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Video Based Vehicle Detection, Tracking, Counting and Classification System

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Abstract:

Traffic analysis and vehicle detection and counting processes provide appropriate information about traffic flow, vehicle crash occurrences on roadways. In this paper, we have proposed a study on vision based counting and classification system of vehicles on moving objects. In this system it requires tracking of individual vehicles. The system involves capturing of video frames to perform background subtraction for background and foreground subtraction in order to detect and track. Here we classify the vehicles as light transport vehicle and heavy transport vehicle. The classification of the vehicles is done by comparing the contour areas to the assumed values. The total count of the number of vehicles passed through the path of choice will be displayed and classified as light transport vehicle (LTV) or heavy transport vehicle (HTV). The method performance for vehicle count was evaluated.

Keywords **—Background Subtraction, Detection, Tracking, Counting, LTV, HTV.**

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I. INTRODUCTION

Traffic problems are increasing nowadays due to fast growing number of vehicles. Due to increasing number of vehicles traffic flow analysis play a fundamental role in gathering information about roads and passing vehicles. The videos stored by these systems are generally analysed by humans, which is a time consuming job. To overcome this time consuming constraint, need of more robust, automatic video based surveillance systems has increased interest in field of computer vision. Video surveillance systems have become cheaper and better because of the increase in the storage capabilities, computational power. Computer vision has also been applied for solving traffic and transportation problems. A good alternative to regular traffic management techniques is a video based surveillance systems. Counting vehicles provides appropriate information about flow of traffic, occurrences of vehicle crash and traffic at peak times. A video sequence of road can be processed and analysed to detect and count vehicles. Further information, such as the speed of a vehicle or traffic density, can also be calculated by using computer vision. This would directly benefits to two groups of people: road users and traffic administrations. On the other hand, traffic administrations can utilize the traffic information in their traffic control systems, resulting to a better traffic management. The main objective of this system is to: detect vehicles in roadways and keeping track of the vehicles and classifying the past vehicles in specified types.

II. RELATED WORKS

In [1], the authors have proposed computer vision based vehicle counting and classification system. Detection and counting of vehicles is done using background subtraction. Classification is done

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using Support Vector Machine, Bag of Features and Contour comparison and the results of each method were compared.

A. Tourani and A. Shahbahrami [2] presented a combination of video-image processing vehicle counter-classifier for object detection, edge detection, frame differentiation and Kalman filter. Experimental results were divided into Detection test and Classification test. Finally, the method performance, its accuracy for vehicle counting and classifying was evaluated.

N. Seenouvong, U. Watchareeruetai, C. Nuthong and K. Khongsomboon, et al. in [4] proposed a method using computer vision technology for vehicle detection and counting. For the detection of foreground objects, the authors used background subtraction technique. Several image processing methods were used in order to detect moving vehicles. Counting of the vehicle was done using virtual detection zone.

M. Tursun, M and G. Amrulla, et al. in [6] proposed a system to detect and count the moving vehicles on the roads. As stated by the authors, the system used a real time traffic surveillance cameras deployed over roads and compute how many vehicles pass the road. Foreground extraction which included moving vehicles was done using double difference image algorithm. In the proposed system counting was done by tracking vehicle movements within a tracking zone, virtual loop.

[7], presents a real time video based vehicle detection and counting system. The authors here have deployed two methods: one is adaptive background elimination and the other is Gaussian shadow elimination for detection of vehicle. Virtual detector method is used in order to count the number of vehicles.

In [8], E. Bas, A.M. Tekalp, and F.S. Salman proposed a video analysis method to detect, track and count vehicles based on an adaptive bounding box size. For road/vehicle detection and tracking, Kalman filter and adaptive background subtraction were used. The proposed algorithm was unable to track vehicles with changing directions but, it is improved to deal with some weather conditions.

Habibu Rabiu proposed a vehicle detection and classification system in [9]. The author used Kalman filter to detect and track the vehicles and LDA classifier for classification of vehicles. The proposed system successful in demonstrating the robustness in vehicle detection and counting, however, occlusions was an issue.

Another video based vehicle counting and classification system was proposed by the authors R.H. Pena-Gonzalez and M.A. Nuno-Maganda in [5]. Vision based system was developed to detect, track, count and classify moving vehicles on any kind of road was proposed. The data acquisition system consists of a real time video from the camera placed on the road, while the information processing is performed by clustering and classification algorithms.

As proposed by the authors S. Kamkar and R. Safabakhsh et al. in [13] detection of the vehicle was done using an active basis model. Counting and classification was done by extraction two features. Classification model random forest was thus used and results were evaluated.

In the proposed system, we develop a method to classify the vehicle as LTV and HTV using image processing techniques. The main objective of this system is to: detect vehicles in roadways and keeping track of the vehicles and classifying the past vehicles in specified types. Detection and counting of the vehicle is done using Gaussian Mixture Model (GMM) background subtraction. Classification has been implemented using Contour Comparison (CC) method.

III. METHODOLOGY

The system can be used for detecting, tracking, counting the vehicles and thus classifying them according to their sizes into two classes. The general vehicle detection, counting and classification system, system block diagram is shown in figure 1. The proposed system is basically based on three modules: background learning, foreground extraction and vehicle classification. Background learning module is about learning the background as to how different it is from foreground. Foreground extraction module consists of steps, background subtraction, detected bounded box and image enhancement. Vehicle classification module consists of contour detection and

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classifying the vehicle into LTV and HTV using CC and counting the number of vehicles.

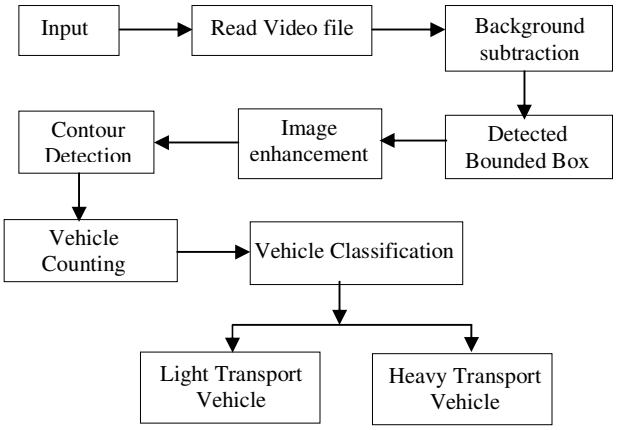

Fig. 1Block Diagram

A. *Vehicle Detection*

1) ***Region of Interest:***ROI is a particular portion of an image on which some operation is to be performed. It gives flexibility to work within a particular region instead of manipulating the whole image. Here only pixels in the region of interest are considered while others are deleted. White lines in figure 2 represent region of interest.

2) ***Background Subtraction:***Subtracting background pixels in a scene thus leaving only the foreground objects of interest means background subtraction, fig 3. As the accuracy of whole process of classification of the objects depends on it, it is an important pre-processing step in creation of any visual surveillance system. Here, a rectangle structuring element is also used but its size is adaptively chosen based on the zone defined (figure 4). The detected vehicle is tracked along the defined region of interest (white lines).

Fig. 2 Region of Interest

Fig. 3 Background Subtraction

Fig. 4 Detected Vehicle. Output of background subtraction, Erosion, Dialation, Detected bounded box

*3) **Contour Extraction:***Contours are the boundaries of the shape which are used for the shape detection and object recognition. OpenCV provide cv2.findContours () method, is used to find the contours in this algorithm.

B. Counting Vehicles

After vehicle contours are obtained, the virtual detection zone which is blue line to count the vehicles going downwards and pink line to count the vehicles going upwards. White lines represent region of interest. The centroid, in this case, the red dot if it reaches the virtual detection which is the blue or pink line, its status will be set to 1 which basically mean that the vehicle is counted, indicating that it has been counted and will not be counted in the subsequent frames. Vehicle counting is shown in figure 5 and figure 6.

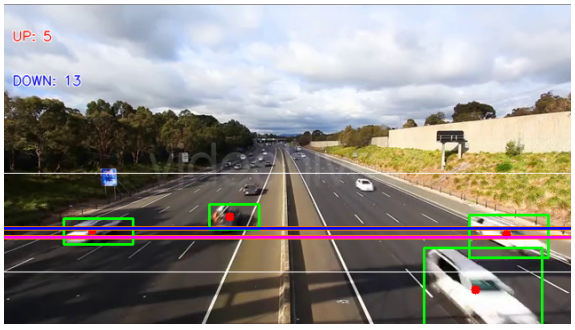

Fig. 5 Vehicle Counting (up and down)

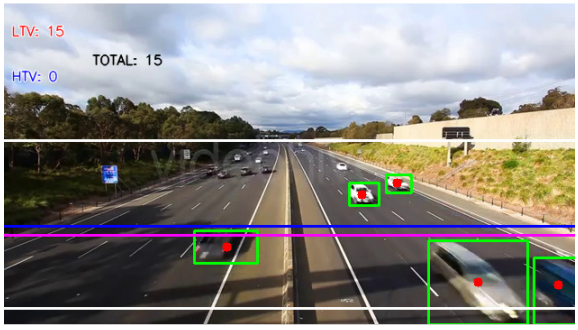

Fig. 6 Vehicle Counting (LTV and HTV)

C. Vehicle Classification using Contour Comparison

For classification using contour, the contour properties such as area of the contour is extracted and compared with already assumed values to determine whether the vehicle is LTV or HTV. In the proposed system openCV's findcontours () method is used to detect contours of the foreground object. First of all, a bounding box is drawn over the contour and its area is found which when intersects with the imaginary line, the vehicles are detected and classification algorithm is triggered to classify the vehicles.

The following values are assumed:

- If the area is between 0 and 10000, the vehicle is classified a LTV.
- If the area is between 10001 and 70000, thevehicle is classified as HTV.

IV. RESULTS AND DISCUSSION

Test has been performed on 5 prerecorded videos for validation and efficiency measurement of the proposed system. These dataset videos include video in MP4, AVI, VLC format and their respective frame rates are 29, 25, 30, 24 and 14 frames per second. Video 1 had 291 passing vehicles in 3:00 minutes, Video 2 had 57 passing vehicles in 15s, Video 3 had 48 passing vehicles in 2:13 minutes, Video 4 had 15 passing vehicles in 37s and Video 5 had 59 passing vehicles in 33s, have been counted manually. The proposed method was implemented in python3.6 programming language and openCV version 4.1.1 library.

TABLE I CLASSIFICATION TEST RESULTS

	Light Transport Vehicle	**Heavy Transport Vehicle**	**Vehicle count by proposed method**
Video 1	153	67	220
Video 2	36	4	40
Video 3	20	8	28
Video 4	3	7	10
Video 5	46	0	46

V. CONCLUSIONS

In this paper, a vehicle detecting, counting and classification technique based on image processing has been presented. The proposed system was able to classify the passing vehicles in roadways using image processing methods. Experimental results indicated that presented method of detecting,

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counting and classification with worked efficiently and were implemented successfully.

TABLE II DETECTION TEST RESULTS

	Real no.of vehicles	Counted no.of vehicles by the method	No.of errors
Video 1	291	220	71(24.39%)
Video 2	57	40	17 (29. 82 %)
Video 3	48	28	20 (41.66 %)
Video 4	15	10	5 (33.33 %)
Video 5	59	46	13 (22.03 %)

It should be noted that there are limitations of the proposed method to be concerned with. The vehicles appeared in the video are assumed to be clear and not occluded inside the detection zone. Furthermore, there are additional vehicle's features to be taking into account for vehicle detection in various setups. These issues will be the major concerns in the future work. As an extension of the proposed work, it is suggested to optimize the features selected and the foremost features with different classifier techniques can be analysed and compared.

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