University of New Haven

Computer Science

Spring 2022

CSCI-6674-01

Data Mining Project

Vehicle Detection Using Convolutional Neural Network

Professor: Dr. Shivanjali Khare

Team: Team Technokrats

Authors

Sindhuja Ganji

Graduate Student

Tagliatela college of engineering

sganj2@unh.newhaven.edu

Sarvani Pogula

Graduate Student

Tagliatela college of engineering

psarv1@unh.newhaven.edu

Abhinav Sai Choudary

Graduate Student

Tagliatela college of engineering

achil2@unh.newhaven.edu

Content

Abstract

Automation plays an important role in the vehicle detection for the security and other purposes. Detecting with the help of camera is an easy but a repetitive task which often requires a working force or a surveillance team to observe such cases and roaming of cars.

This study demonstrates collecting evidence from publications, personal correspondence, and diaries that using deep learning techniques to provide automated environment to the surveillance team is always important in the long run. It basically reduces the workforce cost resulting in the higher revenue. A deep learning model has been introduced and researches are being made with the evidence and proves of the deep learning model result and evaluations.

Introduction

Deep learning is a subset of artificial intelligence that trains a system by introducing it to classified data in a manner that mimics how a human learns and is taught. A machine may "learn" to identify and describe patterns and things on its own. It becomes better over time as it is exposed to more data. Deep Learning makes it possible for technology to advance continuously and fuel more Artificial Intelligence (AI) applications. To enable end users to make video data searchable, usable, and quantifiable, machine learning-based video content analysis software is used in CCTV networks to recognize, extract, classify, and index objects in video (briefcam,2019).

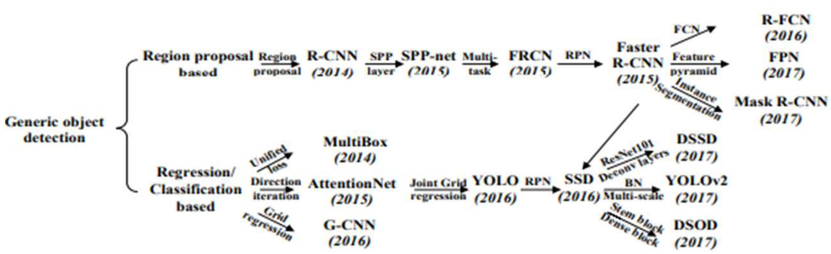
This research focused on the utilization of such techniques in order to tackle the vehicle monitoring and detecting problem. Before the artificial intelligence the problem had not been identified properly therefore a perfect solution doesn't exist in the past. Different vehicle recognition methods were introduced by the computer vision community. Deep learning-based traffic object recognition that uses video sensors, in particular, achieves excellent accuracy and has developed into a development of new techniques in self-driving applications.

Related Work

This section will summarize some of the work in this area with the specific and special target to the object and vehicle detection using the CNN and Open Cv methods.

(i) Object Detection with Deep Learning

Detail analysis and research purpose to detect different objects which basically categorize other types of detection including face, pedestrian and skeleton detection. Different vehicle recognition methods were introduced by the computer vision community. Deep learning-based traffic object recognition that uses video sensors, in particular, achieves excellent accuracy and has developed into a development of new techniques in self-driving applications. Microsoft COCO dataset have been used with several numbers of algorithms and framework being used.



Zhao, Zhong et al. (2019)

(ii) Vehicle Detection and Tracking in Adverse Weather Using a Deep Learning Framework

Vehicle detection is another task and when combined with the factor of weather conditions and most importantly the visibility which can be an obstacle in the detection system. Introduction to a strong deep learning vehicle detection system occurs. Together with hierarchical data associations (HDA), that are split into detection-to-track and track-to-track associations, the conventional Gaussian mixture probability hypothesis density filter-based tracker is used. Here, the Hungarian technique is employed to solve the cost matrix of each phase in order to make up for any tracks that were missed during detection. For quick execution, HDA uses only detection information (i.e., bounding boxes with detection scores) but not visual feature information. We also unveiled DAWN; a brand-new benchmarking dataset created for study on the use of driverless driving in inclement weather. It consists of actual images captured in a variety of bad weather conditions. On the DAWN, KITTI, and MS-COCO datasets, the presented method is evaluated and tested with 21 vehicle detectors.

PERFORMANCE COMPARISON OF AWBLP AND OTHER METHODS ON EACH CATEGORY OF THE DAWN DATASET

Methods	subset	PSNR	AG	IE
DCP [37]	fog	12	10.82	9.21
	rain	13.63	20.75	10.82
	snow	**15.76**	27.26	11.2
	sand	11.91	6.59	8.04
AOD-NET [38]	fog	11.88	10.95	9.05
	rain	11.79	30.74	11.31
	snow	11.12	10.06	10.51
	sand	**13.85**	10.05	8.51
FJBF-EAW [39]	fog	12.83	11.78	9.64
	rain	13.84	26.92	10.89
	snow	14.89	**27.83**	11.53
	sand	12.15	9.75	8.78
AWBLP	fog	**14.64**	**14.05**	**9.53**
	rain	**19.86**	**32.25**	**12.1**
	snow	10.08	15.86	**11.98**
	sand	10.53	**13.58**	**9.62**

PERFORMANCE OF VEHICLE DETECTION ON KITTI

Methods	Backbone	Easy	Moderate	Hard
DeepManta [49]	VGGNet-16	95.77	90.10	80.79
SSD-RRC [50]	VGGNet-16	95.68	90.19	86.97
Subcat-aware [51]	ResNet-101	90.81	89.04	79.27
RetinaNet [11]	ResNet-101	89.88	79.17	66.38
Faster-RCNN [40]	ResNet-101-FPN	86.71	81.84	71.12
CascRCNN [17]	ResNet-101-FPN	94.26	91.60	78.84
RV-CNN [52]	VGGNet-16	91.28	91.67	85.43
Faster-RCNN+DA [45]	SE-ResNet-50	81.83	90.34	71.23
TridentNet [47]	ResNet-101	90.33	88.37	80.57
SINET [8]	VGGNet-16	94.17	91.67	78.60
GYOLOv3 [30]	DarkNet-53	94.12	90.20	81.19
YOLOv3 [27]	DarkNet-53	89.01	85.65	75.89

Hassaballah,M et al. (2021)

(iii) Vision-based vehicle detection and counting system using deep learning in highway scenes

The challenges faced in the detection are often occurred by the variations in the size of vehicles to address the issue focus is mainly on the vision-based vehicle detection and counting system. A highway dataset with some annotation about the tiny objects was chosen to experiment the deep learning model. YOLOv3 network detect the type and location of vehicle whereas ORB algorithm founds the direction of vehicle. The Verification process involved the highway videos to check the accuracy of the output. (Song, Huan sheng et al. (2019).

(iv) Vehicle Image Detection Method Using Deep Learning in UAV Video

At present only the deep learning methods like CNN, OpenCV are used as a detector algorithm the focus on different set of models and techniques were not discovered at the high level. To effectively improve traffic automation management, road traffic data are quickly gathered. The above method's limited flexibility, however, restricts it to the fixed camera's broadcast image for traffic video. The video captured by drones has advantages over conventional video surveillance settings, including a wider surveillance field of view, reduced target occlusion, and more detailed traffic information. The majority of machine learning techniques, however, find it challenging to interpret vast amounts of real-time drone video data. This is why a deep learning solution for vehicle image recognition in UAV footage is suggested.

The accuracy is enhanced by approximately 5% before and after pretreatment. The information is processed by the SSD model of the suggested method following HSV transformation, and the model's potent data learning capabilities can enhance the detection result. 96.49% of vehicles were detected by it. Additionally, the SSD model's detection performance has been improved and it can operate on several feature maps. This detection with the proposed method showed great performance in terms of accuracy. The constraints of deep learning in real-time target tracking applications are determined by these two. In order to solve problems in real time, we will concentrate on using deep learning under small sample training for video target detection in the future

Wang, Xiangqian.(2022).

(v) A Real-Time Vehicle Detection System under Various Bad Weather Conditions Based on a Deep Learning Model without Retraining

The discussion loop on various detection techniques have been the part of researches and variety of methods have been tested with their best and worst performance under specific conditions and circumstances. In order to increase detection accuracy in a variety of inclement weather scenarios, this study suggests a vehicle detection system with a visibility complementation module. The deep learning models can be used in the proposed system without having to be retrained for object detection in various weather scenarios.

The enhancement in the visibility is obtained through the dark channel and convolutional encoder. Showcasing numerous layers to address various effects of various adverse weather. YOLOv3 used for the surveillance of different video sets.

By the use of our recommended sight complementation module, the recall rate improved from 85.22% to 89.82%, the false classification ratio dropped from 14.71% to 9.97%, and the visibility issue in various bad weather situations was adjusted under glare scene settings. Additionally, memory rates increased by nearly 20% in rainy circumstances. Chen,Xiu et al. (2020)

Proposed Method

The research was conducted to detect the vehicle and different cars with the data of non-vehicles inclusion. Main objective was to identify the vehicles and non-vehicles with the image set.

Dataset description: The image collections dataset which was divided into two categories one is of non-vehicle and other for vehicle. All the traffic which includes different kinds of cars and other vehicle contains car in them while non vehicle data contains some blur images and empty roads.

The Datasets used in this project: https://www.kaggle.com/datasets/brsdincer/vehicle-detection-image-set

Model Training: The initials before fitting the parameters dataset was divided into the ratio of 70/30 for train-test split. Both the vehicle and non-vehicle are separately splitted. Target image for the model was 250 and using the tensor flow libraries further parameters are set.

Model selection: Convolutional neural network (CNN) has been chosen and fitted with several parameters like relu, which is an activating parameter, it returns 0 if it is negative and returns random value if it is positive.

The deep layers which is connected to its preceding one with neurons have been activated using the sigmoid function which shows the non-linear relationships.

Early stopping parameter has been used to avoid the over fitting of the variables and to improve the fitting with each iteration.

The samples of the dataset of vehicles and non-vehicles are:

The vehicle image set

The non-vehicle image set

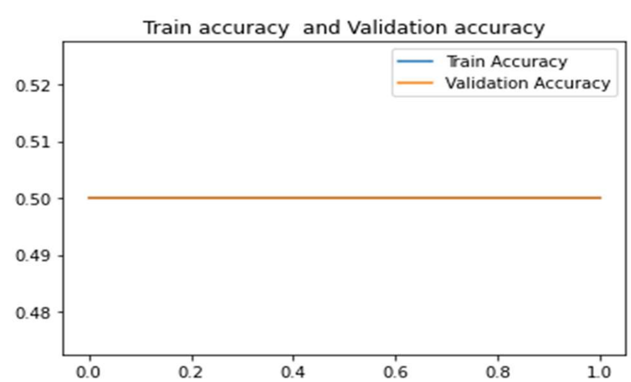
The discussed data set was then tested and tried with the deep learning model for object and image detection known as CNN. Convolutional neural network was applied on the dataset with the achievable accuracy of 50%.

The Experimental Results

Deep learning model have been trained with different parameters and hyperparameters. Relu for the activation and sigmoid type parameters were used for the input and output layers respectively. Following results have been achieved for epochs. The epochs basically become an obstacle and avoids the over fitting in the model.

```
Epoch 1/10
389/389 [==============================] - 761s 2s/step - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - val_accuracy:
0.5000
Epoch 2/10
389/389 [==============================] - 815s 2s/step - loss: 0.6931 - accuracy: 0.5000 - val_loss: 0.6931 - val_accuracy:
0.5000
```

The loss function of the model was visualized with the chart.



Discussion

Research was carried for the detection of vehicles with a prior focus on cars other methodology and reviews were discussed considering the existing one. CNN were almost the Centre of attention for each and every experiment and research-based task conducted in several publications.

When working on the deep learning or even machine learning algorithms after gathering the data from various sources and optimizing the model with several parameters there are always something left behind either in the data collection process. Pre-processing task or in the fitting of the mode. This research based implementation lacks the quality of data analyzing images collection is such a task which really needs attention. A proper csv file or some file with images annotation which can be easily analyzed when in the numerical format.

Conclusion and Future work

Conclusion:

CNN model-based vehicle predictions were carried out on the image set with couple of classification which were split separately in the training and testing dataset. Certain parameters were set to train the model with epoch calculation which actually limit the overfitting and avoid over training of the model. Accuracy of the CNN model was found to be 50% which is considered as a bad accuracy but with such huge data set and parameters which affect the accuracy and final score of the model.

Future work:

With the available model for the detection this can be made better with some modifications with parameters and hyperparameters. The accuracy can be made better with the reduction in the data size and tuning the hyperparameters. R-CNN can be used for further workings with UAV technique for validating the vehicle movement videos. With these few methods and proposal of new algorithms and model a desirable outcome can be achieved.

Appendix for link (Github): https://github.com/Sindhujaganji/Data-Mining

References

1. GOLDMEIER, LIZZI. (2019) “How Can Machine Learning be Used for CCTV Video Surveillance? briefcam , 5th Dec Available at: https://www.briefcam.com/resources/blog/how-can-machine-learning-be-used-for-cctv-video-surveillance/ (Accessed: 5-12-2022)
2. Zhao, Zhong. (2019)” Object Detection with Deep Learning: A Review.”, Available at: https://arxiv.org/pdf/1807.05511.pdf (Accessed: 5-12-2022).
3. Hassaballah,M et al. (2021)” Vehicle Detection and Tracking in Adverse Weather Using a Deep Learning Framework.”, 22(7), pp. 4230 - 4242. Available at: https://ieeexplore.ieee.org/document/9184996 (Accessed 5-12-2022)
4. Song,huansheng.(2019) “Vision-based vehicle detection and counting system using deep learning in highway scenes”, Available at: https://etrr.springeropen.com/articles/10.1186/s12544-019-0390-4 (Accessed: 6-12-2022).
5. Wang,Xiangqian.(2022) “Vehicle Image Detection Method Using Deep Learning in UAV Video” Available at: https://www.hindawi.com/journals/cin/2022/8202535/ (Accessed: 6-12-2022)
6. Chen,Xiu-Zhi. (2020) “A Real-Time Vehicle Detection System under Various Bad Weather Conditions Based on a Deep Learning Model without Retraining”,20(20).Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7600474/ (Accessed: 6-12-2022).