IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 11, Issue 4, April 2023

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

9940 572 462 | 6381 907 438 | ijircce@gmail.com | www.ijircce.com

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 |

|| Volume 11, Issue 4, April 2023 ||

| DOI: 10.15680/IJIRCCE.2023.1104046 |

Design of Hybrid Model for Detection and Classification of Vehicles

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ABSTRACT: Traffic Analysis has been a problem that city planners have dealt with for years. Smarter ways are being developed to analyze traffic and streamline the process. Analysis of traffic may account for the number of vehicles in an area per some arbitrary time and the class of vehicles. People have designed such mechanism for decades now but most of them involve use of sensors to detect the vehicles i.e., a couple of proximity sensors to calculate the direction of the moving vehicle and to keep the vehicle count. Even though over the time these systems have matured and are highly effective, they are not very budget friendly. The problem is such systems require maintenance and periodic calibration. Therefore, this study has purposed a Vehicle detection and classification systems are attracting the attention of many investigators focused on the safety of driving in the field of automotive mechatronics. The system to detect and classify moving vehicles, on any kind of road. The data acquisition by the video which given as an input, while the information processing is performed by clustering and classification algorithms i.e., YOLO model and Mobilenet-SSD model. Here pre-trained model of different vehicle categories is used and the test by giving image or video input of moving vehicles.

KEYWORDS: Vehicle Detection, Vehicle Classification, YOLO (You Only Look Once) model, Mobilenet-SSD (Single Shot Multibox Detection) model, Data acquisition, Clustering.

I. INTRODUCTION

Nowadays countries and governments require reliable and minimal cost systems for traffic automation and vehicle theft control. The enormous increase in the vehicles on roads and highways, the Increasing congestion, and problems associated with existing traffic detectors have motivated the development of new vehicle detection technologies. Still 'Traffic Monitoring' and 'Information Systems' related to classification of vehicles rely on sensors for estimating traffic parameters. Computer vision systems are the most common choice, but several issues must be solved to perform the classification successfully. Identifying and tracking moving objects or vehicles in real-time that appear in different kinds of roads, by an intelligent vision system, is important to many areas of research and technological applications. In recent years, video monitoring and surveillance systems have been widely used in traffic management. Extracting useful information such as traffic density, object speed, driver behaviour and vehicle types from these camera systems has become critical. Manual analysis is now inapplicable. The development of intelligent systems that are able to extract traffic density and vehicle classification information from traffic surveillance systems is crucial for traffic management. Otherwise, surveillance systems are also important in driver assistance applications because a vision system allows the detection and classification of vehicles that appear in a captured scene. Magnetic loop detectors are often used to count vehicles passing over them. In addition to vehicle counts, a much larger set of traffic parameters such as vehicle classifications, lane changes, parking areas etc., can be measured in such type of systems. In large metropolitan areas, there is a need for data about vehicle classes that use a particular highway or a street. A classification and counting system like the one proposed here can provide important data for a particular decision-making agency.

The main aim of this project is to detect and classification of vehicle using YOLO model and Mobilenet-SSD Detection and classification of vehicle is huge laborious task and at the same time, less accurate and can be done only in limited areas. Whereas if automatic detection and classification technique is used it will take less efforts, less time and become more accurate.

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II. RELATED WORK

[1] Sheeraz Memon [1] proposed a system to distinguish, track and check vehicles utilizing a vision-based system. Here the basic interface is created for the client to choose the area important to be investigated that is the region of interest and afterward, image processing techniques are applied to an image to calculate vehicle count and classified the vehicles using machine learning algorithms. Here input source utilized is the traffic camera recordings from an assortment of sources in usage. This system is used for the detection, recognization, and tracking of vehicles for given input it divides detected vehicles into different classes based on their size. This system contains the three modules which are background learning, foreground extraction, and vehicle classification, which can be obtained by some of the inbuilt libraries in machine learning like OpenCV in that BackgroundSubstractionMOG and findContours () methods are used and also make use of BoF an SVM algorithm to classify the vehicle. The limitation of this system is not efficient at detecting occlusion of the vehicle, this problem can be solved by second-level feature classification such as classification based on the color.

[2] Tursun, M and Amrulla, G [2] proposed a video-based real-time vehicle counting system using an optimized virtual loop method. They used real-time traffic surveillance cameras deployed over roads then they compute the input to get how many vehicles pass the road. The vehicle image is extracted using a double-difference image which is generated from the corresponding two successive images and logical AND operations are carried out on this image. This proposed system is making use of the virtual loop concept if the vehicle crosses the virtual loop region, the threshold in that region will be higher, and also make use of detection lines which help to avoid the recounting of a vehicle or avoid the counting of nonmoving vehicle. In this system, the counting of vehicles is carried out in three steps by tracking vehicle movements within a tracking zone called a virtual loop. If we make slight changes to the algorithm this model can be used to extract the other traffic data.

[3] Nilesh J. Uke, and Ravindra C Thool [3] “Moving Vehicle Detection for Measuring Traffic Count Using OpenCV”, This system identifies the movement of vehicles by camera images with the assistance of a webcam on a PC using OpenCV which is coded using Microsoft Visual C++, and the video is stored in standard .avi format using XVID codec. The process of counting the vehicle acknowledges the video from a single camera and analyses the moving vehicles and counts them. Under diminished perceivability conditions, the system functions admirably on blanketed expressways, around evening time when the foundation is consistently dim, and in specific passages. A vehicle recognition and checking system on a roadway is created utilizing OpenCV image advancement units.

[4] A. Suryatali and V.B. Dharmadhikari [4] proposed a Computer Vision-Based Vehicle Detection for Toll Collection System Using Embedded Linux, which helps with vehicle detection that counts and also classifies the vehicles into heavy and lightweight vehicles; Here they use the resolution setting of a camera on toll to get a perfect view to classify the vehicle which helps to detect the vehicle here they use OpenCV library to detect and classify the vehicle, object detection is fulfilled by making use of the Kalman filter which is known for computational efficiency, robustness, accuracy and recursive property which helps in background subtraction and then detecting the object in processed frame OpenCV libraries are used. This system is tested against the image frame sequence of the video captured on the highway and the model is capable of detecting, tracking, and classifying the maximum number of vehicles successfully.

[5] Mithun, N.C., et al [5] proposed a vehicle detection and classification system using time spatial images and multiple virtual detection lines. The proposed detection method uses several VDLs and works in two major steps. First, multiple TSIs each corresponding to a VDL are generated from a video sequence. Next, distinct blobs that are sufficient for counting the number of vehicles is identified from these TSIs. TSI generated by MVDL based model has varying illumination hence here they use MVDL based detection and classification method, here they make use of a two-step K nearest neighborhood (KNN) algorithm adopted to classify vehicles via shape invariant and texture-based features. The result confirms the better accuracy and low error rate of the proposed method over existing methods since it also considers the various illumination conditions.

[6] S. Santra, S. Roy, P. Sardar, and A. Deyasi proposed a system [6] "Real-Time Vehicle Detection from Captured Images" Where they make use of the YOLO algorithm to detect the vehicle from an image. This algorithm is capable of detecting vehicles with a very high sense of precision and also detects nearby people as pedestrians. In this paper, it detects common objects which are seen day-to-day, for which the OpenCV DNN module is used along with the trained YONO model.

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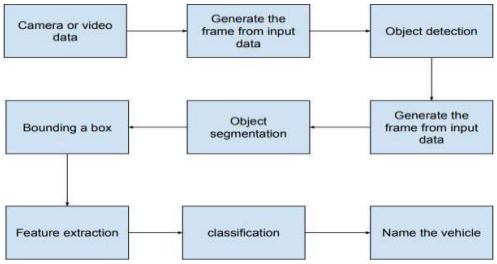
III. PROPOSED ALGORITHM

The object is detected from the given input and pre-processing is carried out on the detected object then it runs against the pre-trained model to classify the detected object, for a more precise outcome model will classify the object into the corresponding vehicle category. The vehicle detection and classification have been done using YOLO and Mobilenet-SSD model for a given input. The accuracy of classification of each vehicle is shown along with the vehicles class.

A. Process Carried out on input data

The proposed model is processed according to the diagram i.e., initially provide the input to the system, and then it generates frames from the input model. Further, it is processed for object detection by applying some of the methods like background substitution, and object segmentation after that the bounding box is created for all the detected objects in a given input model. The next step is to extract the features of objects like the size to classify the object according to their features. Classification such as bike, car, trucks, bus, etc.



B. METHODOLGY

Vehicle Detection and Classification using YOLO

YOLO is an abbreviation for the term 'You Only Look Once'. This is an algorithm that detects and recognizes various vehicles in a picture. vehicles detection in YOLO is done as a regression problem and provides the class probabilities of the detected images. YOLO algorithm employs convolutional neural networks (CNN) to detect vehicles in real-time. As the name suggests, the algorithm requires only a single forward propagation through a neural network to detect objects. This means that prediction in the entire image is done in a single algorithm run. The CNN is used to predict various class probabilities and bounding boxes simultaneously.

Residual block

Figure-3 Residual block

First, the image is divided into various grids. Each grid has a dimension of S x S. The following image shows how an input image is divided into grids. In the image, there are many grid cells of equal dimension. Every grid cell will detect objects that appear within them. For example, if an vehicles center appears within a certain grid cell, then this cell will be responsible for detecting it.

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Bounding Box regression

A bounding box is an outline that highlights a vehicle in an image. Every bounding box in the image consists of the following attributes:

1.Width (bw)

2. Height (bh)

3. Class (for example bus, car, motorcycle, etc.)- This is represented by the letter c for the uploaded image system will process the output on time.

4. Bounding box center (bx, by)

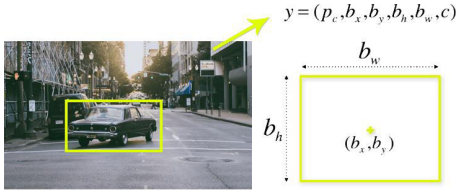

Figure-4 Bounding Box

The following image shows an example of a bounding box. The bounding box has been represented by a yellow outline. YOLO uses a single bounding box regression to predict the height, width, center, and class of objects. In the image above, represents the probability of an object appearing in the bounding box.

Intersection over union (IOU)

Intersection over union (IOU) is a phenomenon in vehicles detection that describes how boxes overlap. YOLO uses IOU to provide an output box that surrounds the vehicles perfectly. Each grid cell is responsible for predicting the bounding boxes and their confidence scores. The IOU is equal to 1 if the predicted bounding box is the same as the real box. This mechanism eliminates bounding boxes that are not equal to the real box.

Combination of Three techniques the following image shows how the three techniques are applied to produce the final detection results.

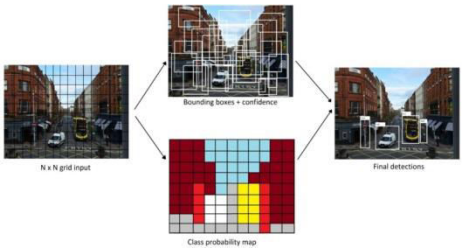

Figure-5 Combination of Three techniques

First, the image is divided into grid cells. Each grid cell forecasts B bounding boxes and provides their confidence scores. The cells predict the class probabilities to establish the class of each object. Intersection over union ensures that the predicted bounding boxes are equal to the real boxes of the vehicles. This phenomenon eliminates unnecessary bounding boxes that do not meet the characteristics of the objects (like height and width). The final detection will consist of unique bounding boxes that fit the vehicles perfectly.

Vehicle detection using Mobilenet SSD (SingleShot Multibox Detection)

Mobilenet is an architecture model of the convolution neural network (CNN) that explicitly focuses on Image Classification for mobile applications. Rather than using the standard convolution layers, it uses Depth wise separable convolution layers. What makes this model stand out is that its architecture lessens the computational cost and very low 16 computational power is needed to run or apply transfer learning. The SSD architecture is a single convolution network that learns to predict bounding box locations and classify these locations in one pass. Hence, SSD can be

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trained end-to-end. The SSD network consists of base architecture (Mobilenet in this case) followed by several convolution layers:

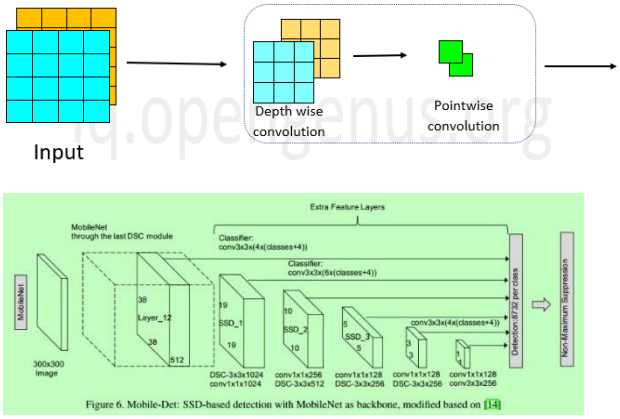

Figure-6 SSD MobileNet Layered Architecture

By using SSD, we only need to take one single shot to detect multiple objects within the image, while regional proposal network (RPN) based approaches such as R-CNN series that need two shots, one for generating region proposals, one for detecting the Vehicles of each proposal. Thus, SSD is much faster compared with two-shot RPN-based approaches.

IV. SIMULATION RESULTS

A. Vehicle detection using YOLO

Here use of pre-trained model which is best.pt to detect the vehicle. The input will run against the best.pt model and classification of vehicle is done according to the threshold value. Here YOLO model can detect hundred vehicles at a time.

Classification of vehicle in the image

Here the Yolo model detect the car along with an accuracy for a given input image

Figure-7 Detect and classify the car in the given image

B. Vehicle detection using Mobilnet SSD

Here we make use of pre-trained model which is" caffemodel" to detect the vehicle. The input will run against the pre-trained model and classification of vehicle is done according to the threshold value. Here SSD model can detect multiple vehicles at a time. When we want to run the model in real time the frame is taken as input and run against" MobileNetSSD-deploy.prototxt.txt" which was created from pretrained model for faster processing.

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Classification of vehicle in the image

Here the mobilenet SSD model detect the car along with an accuracy for a given input image

Figure-8 Detect and classify the car in the given image

Finally, By analyzing the output from YOLO and Mobilenet SSD model and we came to know that both model will have its own application on particular area, As of our analysis the YOLO model will effective in the area where the vehicles move in large ratio because YOLO model have a capable of detecting the hundred vehicle from single frame where it come to SSD it can detect atmost four vehicle from single frame but SSD have a high accuracy in detect the vehicle class when compared to YOLO model. After analyze output we came the conclusion that YOLO model is better than the Mobilenet SSD model in Detection and classification Vehicle.

V. CONCLUSION AND FUTURE WORK

A system has been developed to detect and classify the dynamic vehicles on highways efficiently. The system effectively combines simple domain knowledge about vehicle classes with time domain statistical measures to identify target vehicles in the presence of partial occlusions and ambiguous poses, and the background clutter is effectively rejected. The experimental results show that the classification of the vehicle along with an accuracy YOLO (You Only Look Once) and Mobilenet SSD (Single Shot MultiBox Detector) and the model will help to classify the vehicle from given input.

The computational complexity of our algorithm is linear in the size of a video frame and the classification of vehicles. As considered on highways there is no question of shadow of any cast such as trees but sometimes due to occlusions two vehicles are merged and treated as a single entity. Finally, came to know that YOLO model is better than the Mobilenet SSD due to various reason which is already discussed.

Several future enhancements can be made to the system. The detection and classification of moving vehicle can be extended to real time in traffic camera to analyze the traffic situation based on the vehicle class. Apart from the detection and Classification, process of counting the vehicle from each class can be done which help to analyse the traffic condition based on number of vehicles from class traveling on that road so that necessary action can take.

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INNO SPACE
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Impact Factor: 8.165

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ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA

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