can affect the performance of system.
Hemanshu S. Khatri, Sunil B. Somani	2015	infrared based system	The infrared system contains a pair of transmitter and receiver, each mounted on either side of the lane, forming a magnetic loop between them.	Use of magnetic devices can create a disturbance in field, grounding the sensors are required and maintenance for the same is necessary.

IV. Conclusion

Various approaches are used to solve the problem of vehicle counting, detection and classification considering various scenarios in real time. If one approach can solve one particular problem in vehicle detection and classification, another approach may not solve the same problem but may tackle some different issue and vice versa. Hence, there is a need to identify which approach suits our needs best, sometimes we may combine two or more approaches to get results with greater accuracy and reduced processing time.

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