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A Deep Reinforcement Learning Network For Traffic Light Cycle Control

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Abstract**-- Numerous issues are brought on by a traffic light cycle control, including energy waste and significant delays for moving traffic. The issue cannot be solved using the current traffic signal control technologies and approaches. Vehicle traffic is becoming more and more congested every day. Since there are more cars on a certain side of the road, it is necessary to redesign the traffic light system. Static Signal switching is capable of handling and monitoring signals in real-time. We provide a paradigm of deep reinforcement learning to regulate the cycle of traffic lights, traffic data and gridding the entire intersection . For the model in a real-world scenario, this study addresses the control of the vehicle and attempts to find a solution to the current issue. The YOLO algorithm has been pre-trained, and the fundamental simulation, vehicle identification, tracking, and vehicle counting work is preserved for future signal processing requests. In the initial stages, CCTV cameras are used to record the images. The "Traffic Control Interface" (TraCI) is aSimulation of Urban MObility (SUMO) interface gives users access to a live retrieving values for simulated objects in road traffic simulation, and handles single and multiple-intersection cases.**

Key Words - Deep Learning, Video Processing, ImageProcessing, ObjectDetection, Convolutional Neural Network.

I. INTRODUCTION

All cities now exhibit instability and display complicated dynamics as a result of the quick change that is occurring in this direction[1].Surviving in such a quicker landscape has both advantages and disadvantages. However, safety is compromised as a result of this speed. The number of automobiles on the road is growing significantly daily, and hence, accidents are more common.This outlines the concept of autonomous or self-driving vehicles. A self-driving automobile must be capable to comprehend and follow the adopt them correctly in order to function properly. [2] In order to maximize the efficiency and convenience of Intelligent Mobility Systems, which is one of the key components of Smart Cities, VANet techniques using vehicular communication taken into consideration (ITS). A specialised and distinct kind of vehicular networks are vehicular ad hoc networks. It is based on IEEE 802.11p, which is the only lexicon for describing data transmission [3]. Consequently, the need for effective traffic sign detection tools has increased.

Road accidents can be brought on by careless driving and failing to pay attention to the surroundings. Furthermore, certain weather conditions could impair drivers' ability to see particular signs and result in catastrophic accidents.Traffic lights are typically used to regulate intersections along busy or major highways. However, their ineffective regulation results in a number of issues, including significant energy waste and traveler delays. Even worse, it might result in car accidents.. The detection of vehicles play a major role for the segmentation of an image in the first steps of video processing. The accuracy and efficiency in each vehicles is needed for tracing, gesture and detection for the eventually processing of vehicles. The vehicles detection counting plays a major role in system that need to manage and control traffic within the metropolis. The major aim is detection, counting, tracking and speed estimation of each car with maximum accuracy on roads and highways. The concept applied here is to apply the front objects, Convolutional Neural Network takes the car as input to the video for processing the accurate result for counting vehicles. The purpose of using convolutional neural networks has made a great achievement in the vehicle detection. Convolutional Neural Network has a potential to acquire skill of pictures feature that has an ability to perform multitasks, which are regression and classification. YOLO is abbreviated as “You Only Look Once” This programme uses a convolutional neural network (CNN) to track and identify different items in a picture. It can identify objects like cars. This approach produces precise results with few background errors and only needs one forward propagation across a neural network

The frames can be divided using video or live footage. CNN algorithm is used to track and detects the car when it moves into the Region of Interest(ROI). We can easily recognize and categorize the items in photos, however this is a challenging operation for computers to perform in real time. Though the trained algorithm is powerful enough, the object can still be recognized and accurately identified even if it is only partially visible. Many issues have evolved in modern life that we must deal with, such as traffic accidents and congestion. One of the best contemporary approaches being used by countries to improve the traffic system is the use of this data, which may be critical in many surveys and is essential to the traffic management system. This method allows us to the most cars should be counted precise manner possible. Using this way The most accurate methods of counting the number of automobiles are available. The main The purpose of this endeavour is to create a fast and reliable solution to the traffic congestion problem.The solution must be intelligent and has decision-making capabilities depending on the different situations in the different lanes. There are different phases of the proposed model. The first phase is video processing. The continuous video stream from the traffic camera situated at the traffic signal junction is fed to the model. During the video processing, the frames are extracted from the video input. There are hundreds of frames present in a stream of few seconds, so it is not possible to process each frame and it is not required because there is no such significant change in the vehicle density between two consecutive frames. Therefore, each frame after a particular time interval is taken. After this phase, the processed frame is fed to the model for object detection. There are two separate models developed for object detection using each framework i.e., YOLOv3 and YOLOv5.

Figure 1: Traffic road cycle control

The neural network extracts the features and identifies theobject using bounding boxes. After object detection, The model predicts the class of the vehicle from a car, bike, truck, etc. The total vehicle count of a lane is passed to the traffic signal timer algorithm. The algorithm considers the density of all the other lanes and calculates the relativity between them. Depending on which, it classifies the lane in either low, medium, or high vehicle density class, it decides the green signal timer for a particular lane. The scope of this project is the vehicle detection on roads uses the deep learning technique. Earlier the datasets used for this project was small which falls less in multiple aspects. Firstly, time duration for the road using the vehicle datasets are small in terms. Further, camera is used by the researchers which is useful and supportive for the vehicle detection by using deep learning method which has the limited scope as contrast to the input composed by the transportation authorities.

II.LITERATURE REVIEW

Priyanka Bhamare et.al, [1] tells about the method that is used for vehicle recognition technology used in traffic signals. To detect the cars Smart cameras are integrated into the system to make it work. The use of the automobile detection in the video by CNN algorithm and the images are trained and tested using this algorithm. Indrabayu et.al,[2]talks about the tracking and vehicle detection, here Kalman flite along with Gaussian mixture is used to perform the task. For detection of vehicles the video input is taken from the signals. Li xun et.al,[3]says that the vehicle condition methods that are available in order to extract are not sufficient, an efficient procedure method should be used in sequence to process the model. Ahmad Aliet.al, [4]In this paper low-cost camera is used for the basic idea of building an environment and the algorithm was used for concerning and control the vehicles that are passing on the lanes. Krishnamoorthy et.al, [5]describes about the traffic that are carried out in many countries. In this they used the CCTV cameras to automate the traffic signals connected over the internet to survey various junction at the roads. Jess Tryon et.al, [6]says about the traffic in Philippines that affect the residents and industries sectors. Here the intelligent transportation system is used based on the real-time traffic in cities. The traffic can be controlled by deploying CCTV at every lanes and the data is sent to Raspberry for calculating image density. Asra Aslam et.al [7] finds an enormous amount of sensing data devices that collects the information over the internet of things. The services that are provided by IOT are sensing, networking, service and application-level services. Poonam A et.al [8] says about the object detection is most important and challenging branches that are used in computer vision. the rapid development of deep learning methods is used for detection tasks after that variety of object methods are used for detecting covering with the one-stage and two-stage detectors. Imran Mahmud et.al, [9] focused on the traffic density of the capital of Bangladesh, dhaka. Here its very tough for the traffic police to controlling the traffic who break the laws and jump the traffic signals. Lv Ning et.al, [10]tells about the vehicle counting from an aerial video(UAV) in traffic monitoring, which can be deployed in areas by collecting the data from camera as a visual sensors. Akoum et.al, [11] had implemented a Smart traffic controllers used real-time images as well as a filtering technique to remove only the waste objects from the images. shows the objects like cars. Nadia Baha, [12] says about the sensor that are used to detect the obstacles utilising real-time stereo vision in both indoor and outdoor environments. The method combines with thresholding and accumulating techniques to cluster and detect using a disparity map to identify obstacles.

III. PROBLEM STATEMENT

In today's world the theft of vehicles are increasing more and reported every year. If the vehicles that are being stolen are not recovered early, then it has been sold or burned. It is very tough to find the stolen vehicle using this paper we can detect and track, which protects the vehicles. Traffic surveillance is commonly used to detect and track moving vehicles. The tracking of vehicle is very versatile and can be refined to do additional tasks such as vehicle tracking and counting. Figure2The cost estimation using this technology will be very less, Video and image filtering has been used for traffic observation, analysis and monitoring the traffic condition in many cities and urban areas. All process attempt to increase the accuracy and decrease cost for hardware implementation.

The main objective of this paper is detection of vehicles, tracking and estimating the speed accuracy on highways and in small lanes using convolutional neural network algorithm. YOLO algorithm detects the static vehicles and ignore the shadows and reflection which results in traffic on highways.

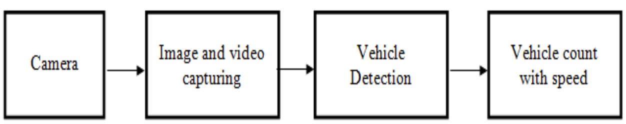

Figure 2: Overview of the proposed system

IV. METHODOLOGY

The system aims to provide a solution for managing the vehicle in real time scenario. To perform a specific task the pre-trained model YOLO is used to detect the objects in the sense of vehicles, Image processing is employed for speed calculation and count of vehicles. At an initial level the model is ready with all types of camera even the low cost including the surveillance camera. The model will receive a captured image for the vehicle detection purpose, after that using single camera the whole process will be repeated for all four sides of the road. To capture the image the camera will be fixed at one place. The vehicles will be detected and counted which are captured inside the given Region of Interest(ROI).

The image size remains constant after being captured. The object tracking and detection plays an important role using OpenCV library within the rectangular box inside the vehicles. In all the sides of road the count can be obtained after passing the input to the data storage. The different images obtained from the count of vehicles can predict the result by using the computers and laptops. The system have a threshold unit value that are fixed and after that if the result from the images limit within the threshold then simple switching is started for every signal to control the vehicles in the traffic, after that if there is more traffic in one direction then the vehicle will be sent to another direction by switching the traffic signals. The methodology of proposed system is illustrated in the figure 3.

1) **Video accession** : This method is used for acquiring the video through any one the devices video camera, smart-phone camera, universal serial bus camera etc.
2) **Frame transformation**: Frame transformation is a process of converting the frames one by one using the given video. Once the videotape that capture the videos, those videos are converted into fixture and suitable type of process can be done accordingly to the frame.
3) **Pre-Processing** : The Pre-Processing method is added for the video which is used to decrease the sound. some of the techniques of preprocessing are smooth, dilate, erode and median etc.
4) **Background Modeling**: The pre-processing is used to create an ideal background according to the environmental changes. The image subtraction operations can be performed by using the background modeling. There are two types of techniques recursive or non-recursive that are used in background modeling.
5) **Background Subtraction:** he background subtraction is the main move for processing. First in this any changes in the image region from the background of the model are predictied, then the pixels are arranged in the given regions after that the changes are made for further processing. The labelling algorithm is used to connect the regions of the component.
6) **Post-Processing**: To improve the results of pre-processing which is used after subtraction and background modeling, the foreground mask is implemented in pre-processing techniques.
7) **Foreground Extraction** : This is the last step for processing the computer vision and processing the image, whose aim is to detect changes in sequences of images using subtraction of the background method for further processing.

Video Processing:

In this first part of the traffic control system, the inputs will be accepted in separate four individual videos of each lane infocus. These videos might come in any resolution or color format. The first task in this segment of the solution will be to update the resolution of the input videos to make all four input suniform and consistent for the detection model. The videos are adjusted to a specific resolution of 416 by 416 pixels each and the color formats of the video will be adjusted in the RGB (Red, Green, Blue) color format. Any videos which might get sent in other color schemas like CMYK (Cyan, Magenta, Yellow, black) or HSV (Hue, Saturation, Value) will be converted to RGB in a 3-dimensional array structure, containing 3, 2-dimensionalmatricesofeachcolorcomponent value in the video frames. Finally, these videos will be chopped down to some selected frames based on a certain interval.

Object Detection:

The next phase of the proposed solution is to apply object detection to the received frames from the previous stage. Here the frames received will be passed to the object detection model of the user's choice in a multi-threadedenvironmenttoconcurrentlygetthedetectionsofal lproperly visible vehicles in each scene. To achieve this object detection there are two proposed choices of well-known object detector strained on the MS-COCO dataset, as explained in the previous section. The detailed description of both these lected models has explained here after.

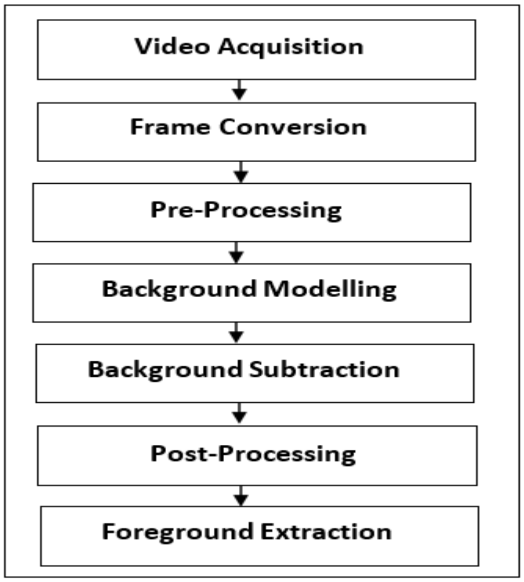

Figure 3: Proposed Methodology

V. MODELS

Data Collection

1.Smart Camera: The smart camera device has a multiple boner that allow to perform the work with different applications. Optical character affirmation , Design coordinating, and data organize code are used as an example for the camera. The execution of the persistent eye estimation adheres to the entire layout, which delivers important, necessary standard-scale images. When the astute camera is connected by Ethernet or FTP, precisely, The choice to transfer the data to different devices would then be available. We are using a web camera to demonstrate this project.

2. Object Detection:The detection of object is a picture-processing-related technology and computer vision that focuses on detection case for the inter pretation objects of a given class (such as cars, buildings, or humans) in digital videos and images. First, the vehicle dataset can be clustered using the scales and aspect ratio. To detect a vehicle we use the convolutional neural network(CNN).Here we utilize the feature techniques to find the lesser and higher features to detect the different vehicle sizes using different methods. Using the background images we extract the vehicle region for CNN-based detection and categorization. To improve the recognition accuracy we perform the test about the generalization ability using the dataset then geographic segmentation, background noise elimination, and can be performed for the vehicles. The categorization and feature extraction of the training image dataset for many vehicle types can be implemented using convolutional neural network by this will enable the work of recognising various automobiles to be completed.. In the vehicle detection process it focus on the real-time performance, selection accuracy and recognition accuracy. To improve the speed, we does not use fully connection(FC) layers instead of that naturally adopt fully convolution architecture can be utilized.

3.Convolution Neural Network (CNN):CNN is used mainly for image classifications and image recognition. The CNN used for classification of image which takes as an input, and classify it under certain categories. To perform specific task such as recognition of image, image classification and detection of object the neural network CNN algorithm is used for classification. The classification of image is the work of taking an input image and outputting a class and finding a probability that best tells about the image.The image data that is used for working with the model a neural network helps which is known as CNN.A computer should differentiate between all the images it is given. For that execution image caterozing by looking for less-level feature like as edge and curves then building up to more abstract concept through a string of convolution layer. In CNN the input image pass through a series of convolution layer and, pooling (down sampling) layer and fully connected layer and finally produce the output which can be simple class or probability of classes at best describes the image. Figure 4 shows the structure of CNN.

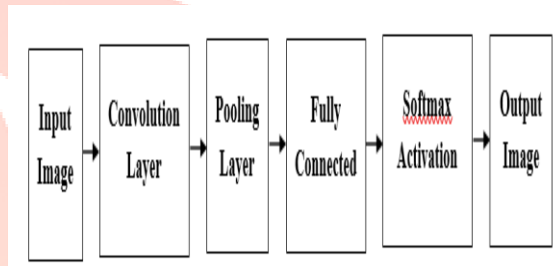

Figure 4:Convolution Layers

Convolutional layer perform an operation called a convolution, hence the neural is called convolutional neural network. It extract features for the input image. Convolution is a linear performance that involves the multiple of a set of weights with the input.

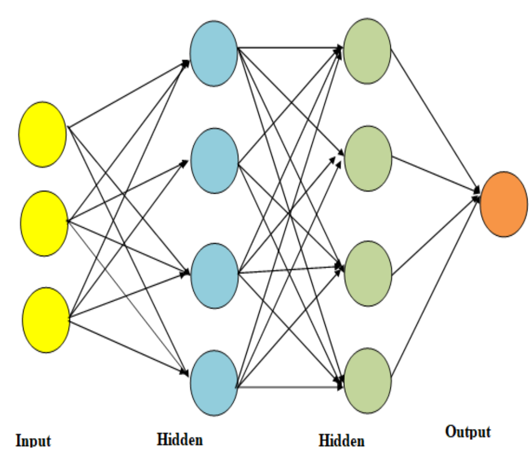

Figure 5: Convolutional Neural Network

The above Figure 5 shows the neural network with many convolutionn layers. Initially give the different input images to neural network, each image are classified into 2 hidden layers. In the first hidden layer convert all RGB image to Gray scale image and in second layer Gray scale image matches with the expected image.

Table1: Working Flow of CNN algorithm for Vehicle Detection.

Input: B = (b_1 _ _ _ b_n), S, T, N_t
Where, B is a set of detected bounding boxes
S and T are functions mapping bounding boxes to confidence
N_t is the NMS threshold
1.Begin
2.D← ∅
3. While B ≠ ∅ do
4. b_m ← argmax(b_j)
5. B← B \ { b_m }
6. S← S (b_m)
7. For b_j in B do
8. If iou (b_m , b_j) ≥ N_t
9. S← Max (S, S(b_j))
10.B← B \ {b_j }
11.End
12.D← DU {(b_m ,S)}
13.Return D

4.You Only Look Once (YOLO):An algorithm called You Only Look Once looks forand distinguishes different objects in a picture.In YOLO, object detection is handled as a regression problem. and furnishes the likelihoods of the given class for the detected image. the YOLO algorithm uses convolutional neural networks real-time object detection and it only needs one propagation through the neural network. which has the excellent learning capabilities that provide it the ability to learn how items are represented.

The YOLO algorithm works with three techniques that are described below:

- Residual Blocks
- Bounding Box Regresion
- IntersectionOverUnion(IOU)

The working flow of YOLO algorithm is described below:

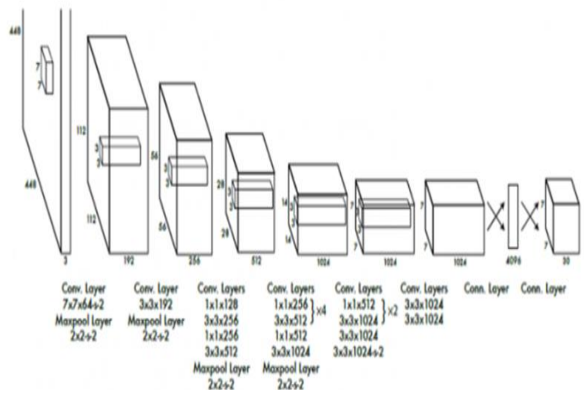

Figure6 : YOLO architecture

Table 2: Working Flow of YOLO algorithm for forming rectangular box.

1.Input: Original Test Image
2.For i← 1 to num of scales of images do
3.Downsample image to create image
4.For j← 1 to num of shift steps of sub-window do
5.For k← 1 to num of stages in YOLO classifier do
6. For l← 1 to num of filters in of stages k do
7.Accumalate filters output
8.End for
9.For $b_x = \sigma (b_x) + c_x$
$b_y = \sigma (t_y) + c_y$
$b_w = \text{pwe}^{tw}$
$b_h = \text{pwe}^{th}$
P_r (object) * IOU (object) = $\sigma (t_o)$
10.Break this K for loop
11.If y = (p_c , b_x, b_y, b_h, b_w , c)
12.End if
13.End for
14.If sub-window passes all stages then check
15.Aceept this sub-window as a vehicle
16.End if
17.End for
18.Output: Image with detected vehicles as rectangles
19.End

VI.RESULT ANALYSIS

The outcome of this whole paper with output is described below using CNN and YOLO algorithm to detect the vehicles. Experimental Conditions. Since its release in 2001, SUMO has allowed users to model multimodal traffic networks involving road cars, public transportation, and pedestrians. The "Traffic Control Interface" (TraCI) is an SUMO that interface gives users access to a live retrieving values for simulated objects in road traffic simulation, and handles single- and multiple-intersection cases. Four road segments connect each intersection. each of which consists of a straight lane, a straight lane going left, and a straight lane going right.

when the red signal timer of the next signal reaches 0, the number of vehicles at the signal is detected and the green signal time is set accordingly. the first process of the video where the vehicle will be moving from one position to the given region of traffic on four way intersection signals are red, yellow and green indicates the traffic on road at one moment.

```
GREEN TS 1 -> r: 0  y: Lane-wise Vehicle Counts5
Lane g: 157
:  RED TS  492
Lane-> r: 2  62 : y: 49 5
Lane  g: 320
:   RED TS26 3
Lane-> r:  4127  : y:  275
Total vehicles passed:  g:  15220

Total time passed:   RED TS  3004
No. of vehicles passed per unit time: -> r:  0.5066666666666667147
```

Figure7 :the Simulation of Traffic Light Controller.

```
GREEN TS 1 -> r: 0   y: 5   g: 18
  RED TS 2 -> r: 23   y: 5   g: 20
  RED TS 3 -> r: 148   y: 5   g: 20
  RED TS 4 -> r: 148   y: 5   g: 20

GREEN TS 1 -> r: 0   y: 5   g: 17
  RED TS 2 -> r: 22   y: 5   g: 20
  RED TS 3 -> r: 147   y: 5   g: 20
  RED TS 4 -> r: 147   y: 5   g: 20

GREEN TS 1 -> r: 0   y: 5   g: 16
  RED TS 2 -> r: 21   y: 5   g: 20
  RED TS 3 -> r: 146   y: 5   g: 20
  RED TS 4 -> r: 146   y: 5   g: 20

GREEN TS 1 -> r: 0   y: 5   g: 15
  RED TS 2 -> r: 20   y: 5   g: 20
  RED TS 3 -> r: 145   y: 5   g: 20
  RED TS 4 -> r: 145   y: 5   g: 20

GREEN TS 1 -> r: 0   y: 5   g: 14
  RED TS 2 -> r: 19   y: 5   g: 20
  RED TS 3 -> r: 144   y: 5   g: 20
  RED TS 4 -> r: 144   y: 5   g: 20

GREEN TS 1 -> r: 0   y: 5   g: 13
  RED TS 2 -> r: 18   y: 5   g: 20
  RED TS 3 -> r: 143   y: 5   g: 20
  RED TS 4 -> r: 143   y: 5   g: 20
```

Figure8 :All signals are loaded with default values.

Figure 9 :Traffic on a road at one moment.

The above figure 9demonstrates the first process of the video where the vehicle will be moving from one position to the given region of traffic on four way intersection signals are red, yellow and green indicates the traffic on road at one moment.

VII.CONCLUSION

The object detection and vehicle counting can be exploited in respective fields to help the humans enhance the environment and provide comfort leave. The detection of objects can be used in various fields like Government, businesses, digital cities, academics, and scientific research. One aspect of the object detection employed in cities is the detection and tracking of cars.highways and traffic. The management of car and traffic has a rapid development, in order to manage the traffic in population density in the world has brought the several techniques and tools in technology. Using this algorithm the improvement can be done for the accuracy and models via available tools and techniques.The detection, tracking and calculating the speed of vehicle was done by which was developed by using the two classifier algorithm. The CNN algorithm was used for the vehicles based on the various studies in literature review. This model was approved and used most by other researchers. To gain the best result and increase the accuracy level many techniques have been deployed. The CNN shows the evaluation result where the models are trained and tested with the same dataset.

VII.FUTURE ENHANCEMENT

The vehicle detection has a major role in controlling the traffic. In future the sensors can be deployed inside the vehicle for tracking the location, speed, direction and it can be used in autonomous cars that reduces the congestion, pollution and emission with greatly improved safety measurements and transport interconnectivity. If the vehicles are passing only in one direction and get stucked in traffic using this we can change the direction for each vehicle by automatic traffic signal switching then the traffic can be controlled using these methods. GPS can be implemented for vehicles to know the direction for their destiny and they can find the shortest route.

The testing can be implemented providing these models with a decent and larger dataset from a huge number of objects, including photos of cars and other things from various angles, locations, and road lengths.

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