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Intelligent Traffic Light Control Using YOLO for Vehicle Detection and Flow Optimization

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ABSTRACT_Traffic congestion is fast becoming one of the most important problems as cities grow in population and cars. Traffic congestion not only increases fuel use and air pollution but also adds time and stress to drivers. Though it seems to be everywhere, megacities are the most impacted. This calls for real-time road traffic density calculation to improve signal control and efficient traffic management. Traffic controllers are among the key determinants of traffic flow. Traffic control optimisation is therefore more necessary to better fit this growing need. The paper estimates traffic density over all lanes using traffic cameras and YOLO object identification algorithms, then modifies red and green signal timing.

1.INTRODUCTION

Many road systems are suffering from the capacity decline of roads and the related Level of Service caused by the growing number of cars in cities. Many traffic-related problems arise in light of traffic signal systems on crossing points that use fixed signal clocks. They rehash a similar stage succession and its nomenclature with no modifications. Increased desire for street limit also increases the need for new solutions for traffic light that may be found in the domain of Astute Vehicle Frameworks. Let us consider the contextual study of Mumbai and Bangalore. According to a study listing the traffic situation in 416 urban areas across 57 countries, Bangalore's traffic stream is the most awful on the globe; Mumbai is not far behind in that frame of mind. Rush hour adds 71% to the length of a trip in Bangalore. In Mumbai, it is 65 percent longer [1]. Currently, three conventional methods of traffic control are: Controlling traffic calls for personnel, as the name implies. A required area is given traffic police to regulate traffic. To regulate the traffic, the traffic police use whistle, sign light, and billboard. Timers fixed in stone

govern customary traffic signals with static clocks. The timer runs on a constant integer number. In light of the clock esteem, the lights are naturally shifting between red and green. Yet another sophisticated approach is putting loop detectors or proximity sensors on the road. This sensor provides data on the traffic out and about. The data from the sensors controls the traffic signals. These conventional methods have several drawbacks. The manual controlling mechanism calls for a great deal of human effort. Traffic police are not strong enough to manually control all of a city or town. This calls for a better traffic control system. Static traffic control uses a fixed traffic signal with a timer for each phase that does not vary in reaction to the present traffic on that road. When electronic sensors—such as proximity sensors or loop detectors—are utilised, accuracy and coverage often conflict since the gathering of high-quality data usually depends on sophisticated, expensive technology, which means that less facilities will be available owing constrained funds. Moreover, the total inclusion on an organisation of offices usually calls for a lot of sensors as most sensors have limited successful range. Recently, video monitoring and observation systems have been widely used in rush hour jam management for security, slope metering, and providing information and updates to travellers progressively. Video monitoring systems can also be used to measure traffic density and vehicle classification; these systems can then be used to regulate the traffic light clocks to optimise traffic flow and minimise congestion. Our suggested system intends to design a traffic signal controller based on PC Vision that can fit the current traffic situation. For real-time traffic density computations, it counts the number of cars at the intersection and changes the green signal timing according to live views from CCTV cameras. The vehicles are classified as car, bike, bus/truck, or rickshaw to obtain an accurate estimate of how long it will take for the green light to come on. It is Just go for it to determine the number of cars and then set the traffic light clock according vehicle thickness in the corresponding course. Unlike a static system, traffic is cleared far more quickly, which means less unwanted delays, congestion, and waiting times—all of which will lower pollution and fuel use. This also maximises the times of green signals.

2.LITERATURE SURVEY

[1] TomTom.com, "Tom Tom World Traffic Index", 2019

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Abstract:

The TomTom World Traffic Index provides detailed insights into global traffic congestion levels in major cities. The 2019 report ranks cities based on traffic congestion percentages, peak time delays, and travel trends throughout the year. It highlights critical traffic hotspots and evaluates the impact of congestion on urban mobility and productivity. This dataset serves as a valuable resource for traffic engineers, urban planners, and researchers aiming to develop intelligent traffic control solutions.

[2] Khushi, "Smart Control of Traffic Light System using Image Processing," 2017 (CTCEEC)

Abstract:

This paper proposes a smart traffic control system utilizing image processing techniques to detect vehicle presence and density at intersections. The system captures real-time images, processes them to count vehicles, and adjusts traffic light durations dynamically to minimize waiting time and congestion. The study demonstrates that integrating image-based vehicle detection leads to more efficient traffic flow compared to static time-based systems.

[3] A. Vogel et al., "Improving Traffic Light Control by Means of Fuzzy Logic," 2018 (ELMAR)

Abstract:

This study introduces a fuzzy logic-based traffic light controller aimed at improving the adaptability and efficiency of signal systems. The controller takes input from sensors to determine vehicle density and optimizes light switching intervals using fuzzy inference rules. Simulation results show that the fuzzy logic approach reduces traffic congestion and waiting times, particularly in urban environments with fluctuating traffic patterns.

[4] A. A. Zaid et al., "Smart Controlling for Traffic Light Time," 2017 (AEECT)

Abstract:

The authors present a smart traffic light timing system that adjusts green light durations based on real-time vehicle flow. Using sensor inputs and microcontrollers, the system dynamically alters signal timing to prioritize lanes with heavier traffic, thereby improving throughput. The paper highlights the use of adaptive algorithms to replace conventional fixed-time control, leading to better traffic management in busy intersections.

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[5] Renjith Soman, "Traffic Light Control and Violation Detection Using Image Processing," IOSR Journal of Engineering, 2018

Abstract:

This paper proposes a dual-function system that not only manages traffic light control using vehicle density estimation through image processing, but also detects signal violations by identifying vehicles crossing red lights. The system employs video surveillance, background subtraction, and contour detection to monitor traffic in real-time. It enhances both traffic flow and safety by penalizing rule violators while optimizing signal timing.

[6] A. Kanungo et al., "Smart Traffic Lights Switching and Traffic Density Calculation Using Video Processing," 2014 (RAECS)

Abstract:

The paper introduces an intelligent traffic light system that leverages video processing for real-time traffic density analysis. The system processes frames from surveillance cameras to estimate vehicle count and adjusts signal timing accordingly. It reduces idle time for empty roads and increases efficiency at busy junctions. The authors demonstrate how video-based automation improves responsiveness over traditional systems and discuss implementation challenges.

[7] Siddharth Srivastava et al., "Adaptive Traffic Light Timer Controller," IIT Kanpur, NERD Magazine

Abstract:

This article presents an adaptive traffic light timer that modifies signal durations based on live traffic density. The proposed model uses sensors to count vehicles approaching an intersection and dynamically sets green light durations, aiming to reduce congestion and waiting time. Developed by students at IIT Kanpur, the project emphasizes cost-effective implementation and scalability for Indian traffic conditions.

3.PROPOSED SYSTEM

To overcome the limitations of traditional traffic control systems, several methods have been used in the past, such as manual control—which demands a large workforce—and static time-based control, which lacks efficiency as it assigns equal timing to all lanes regardless of traffic volume. Even sensor-based systems have shown limited effectiveness, as they often fail to adapt signal timing to varying traffic densities across different lanes.

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To tackle these challenges, this paper proposes an intelligent traffic management approach utilizing surveillance cameras and the YOLO (You Only Look Once) object detection algorithm. This system captures periodic images of each lane—every five seconds—to assess vehicle density and dynamically adjust traffic signal timings accordingly. The traffic flow is optimized by allocating green and red light durations based on the real-time density of vehicles in each lane.

For experimental purposes, the author employs the PYGAME framework to simulate a traffic environment, while YOLO is applied to real-world traffic video footage to detect and count vehicles, validating the system's effectiveness under practical conditions.

3.1 IMPLEMENTATION

1) Run Traffic Simulation: using this module we can start PYGAME traffic simulation where you can see traffic control based on traffic density

2) Run Yolo Traffic Detection & Counting: using this module we will upload traffic videos and then YOLO will detect traffic vehicles and estimate their density with speed

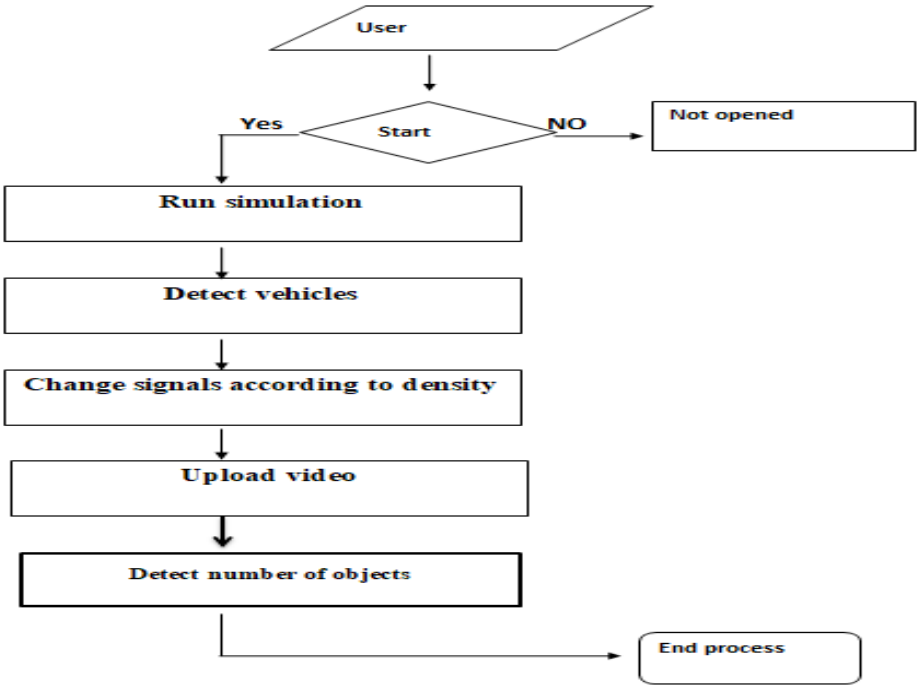

Fig 1:Working

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4.RESULTS AND DOSCUSSION

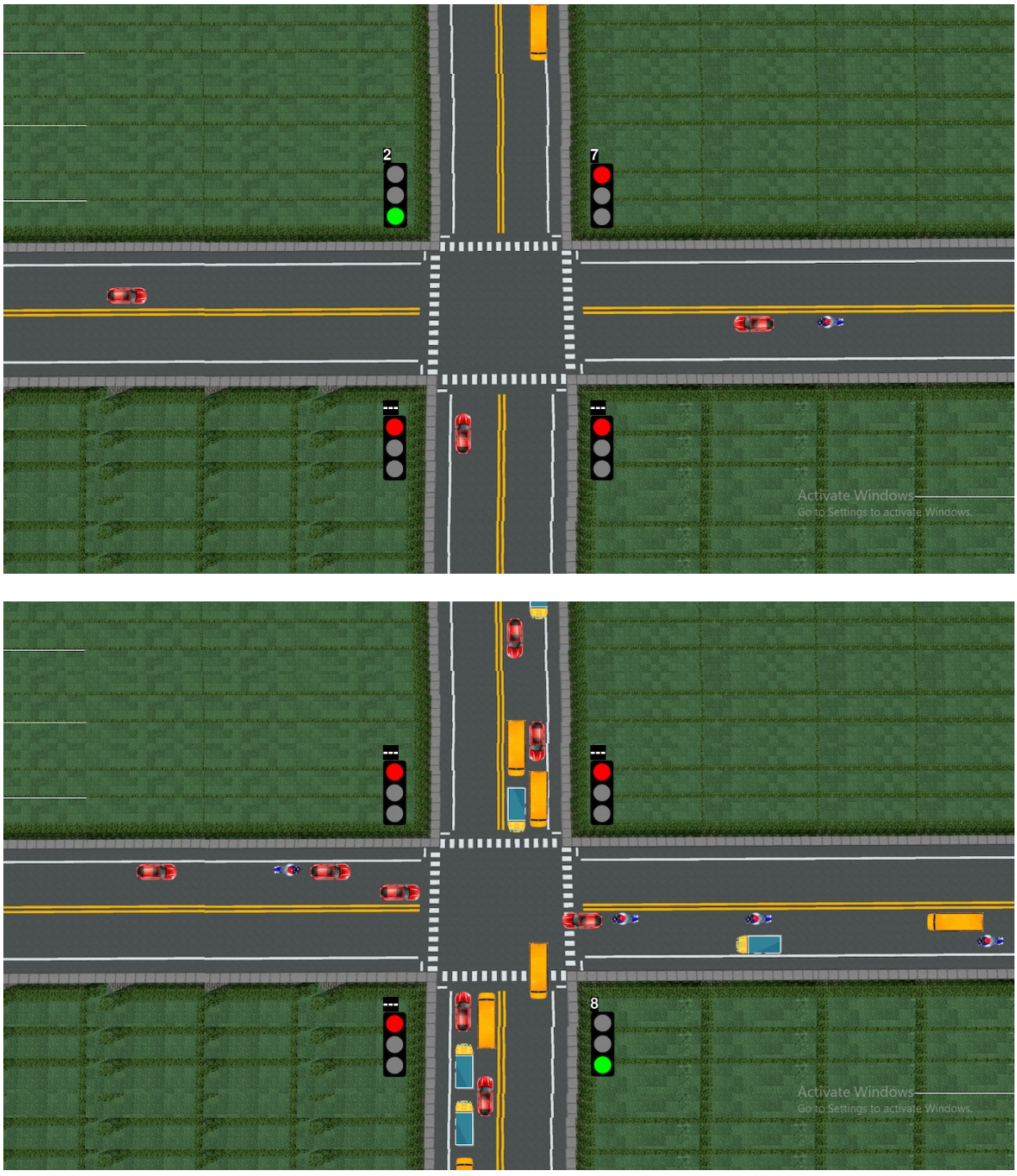

Fig 2:In above screen you can see PYGAME simulation output and at each lane traffic density is calculated and then adjust green and red line. This simulation run in INFINITE loop so you press 'windows' key from keyboard and then close application and then restart and run second YOLO module

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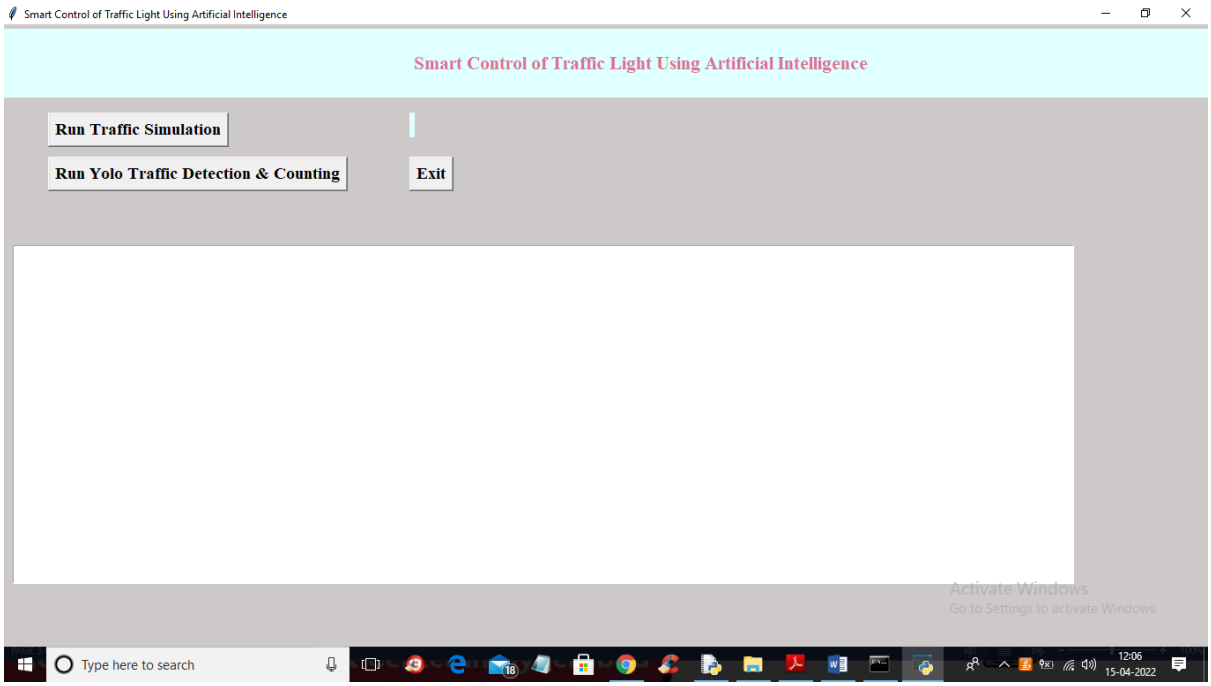
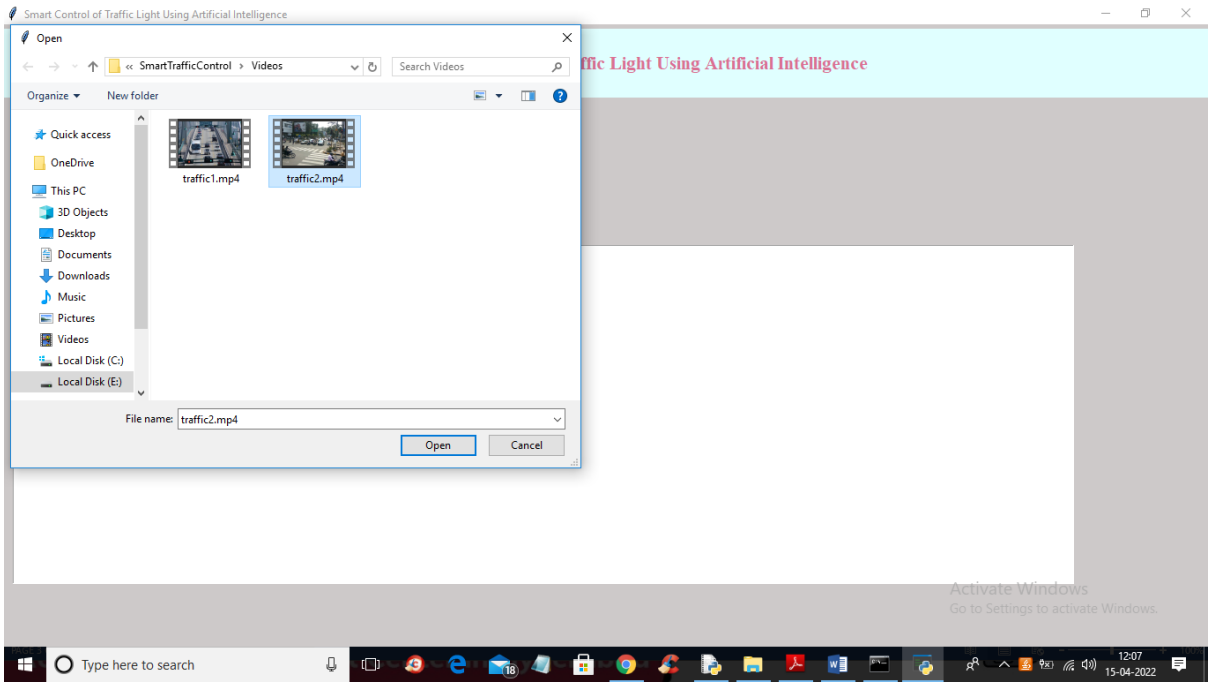


Fig 3:Now in above screen click on 'Run Yolo Traffic Detection & Counting' button to upload traffic video and then estimate traffic density



Fg 4:In above screen selecting and uploading 'traffic2.mp4' video and then click on 'Open' button to get below output

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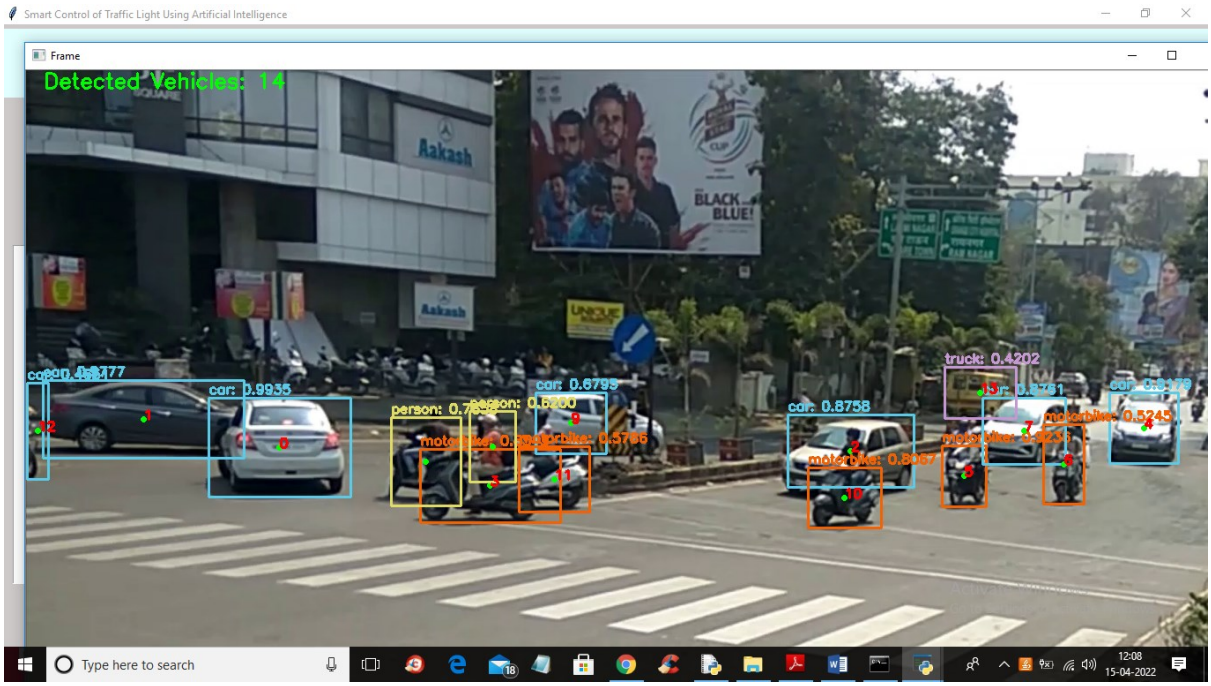

Fig 5:In above screen detecting traffic and then estimating its count and based on that traffic time will be adjusted. YOLO runs very slowly in normal laptop so let it finish all frame processing then u will get output.mp4 file which you can play as normal video with traffic density.

5.CONCLUSION

All in all, the suggested framework ensures that the bearing with more traffic is given a green sign for a longer drawn out term of time when contrasted with the heading with lesser traffic and adjusts the green sign time adaptively as per the traffic thickness at the sign. This will reduce congestion, wait times, and unwanted delays as well as fuel use and pollution. Simulation findings show that the system improves by almost 23% over the present one in terms of the number of vehicles crossing the intersection, which is a major improvement. Using real-world CCTV data as training data for the model, more calibration could help this system to perform even better. Furthermore, the suggested framework offers particular advantages over the present smart traffic signal systems now in use, for example, Tension Mats and Infrared Sensors. As crossing sites with heavy traffic are already equipped with such cameras, the cost anticipated to carry the system is irrelevant as film from CCTV cameras from traffic lights is used, which calls for no more equipment by and large. Perhaps only little alignment is required. The cost of maintenance is also reduced when compared to other traffic monitoring systems like pressure mats, which usually suffer wear and tear from their location on

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roadways under continual great pressure. Thus, the suggested framework can therefore be coordinated with the CCTV cameras in major urban areas to operate with improved traffic control.

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