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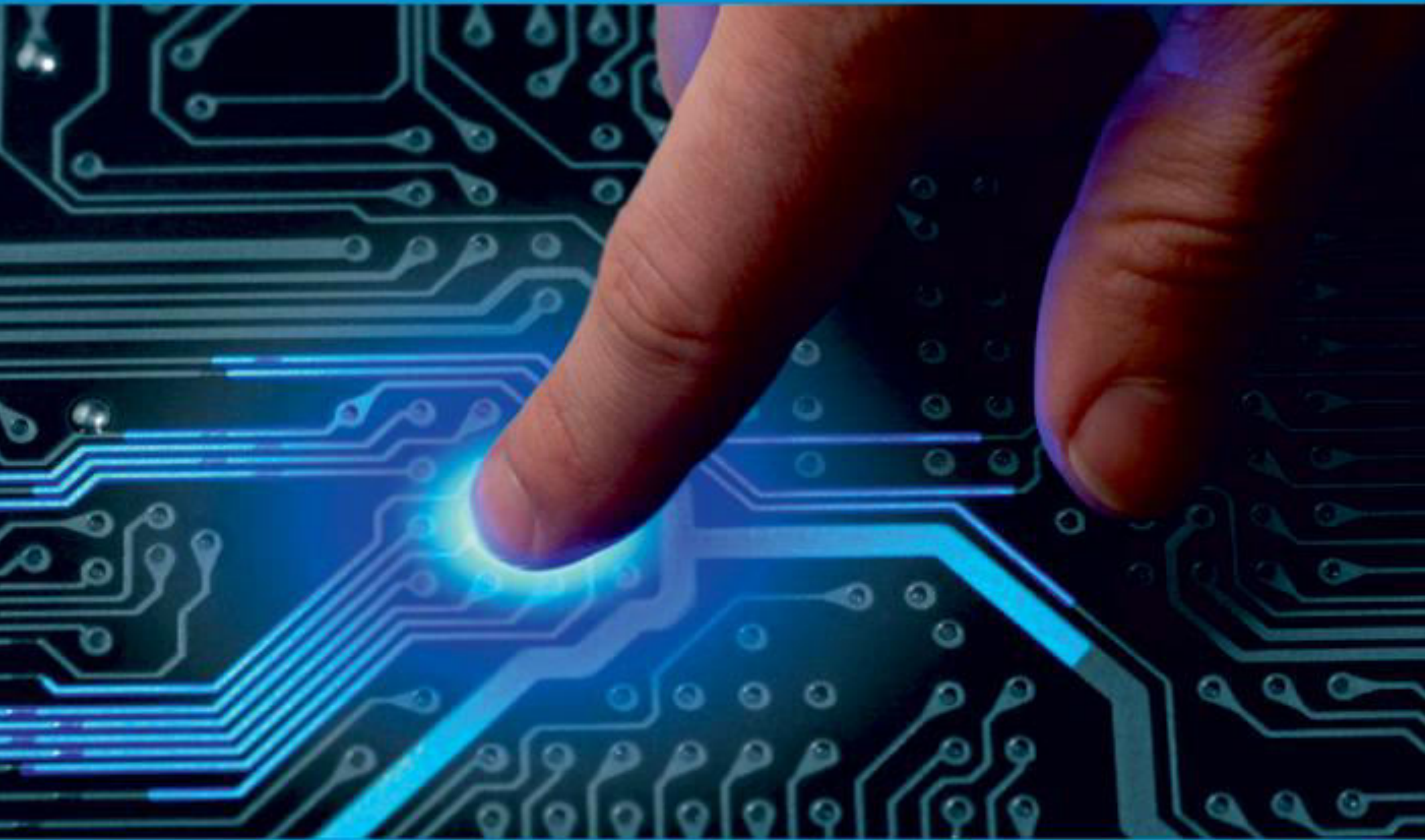

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Smart Traffic Light Scheduling in Smart City Using Image and Video Processing

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ABSTRACT: The project is designed to develop a density based dynamic traffic signal system. The signal timing changes automatically on sensing the traffic density at the junction. Traffic congestion is a severe problem in many major cities across the world and it has become a nightmare for the commuters in these cities. Conventional traffic light system is based on fixed time concept allotted to each side of the junction which cannot be varied as per varying traffic density. Junction timings allotted are fixed. Sometimes higher traffic density at one side of the junction demands longer green time as compared to standard allotted time. The object detection in the traffic signal is processed and converted into simulator then its threshold is calculated based on which the contour has been drawn in order to calculate the number of vehicles present in the area. After calculating the number of vehicles we will came to know in which side the density is high based on which signals will be allotted for a particular side.

KEYWORDS: Traffic Signal System, Object Detection, Vehicle Count, Signal Switching, YOLO, Traffic Management.

I. INTRODUCTION

Traffic congestion is becoming one of the most critical problem with increasing population and automobiles in cities. Traffic jams not only cause extra delay and stress for the drivers, but also increase fuel consumption and air pollution. Although it seems to pervade everywhere, megacities are the ones most affected by it. And its ever-increasing nature makes it necessary to calculate the road traffic density in real-time for better signal control and effective traffic management[1]. The traffic controller is one of the critical factors affecting traffic flow.[2] Therefore, the need for optimizing traffic control to better accommodate this increasing demand arises. It uses You Only Look Once in order to detect the number of vehicles and then set the timer of the traffic signal according to vehicle density in the corresponding direction. This helps to optimize the green signal times, and traffic is cleared at a much faster rate than a static system, thus reducing the unwanted delays, congestion and waiting time, which in turn will reduce the fuel consumption and pollution.

II. WHAT IS TO BE DEVELOPED

We can integrate our system with an application for analyzing the official traffic signal, so as to capture traffic condition notifications in real-time. To Design a real-time detection system for traffic analysis. To assign suitable class label to every frame, as related with an activity of traffic event or not. To implement traffic signal released module as per vehicles density. To Design a real-time detection system for traffic analysis.

III.SCOPE OF PROJECT

The conventional methods faces many drawbacks. The manual controlling system requires a large amount of manpower. As there is poor strength of traffic police, we cannot have them controlling traffic manually in all areas of a city or town. So a better system to control the traffic is needed. Static traffic controlling uses a traffic light with a timer for every phase, which is fixed and does not adapt according to the real-time traffic on that road.So our proposed system is developed for detecting the real time vehicle density on road and provide this vehicle density to signal switching algorithm to set green signal time according to the real time traffic present on a road, and also set red signal time.so it minimize the waiting time at traffic signal and traffic congestion on a road.

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IV.TECHNOLOGY USED

Computer Vision: Computer vision is an interdisciplinary scientific field that deals with how computers can gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to understand and automate tasks that the human visual system can do.

Object Detection: Object detection algorithms typically leverage machine learning or deep learning to produce meaningful results. When humans look at images or video, we can recognize and locate objects of interest within a matter of moments. The goal of object detection is to replicate this intelligence using a computer.

V.PROJECT REQUIREMENTS

Software requirements:

- Road CCTV surveillance
- Operating System:Windows 10
- Coding Language:Python
- IDE:GoogleColab

Hardware Requirements :

- System : Intel i5 Processor
- Hard Disk : 1 TB.
- Ram : 4 GB

VI. DESIGN OF PROJECT

System Analysis:

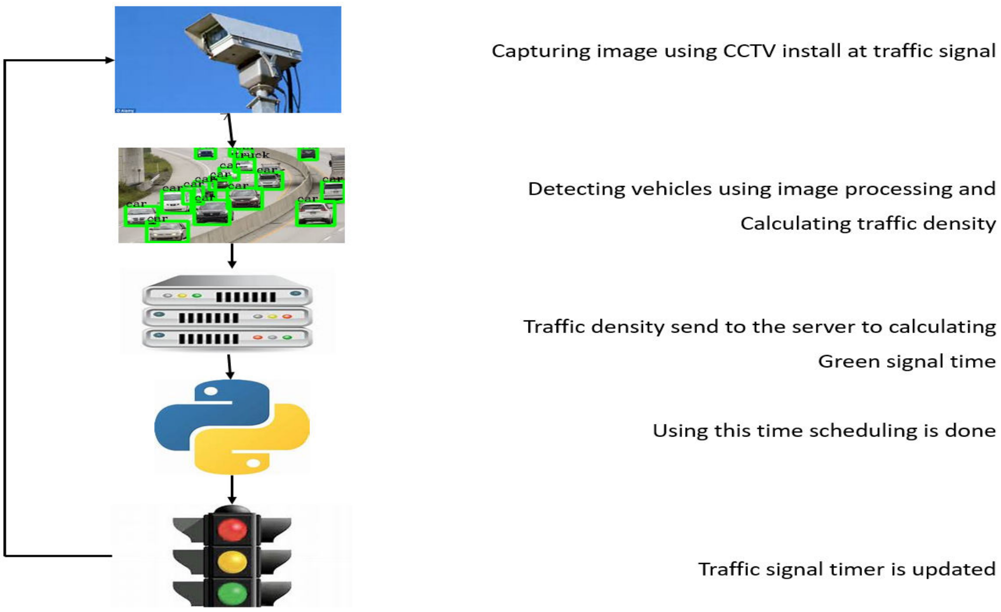

Figure1:System Design Analysis

VII.SYSTEM PROPOSED ARCHITECTURE

Our proposed system takes an image from the CCTV cameras at traffic junctions as input for real-time traffic density calculation using image processing and object detection. This system can be broken down into 3 modules: Vehicle Detection module, Signal Switching Algorithm, and Simulation module. As shown in the figure below, this image is passed on to the vehicle detection algorithm, which uses YOLO. The number of vehicles of each class, such as car, bike, bus, and truck, is detected, which is to calculate the density of traffic. The signal switching algorithm uses this

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density, among some other factors, to set the green signal timer for each lane. The red signal times are updated accordingly. The green signal time is restricted to a maximum and minimum value in order to avoid starvation of a particular lane. A simulation is also developed to demonstrate the system's effectiveness and compare it with the existing static system.

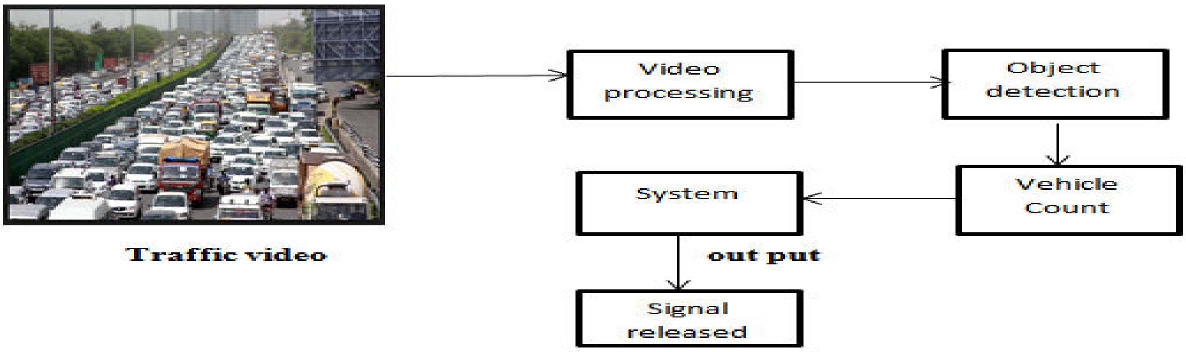

Figure2:System Architecture

SYSTEM IMPLEMENTATION

Algorithm:

You only look once: This algorithm works using the following three techniques:

1.Residual block .

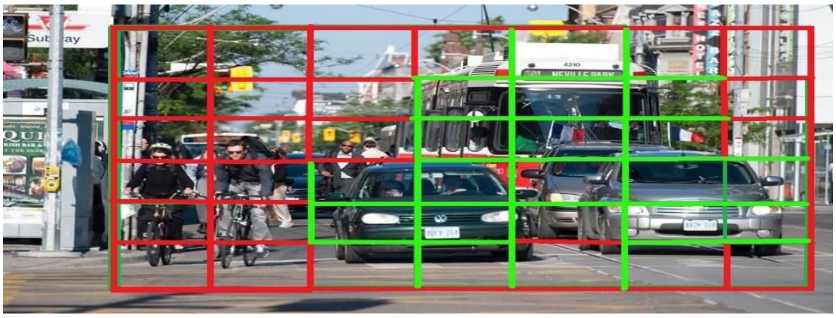

Figure3:Residual block

2.Bounding box regression

Figure4:Bounding box regression

3.Intersection over union.

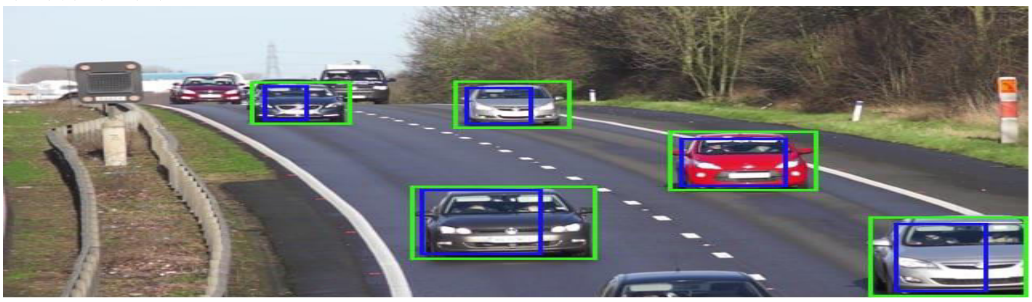

Figure5:Intersection over union

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Working of the Algorithm

When the algorithm is first run, the default time is set for the first signal of the first cycle and the times for all other signals of the first cycle and all signals of the subsequent cycles are set by the algorithm. A separate thread is started which handles the detection of vehicles for each direction and the main thread handles the timer of the current signal. When the green light timer of the current signal (or the red light timer of the next green signal) reaches 0 seconds, the detection threads take the snapshot of the next direction. The result is then parsed and the timer of the next green signal is set. All this happens in the background while the main thread is counting down the timer of the current green signal. This allows the assignment of the timer to be seamless and hence prevents any lag. Once the green timer of the current signal becomes zero, the next signal becomes green for the amount of time set by the algorithm. The image is captured when the time of the signal that is to turn green next is 0 seconds. This gives the system a total of 5 seconds (equal to value of yellow signal timer) to process the image, to detect the number of vehicles of each class present in the image, calculate the green signal time, and accordingly set the times of this signal as well as the red signal time of the next signal. To find the optimum green signal time based on the number of vehicles of each class at a signal, the average speeds of vehicles at startup and their acceleration times were used, from which an estimate of the average time each class of vehicle takes to cross an intersection was found.Then the green signal is Fixed.

COMPARATIVE STUDY OF ALGORITHMS

MODEL	PASCAL VOC 2007	PASCAL VOC 2012	COCO 2015 (IoU=0.5)	COCO 2015 (IoU=0.75)	COCO 2015 (Official Metric)	Real Time Speed
R-CNN	X	X	X	X	X	NO
R-FCN	82.00	X	53.20	X	31.50	NO
YOLO	63.70	57.90	X	X	X	YES
SSD	83.20	82.20	49	30.30	31.50	NO
YOLO-V2	78.60	X	44	19.20	21.60	YES
NASNet	X	X	43.10	X	X	NO
Mask-RCNN	X	X	62.30	43.30	39.80	NO

WORKING MODULES

VEHICLE DETECTION

The proposed system uses YOLO (You only look once) for vehicle detection, which provides the desired accuracy and processing time. A custom YOLO model was trained for vehicle detection, which can detect vehicles of different classes like cars, bikes, heavy vehicles (buses and trucks), and rickshaws. The dataset for training the model was prepared by scraping images from google and labelling them manually using Label IMG, a graphical image annotation tool. Then the model was trained using the pre-trained weights downloaded from the YOLO website. The model was trained until the loss was significantly less and no longer seemed to reduce. This marked the end of the training, and the weights were now updated according to our requirements. These weights were then imported in code and used for vehicle detection with the help of OpenCV library. A threshold is set as the minimum confidence required for successful detection. After the model is loaded and an image is fed to the model, it gives the result in a JSON format

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i.e., in the form of key-value pairs, in which labels are keys, and their confidence and coordinates are values. Again, OpenCV can be used to draw the bounding boxes on the images from the labels and coordinates received.

SIGNAL SWITCHING ALGORITHM

The Signal Switching Algorithm sets the green signal timer according to traffic density returned by the vehicle detection module, and updates the red signal timers of other signals accordingly. It also switches between the signals cyclically according to the timers. The algorithm takes the information about the vehicles that were detected from the detection module, as explained in the previous section, as input. This is in JSON format, with the label of the object detected as the key and the confidence and coordinates as the values. This input is then parsed to calculate the total number of vehicles of each class. After this, the green signal time for the signal is calculated and assigned to it, and the red signal times of other signals are adjusted accordingly. The algorithm can be scaled up or down to any number of signals at an intersection. The following factors were considered while developing the algorithm: 1.The processing time of the algorithm to calculate traffic density and then the green light duration – this decides at what time the image needs to be acquired. 2.Number of lanes. 3.Total count of vehicles of each class like cars, trucks, motorcycles, etc. 4.Traffic density calculated using the above factors. 5.Time added due to lag each vehicle suffers during start-up and the non-linear increase in lag suffered by the vehicles which are at the back. 6.The average speed of each class of vehicle when the green light starts i.e. the average time required to cross the signal by each class of vehicle. 7.The minimum and maximum time limit for the green light duration - to prevent starvation. The average time each class of vehicle takes to cross an intersection can be set according to the location, i.e., region-wise, city-wise, locality-wise, or even intersectionwise based on the characteristics of the intersection, to make traffic management more effective. Data from the respective transport authorities can be analyzed for this. The signals switch in a cyclic fashion and not according to the densest direction first. This is in accordance with the current system where the signals turn green one after the other in a fixed pattern and does not need the people to alter their SVPM's COE, Malegaon(Bk) 34 Smart Traffic Light Scheduling in Smart City Using Image and Video Processing ways or cause any confusion. The order of signals is also the same as the current system, and the yellow signals have been accounted for as well. Order of signals: **Red → Green → Yellow → Red**.

SIMULATION MODULE

A simulation was developed from scratch using Pygame to simulate real-life traffic. It assists in visualizing the system and comparing it with the existing static system. It contains a 4-way intersection with 4 traffic signals. Each signal has a timer on top of it, which shows the time remaining for the signal to switch from green to yellow, yellow to red, or red to green. Each signal also has the number of vehicles that have crossed the intersection displayed beside it. Vehicles such as cars, bikes, buses, trucks, and rickshaws come in from all directions. In order to make the simulation more realistic, some of the vehicles in the rightmost lane turn to cross the intersection. Whether a vehicle will turn or not is also set using random numbers when the vehicle is generated. It also contains a timer that displays the time elapsed since the start of the simulation. Key steps in development of simulation

1.Took an image of a 4-way intersection as background.

2.Gathered top-view images of car, bike, bus, truck, and rickshaw and Resized them.

3.Give images of traffic signals - red, yellow, and green.

4.Code For displaying the current signal time i.e. the time left for a green signal to turn yellow or a red signal to turn green or a yellow signal to turn red. The green time of the signals is set according to the algorithm, by taking into consideration the number of vehicles at the signal. The red signal times of the other signals are updated accordingly.

5. Generation of vehicles according to direction, lane, vehicle class, and whether it will turn or not all set by random variables. Distribution of vehicles among the 4 directions can be controlled. A new vehicle is generated and added to the simulation after every 0.70 seconds.

6.Code For how the vehicles move, each class of vehicle has different speed, there is a gap between 2 vehicles, if a car is following a bus, then its speed is reduced so that id does not crash into the bus.

7.Code For how they react to traffic signals i.e. stop for yellow and red, move for green. If they have passed the stop line, then continue to move if the signal turns yellow.

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8.Displaying the number of vehicles that have crossed the signal.

9.Displaying the time elapsed since the start of the simulation.

10.Code: For updating the time elapsed as simulation progresses and exiting when the time elapsed equals the desired simulation time, then printing the data that will be used for comparison and analysis.

Following is the image of the final simulation:

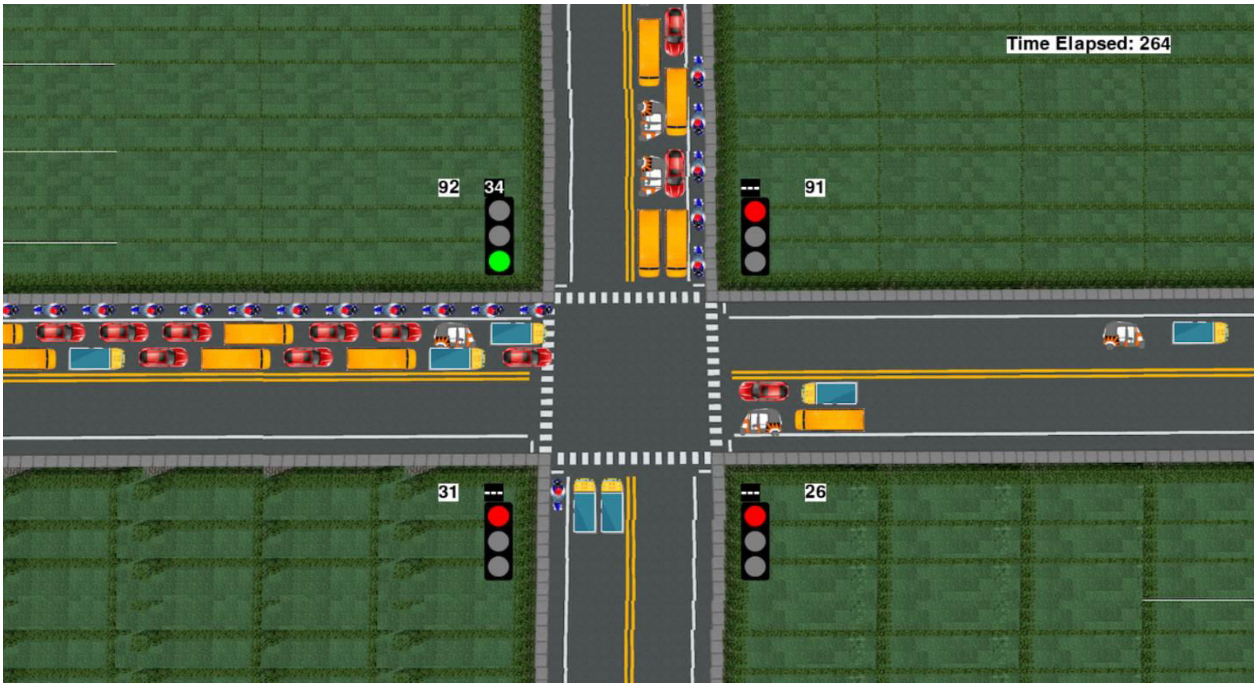

Figure 6:Final Output

VIII.CONCLUSION AND FUTURE WORK

Thus, we proposed the system which sets the green signal time according to the vehicle count on which lane has more no of vehicles that lane green signal time set for longer duration as compared to the direction with lesser traffic. This will lower the unwanted delays, and reduce congestion and waiting time which in turn will reduce the fuel consumption and pollution. This system can be integrated with the CCTV cameras in major cities in order to facilitate better management of traffic..

Identification of vehicles violating traffic rules:The vehicles running red lights can be identified in an image or a video stream by defining a violation line and capturing the number plate of the image if that line is crossed when the signal is red. Lane changing can also be identified similarly. These can be achieved by background subtraction or image processing techniques.

Synchronization of traffic signals across multiple intersections: Synchronizing signals along a street can benefit the commuters as once a vehicle enters the street, it may continue with minimal stopping.

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BIOGRAPHY

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