Big Data: A Novel approach in implementing and analyzing the real time vehicle detection and counting system

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Abstract

The progress in recent deep learning methods has shown that steps in object detection is one of the key software components in the next generation of autonomous cars. Classical computer vision and machine learning approaches for object detection usually suffer from the slow reaction time .Modern algorithms and architectures based on artificial neural networks, like YOLO (You Only Look Once) algorithm, solve this problem without precision losses. In this providing the demonstration of the usage of the most recent YOLOv3 algorithm for the detection of traffic vehicles. Have to train the network for different vehicle objects and have demonstrated the effectiveness. A novel and effective method based on convolutional neural networks is used to achieve high-quality and real-time vehicle detection. The experimental results validate the effectiveness and robustness of our algorithm. In addition, our system runs at real-time of 10 frames per second.

Keywords: Machine Learning ,CNN, YOLOv3

1. Introduction

During the past few decades, the car industry has experienced dramatic development. New technologies are inventing from time to time, which make our lives easier to use. Meanwhile, thanks to the growing number of vehicles, the transport problem arises the main challenges for the transportation are traffic jam , environment effects, energy consumption, safety hazards, high maintenance cost, and land occupation. The primary problem is traffic congestion. The number of vehicles in China has reached 319 million. Among them, there are quite a million cars in 58 cities, and quite three million cars in 7 cities. The large number of vehicles led to ubiquitous congestions and transport delays, especially within the high-dense populated area .Secondly, pollution and energy consumption brought by the big number of vehicles couldn't be neglected, and therefore the traffic congestions had made the case even worse. Thirdly, under the pressure of fast-paced life, people were tired of being stuck within the traffic jams; and this might cause chaotic driving behavior and potential accidents. From the attitude of transport construction, everyone anticipates a self-contained and efficient transportation . However, adding more transport infrastructure means adding considerable expense, Let high maintenance costs and land consumption. Under these circumstances, the intelligent transportation (ITS) is conceived to unravel the issues and gradually becomes a worldwide phenomenon. Intelligent Transportation System is an integrated transportation, which aims at pro- viding innovative services for all types of transportation and traffic management in order that users can learn more about the transportation network and use it more safely, coordinately, and intelligently. From the system perspective, the main components of the intelligent transportation are transportation infrastructures, vehicles, and users. Many problems result from the shortage of timely and accurate information also because the lack of coordination of the users in the system. Intelligent transportation combines the normal transportation infrastructure with new technologies within the data system, communication system, sensor system adopts advanced mathematical methods for optimized planning. These technologies provide the users within the system a far better understanding of the traffic condition in order that they will make synergetic decisions. During this way, transportation sustainability and mobility are improved, energy efficiency is increased, environmental impacts are reduced, and traveling safety is secured.

1.1 Objectives of Research.

The aim of the research to solving such problems of traffic control systems as the detection, tracking, counting of passing vehicles. In addition, the road marking detection algorithm is proposed. The solution of these problems is considered for a stationary video camera installed above the road surface. After detecting of vehicle count the vehicle passed through the surface. This paper presents a completely unique and effective vehicle detection, tracking and counting system to realize real-time and robust leading vehicle localization using Yolo. The system consists of (i) vehicle detection and tracking, (ii) sky and road region recognition, (iii) vehicle counting. First, vehicle detection and sky and road recognition are performed to scale back the possible region of leading vehicle. Then vehicle detection is applied to urge all vehicles in per image. Compare with ROI information, making vehicle is accurately localized. Finally, vehicle tracking is employed to form the entire system faster and more robust. The core a part of the entire system is vehicle detection and then sorting of tracked vehicles and count them.

1.2 Scope of the Research

The emergence and actualization of various tasks in the field of transport analytics are associated with constantly growing number of vehicles on roads, which leads to a significant increase in economic and social costs. Insufficient traffic safety and traffic jams are major problems in cities around the world. A solution of these problems is expensive in the face of growing pressure on transport infrastructure. One possible approach is the application of adaptive traffic control systems placed in streets of a city. The traffic control systems not only reduce delays and congestion but also solve other problems the requirement to implement image processing algorithms on an embedded platform of intelligent video cameras was taken into account when developing these algorithms. In the proposed system, first step is collecting data of which includes collection of vehicles with good resolution image. The next process is to train the image dataset with the model to detect the vehicle. This can be processed in darknet where ”Yolo” algorithm implemented which is of Deep learning Model. The second process is to track detected vehicle. Then Count the vehicles using sorting algorithm.

2. LITERATURE REVIEW

Vehicle detection is the core part of our whole system. A novel and effective vehicle detection method based on deep learning is proposed. According to the introduction of deep learning and object detection Faster R-CNN and Multibox are two most effective and meanwhile fast detection method. Although the method of Faster R-CNN is better, but the real-time performance of the method depends on the usage of GPU, the expansibility and practicability are limited. So we use the method based on Multibox pipeline and make some improvements of the original method, applying it to our leading vehicle detection system The fundamental idea is to train a convolutional neural network that outputs the coordinates of the object bounding boxes directly.[1]To make the network easier to be converged, instead of predicting the coordinates of the object bounding boxes directly, we perform clustering of ground truth coordinates and find K centroids.

Thus, the K centroids are used as original bounding boxes and bounding box regression are learned as in DPM for each of the predicted locations. On the other hand, since we must classify the predicted bounding boxes, box confidences are also learned from the network for each predicted bounding box. So, the loss is the weighted sum of the bounding box regression part and the classification part. [2]Vision-based Intelligent transportation is extensively utilized in lifestyle because of four reasons. Firstly, people are used to visual information. The information does not need to be transformed or derived, which would save a lot of time for the users to make judgments. Secondly, video sequences can detect the time-varying tendency since they contain an extensive range of information which can reflect the traffic condition directly. Thirdly, the installation, operation, as well as maintenance of video sensors are simple. Lastly, the vision-based device is cost-effective. The detection, recognition, and tracking of objects in traffic system are widely used in vision-based Intelligent Transportation System. [3][4]Vehicle detection and tracking, in, has broad applications such as over-speeding and red-light running identification, parking lot access control, automatic charging, and lost vehicle tracking. Moreover, it can be used to construct a “vehicle-road-user” system.[5][6] Real-time traffic image sequences are collected by cameras on road; traffic flow parameters are extracted by vehicle detection, recognition and tracking module; then the traffic information is processed in the control center and sent to the users, so as to build interactions among road, vehicle, and users. [7]There are some issues about vehicle detection and tracking in the Intelligent Transportation System. Firstly, the vehicles have different shapes, sizes, and colors, which increase the difficulty of detection. Secondly, the figure of vehicles will change with its pose and orientation. Thirdly, environmental factors could affect the result of detection and tracking. Fourth, the fast movement and the tracking algorithm require high computing power. Lastly, the motion and drifts of vehicles require higher robustness.

3. Proposed System

In the proposed system, first step is Data Collection which includes collection of vehicles. The next step is to train the model with the dataset to detect the Vehicle. This is done using YOLO (Deep learning Model).. In that way, the network has knowledge about the whole scenery and objects environment, which helps the network to perform better and achieve higher precision results comparing to the methods which use the sliding window approach. The concept of breaking down the images to grid cells is unique in YOLO, as compared to other object detection solutions.

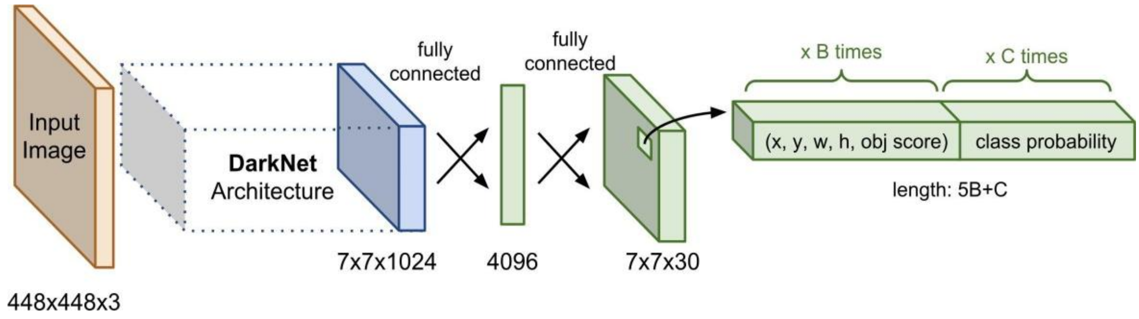

Figure 1. **Yolo model**

The input image is divided into an S x S grid of cells where each grid cell can predict 3 bounding boxes. Predictions whose pc is lower than 0.5 are ignored and that way, most of the false predictions are filtered out. Remaining bounding boxes are usually prediction of the same object inside the image. They are filtered out using the non max suppression algorithm.

The second Phase is to track detected vehicle using Tracking algorithms. [8]Camshift Tracking(Continuously Adaptive Mean-SHIFT): it have relevance with the mean shift with new scaled search window and previous window location. The process continues until the required accuracy is met. CSRT tracking. This tracker works by training a correlation filter with com- pressed features. The filter is then used to search the area around the last known position of the object in successive frames. KCF Tracking. The task of a tracker is to follow the object in the video by up- dating the bounding box parameters (the position at the simplest case). The final phase is to count the tracked vehicles after crossing the region of interest by using sorting algorithms.

3.1 General Architecture

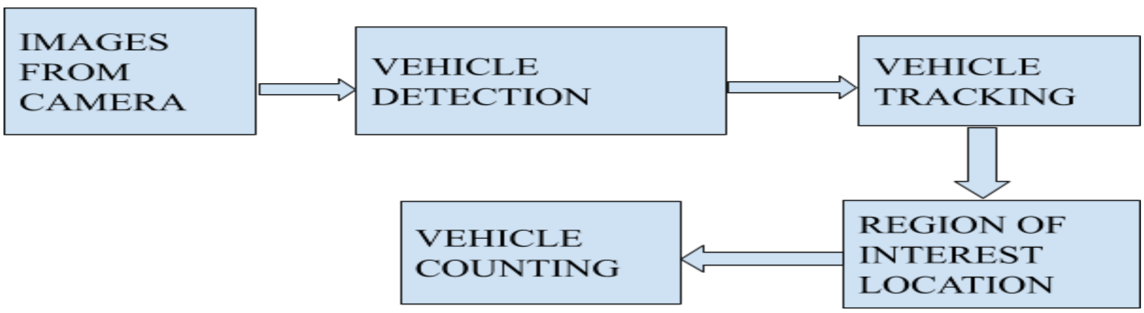

Figure 2: **Architecture Diagram**

The above diagram describes the complete explanation of the research, by taking dataset image and detect Vehicles. Detected vehicles are tracked accordingly. Tracked vehicles are counted, respectively.

3.2 Module Description

Video observation was carried out under different weather conditions and at different times of the day. The size of processed images is 1024 768 pixels. [9] The initialization stage of the algorithm consists in the background modeling in each zone. At this stage, the algorithm determines frames without motion. For this purpose, the number of moving points on each frame is estimated: Calculating the difference be- tween the current frame and previous frame. Obtaining the number of moving points by thresholding. If the number of moving points is greater than the threshold, depending on the resolution of the image, then it is considered that motion is detected in the zone. Otherwise, there is no motion. [10] The zones are synchronized to deter- mine the moment when a vehicle left the entry zone and then left the exit zone. This step is necessary to exclude the selection of a reference frame at the time when a vehicle stopped in the zone. If there is no motion in the zone within the specified short time interval, then a reference frame is selected for background estimation. After the reference frame selection, the stability of the background is checked for a predetermined time interval (usually several seconds). The difference between the reference frame and the current frame is analyzed for this purpose. After the stage of the background estimation is completed, the zone goes into the normal operation mode, which contains the following steps: Calculating the difference between the current frame and background frame.

4. RESULTS AND DISCUSSIONS

Implementation is the phase of the venture when the hypothetical plan is trans- formed out into a working framework. Along these lines it very well may be viewed as the most basic stage in accomplishing a producing helpful new framework and in giving the client, certainty that the new framework will work and be effective. The execution arrange includes cautious arranging, examination of the present frame- work and its requirements on usage, different planning techniques to accomplish changeover and assessment of changeover strategies.

4.1 Input Design

The YOLO v3 neural network was trained and evaluated on Dark net. The dataset which consists of 300 train images and 300 validation images, was used for the training. At the beginning of the training, weights were initialized using a model pretrained on the COCO dataset. The software solution is based on Darknet neural network framework written in C programming language. The algorithm used in the solution is presented on Fig 1. The video stream is captured from the forward-facing camera placed on the car. Frames captured with the camera are resized and forwarded as the YOLO network's input. After the post-processing outputs, valid detections are drawn on the original frame and forwarded to the output file stream. Furthermore, valid detections from the last three frames are also analyzed and considered, when visualizing current frame predictions. After detecting the object in the current frame, search for that object is performed in the last three frames. Depending on the dimensions and class of the object, previous detections are filtered out. Also, the size of the area in the image where the search is performed depends on the dimensions of the object.

4.2 Output Design

The labeled objects in the dataset, precision and recall values were not reaching high values as expected. Common false detections found in the outputs of the neural network were further investigated on the smaller custom dataset and video. The YOLO algorithm activates input video stream of downloaded videos with the frame resolution 1920 x 1080 px at the typical of 23 frames per second using previously described

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hardware. That confirmed the statement that YOLO algorithm are often used for the important time video processing. The tracked vehicle then counted passed by the area.

Figure 3 **Label Image**

Figure 4 **Detection and Counting**

Figure 5 **Test Image**

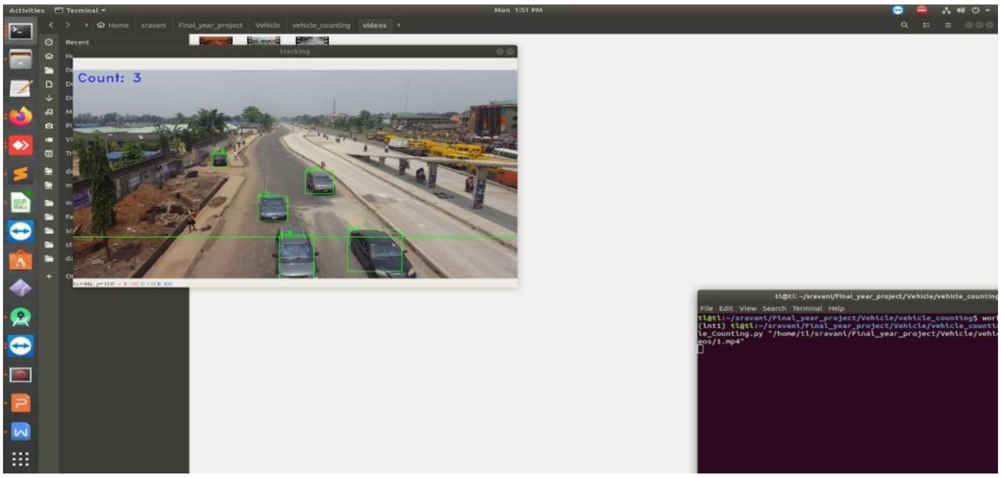

Figure 4.2.4: Tracking and Counting

4.3 Efficiency of the Proposed System

The proposed system effectively for both Vehicle Detection and Counting. For vehicle detection, the developed vehicle detection and counting algorithm requires the definition of special regions of interest in the image. the system is installed . Based on the 80% training set and 20% test set, we used the test set to calculate the model's average precision (map); map represents the average of the average accuracy (ap) of the total object class number (the class number in the experiment is 3). For each category, ap describes the average of 11 points for each possible threshold in the category's precision/ recall curve. We used a set of thresholds [0, 0.1, 0.2, ..., 1]. For recall greater than each threshold (the threshold in the experiment is 0.25), there will be a corresponding maximum precision pmax(recall). The above 11 precisions are calculated, and ap is the average of these 11 pmax(recall). We used this value to describe the quality of our model

$$ap = \frac{1}{11} \sum_{recall=0}^{1} p_{max}(recall) \qquad recall \in [0,0.1 \ldots \ldots .1]$$

$$map = \frac{\sum ap}{class\ number} \qquad (1)$$

The calculation of *precision* and *recall* is as follows:

$$precision = \frac{TP}{TP+FP}$$

$$Recall = \frac{TP}{TP+FN} \qquad (2)$$

where TP, FN, and FP are the numbers of true positives, false negatives, and false positives, respectively. We obtained a final map value of 95.88%, which indicates that the method is a good way to locate and classify different vehicle objects. It can be concluded from the above analysis that the correct overall rate of our object detection is 95.46%, which indicates good location and classification of different vehicle objects and provides better detection results for multi-object tracking.

Conclusion

A real-time and effective leading vehicle detection system is proposed in this paper. The whole system is combined with vehicle detection and tracking, sky and road region recognition, vehicle detection based on convolutional neural networks, and vehicle tracking. The experimental results show that our system can achieve higher recall and accuracy in real scenes videos. The efficiency of the algorithms and developed software has been experimentally confirmed. After the analysis of the results, we can conclude that the developed algorithms allow to solve the considered problem in real-time under different observation conditions.

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