EagleView AI

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***Abstract*: The traffic alerts brought on by the population growth that is occurring so quickly are one of the most significant issues facing modern civilization. The public's safety is being threatened by the enormous scale of traffic accidents in India. Traveling on Indian roadways now poses a life-threatening risk due to the rise in traffic accidents. In most of the metro cities it is difficult to reach any destination on time due to heavy traffic. Drivers are forced to deal with stress and problems for a prolonged period of time as a result, which raises fuel consumption and air pollution. Although it is a worldwide issue, megacities are where it is most prevalent. It's crucial to assess traffic speed precisely, on time, and to optimise the signal in order to address this issue. In the past, traffic generation was significantly aided by passenger transportation. However, as new technologies evolve, more emphasis is being placed on the creation of vehicle management tailored to the needs of the person. Despite efforts to control the issue, traffic congestion is anticipated to keep becoming worse in the next years. Future generations will find it difficult to breathe pure air unless there is a pressing need. The introduction of autonomous vehicles is viewed as a solution, but for the technology to work well, it must be included into the broader traffic management system. Therefore, the only way to deal with traffic is by combining technology, legislation, and increased public awareness.**

Keywords-video processing, CCTV cameras, real-time monitoring, traffic congestion, traffic flow.

1. Introduction

Traffic congestion is a significant problem in modern life, leading to longer travel times, more fuel consumption, and increased air pollution. Conventional traffic light systems have static timers that are unable to adapt to changing traffic conditions, making congestion worse. The solution to this problem is to develop a system that can automatically determine the best green signal time based on the amount of traffic at each signal, which will guarantee that green signals are displayed for a longer amount of time in the direction with more traffic than in the direction with less traffic. This will bypass the old, hard-coded traffic light system, allowing us to reduce wait times and traffic congestion, which will reduce fuel consumption and air pollution.

To address this issue, a firmware-based vehicle detection technique has been developed that uses artificial intelligence and machine learning to measure the density of traffic on highways. By detecting the number of vehicles in each lane, the system calculates the density of traffic at any given time, allowing it to dynamically change the timing of traffic lights based on real-time data. The high-level programming language and interactive environment known as YOLOv4 is frequently employed in engineering and scientific applications, and it is being used in this system to gather information about the volume of traffic going through a certain area as well as the pace at which it is moving.

Once this information has been gathered, it is put into a microcontroller, which modifies the length of the green light for each route in accordance with the volume of traffic. It optimizes the green signal in every situation, including the time of day and the weather, and can observe the average speed of a vehicle at a particular time or situation to pass a signal and compute and determine a timing of green signal according to the situation.

The incorporation of cutting-edge technology like artificial intelligence and machine learning into traffic management systems is changing the way we manage traffic. These technologies can assist in creating transportation networks that are safer, more effective, and more sustainable by utilizing real-time data and advanced algorithms.

Intelligent traffic light control systems powered by AI algorithms can effectively manage heavy traffic loads and adjust to shifting driving circumstances, leading to a decrease in the likelihood of accidents. Additionally, these systems can make it possible to gather important traffic data that can help with municipal planning and traffic management. City planners can use this data to analyze traffic patterns, forecast traffic flow, and make more informed decisions concerning infrastructure design and traffic management.

Smart traffic management systems are crucial technology that many groups, including drivers, pedestrians, and law enforcement personnel, need. The main objective of a smart traffic management system is to offer practical information that can be used to make informed decisions about how to manage traffic more effectively. This will help alleviate traffic congestion, reduce fuel consumption, and minimize air pollution.

In conclusion, the use of AI-powered smart traffic signal management systems has emerged as a promising remedy for addressing traffic congestion and enhancing the effectiveness of the road network. These systems can be used to adjust traffic signal timings to reflect current traffic conditions, ease congestion, improve traffic flow, and increase road safety. They can also gather important traffic data that can help with municipal planning and traffic management, and create transportation networks that are safer, more effective, and more sustainable. By utilizing real-time data and advanced algorithms, intelligent traffic light control systems can effectively manage heavy traffic loads and adjust to shifting driving circumstances, leading to a decrease in the likelihood of accidents. Overall, the development of AI-powered traffic management systems has the potential to make our cities more efficient, safer, and more liveable.

2. Literature survey

This paper focuses on the pressing need to improve road safety in the face of the remarkable growth of the global vehicle fleet and the increase in accidents. It discusses the potential of Vehicular Ad Hoc Network (VANET) and Intelligent Transportation Systems (ITS) for facilitating communication between vehicles and road-side units in smart cities and living labs. The authors highlight the benefits of VANETs in reducing pollution and congestion, preventing accidents, and identifying traffic violations. They propose a smart city framework that transmits traffic information and compare various routing protocols. Overall, the paper emphasizes the importance of VANETs in improving road safety and stimulating economic growth. [1].

In conclusion, this study introduced a modular image processing technique for real-time traffic signal detection in both urban and rural settings. The suggested approach performs better than conventional object-recognition learning procedures and is able to recognize traffic signals from different nations. Our findings demonstrate that, despite the system still having room for development, such as the addition of a tracking algorithm, it was very accurate at identifying traffic signals [2].

A fuzzy logic traffic light controller for an isolated traffic intersection is presented in the study by Alan Vogel, Izidor Oremovic, Robert Simic, and Edouard Ivanjko. For both low and high traffic demand situations, the study compares the performance of the fuzzy logic controller to that of a fixed control scenario. The findings demonstrate that the fuzzy logic controller outperforms the fixed control scenario in terms of decreasing the average and maximum durations of queues, increasing the number of vehicle stops in primary driveways, and lowering pollution levels. However, because the design favors principal driveways, the performance of the fuzzy logic controller for secondary driveways is marginally inferior. According to the study, fuzzy logic offers great efficiency and the capacity to assess data in real-time, making it a potential method for enhancing traffic flow. The authors suggest exploring the use of evolutionary algorithms for optimizing the fuzzy rule sets and further enhancing the system through cooperative control. The study offers a potential strategy for enhancing traffic flow and easing congestion in sparse traffic junctions overall [4].

In this research, a more dynamic traffic light system is proposed as an alternative to the outdated fixed traffic signal system for decreasing traffic congestion. The new approach is anticipated to shorten wait times, lessen mishaps, use less fuel, and aid in air pollution control. The suggested system is also built to support coordination control, which synchronises traffic signals to provide vehicles extended durations of green lights. By locating regions with lengthy wait times and immediate repair requirements, this technology may also gather data for upcoming road design and development. Overall, the report attempts to enhance traffic flow and lessen harmful effects on drivers and the environment. Intelligent traffic sensors and cameras are being used to monitor traffic conditions and gather real-time data, significantly enhancing these systems. In order to address these problems, traffic management authorities might use this data to identify congested regions with high traffic density [6].

According to Lindner, Kressel, and Kaelberer, the colour camera system can be a useful aid in urban traffic by directing the driver's attention to traffic signals after colour cameras are made accessible and traffic signals are logged in upgraded digital maps. Precise position data and/or a lane detection algorithm are required to develop a stable and dependable system that is equivalent to transponder systems, which demand large extra infrastructure expenses. Without colour information, the detection stage is now crucial, but a combination of cascade classifiers and matched filter algorithms may provide a solution by fusing the identification performance of a complete-object detector-classifier with the real-time functionality of created matched filters [7].

In order to track geographic objects from a video sequence captured from a moving vehicle, the research offers a multi-modal tracking approach. In order to offer a search area for object tracking, the suggested technique makes use of location and attitude data of the vehicle computed from a GPS or INS. Also provided is an adaptive window approach for a traditional block-matching method. The report includes early experimental findings that show how reliable the suggested system is for locating geographic items. The old pre-timed traffic signal system in India is no longer functional and unable to handle the country's growing vehicle population and traffic congestion. Regardless of the actual traffic volume, because most traffic lights run on fixed-time schedules, traffic flow is constrained to predefined patterns. Longer wait times and poor traffic flow are frequently the outcomes, which worsen congestion, increase fuel use, and produce hazardous pollutants [9].

The rapid radial symmetry detector's efficiency in identifying and detecting signs is highlighted in this work. The study shows that the detector, when used in conjunction with appropriate classification, has a low false-negative rate and a sufficiently low false-positive rate, making it a trustworthy tool for online sign identification. As a pixel-based, real-time detector, the rapid radial symmetry detector is resistant to variations in illumination that might trouble colour-based detectors. Overall, the study contends that the quick radial symmetry detector, which offers dependable performance and robustness under difficult circumstances, is a viable method for sign detection and recognition [10].

The method for identifying traffic signs from video sequences in outdoor settings is presented in the study. The system consists of two modules: one that uses linear SVMs to classify shapes and another that uses Gaussian kernels to identify the inner region. A candidate sign is taken into consideration legitimate if it is found and recognised in at least two frames of a sequence, even when a tracking mechanism has not yet been created. The testing findings show that the system accurately detects various shapes and performs effectively in difficult environments including dim lighting and partially obscured signage. Additionally, the system is unaffected by rotations, size changes, and alterations in position. The study makes the case for potential future advancements. Overall, the suggested strategy for preserving traffic signs may be helpful [11].

3. Proposed System

The suggested system uses methods for image and video processing to enhance the timing of traffic signals. In order to gather information on traffic density, the system uses CCTV cameras installed at lane junctions to take pictures of the lanes. These pictures are then processed using techniques like edge detection. This information is given to a traffic density shift algorithm, which may precisely control traffic flow and lessen congestion.

The system makes it possible to monitor traffic conditions in real-time and gives authorities the ability to take the required actions to guarantee efficient and safe road travel. This information can be used to optimise the timing of traffic signals, which will improve traffic flow. In urban regions where traffic numbers might vary and conditions can change, this approach is extremely useful.

Fig 1 Traffic intersection

3.1 Methodology

1. Data collection and labelling: The initial phase is gathering a sizable dataset of pictures or videos depicting traffic situations. Cameras or sensors placed nearby can be used to get this data. Data must be tagged once it has been gathered. This entails manually setting the positions and sizes of each object in the scene in the photograph, such as the automobiles, people, traffic signals, etc. Using this tagged data, the object detection system is trained.
2. Faster R-CNN, RetinaNet, and SSD are just a few of the object identification algorithms that may be applied to traffic control. These systems identify and categorise items in a picture using deep neural networks. The tagged data is used to train the neural network, which then learns to anticipate the positions and types of objects in a scene.
3. Object tracking: Traffic control requires more than just object detection. To accurately forecast the future motions of the items in the picture, the system must track them throughout time. In order to follow things across video frames, object tracking techniques combine object identification and motion estimates.
4. Traffic control: The system may decide how to manage traffic using precise item identification and tracking. For instance, the system may automatically cause a traffic signal to turn red and stop all vehicles until a pedestrian has safely crossed the street if one is identified in the road. The technology is also capable of detecting traffic congestion and modifying traffic lights to improve traffic flow.
5. Optimising Traffic: With the help of object detection, the system can calculate the no. of vehicles and with this information can optimise green signal timing to improve flow of traffic and movement of vehicles efficiently.
6. Continuous Updating: With all data acquired and analysed the system can continuously update and improve the accuracy of traffic optimisation in each and every circumstances.
7. Continuous improvement: With more information and feedback from the system's operation in the actual world, object identification algorithms may be enhanced yet more. To increase accuracy and decrease false positives, this entails gathering additional data, retraining the neural network, and fine-tuning the object tracking algorithms.

3.2 Architecture

The architecture of our system consists of several key components that work together to gather and analyze data on traffic flow and adjust traffic signal timings in real-time.

The first component of the system is the traffic sensors, which are placed at strategic locations along the roadways to capture traffic data. These sensors can be in the form of cameras, radar, or other types of detectors. They use computer vision techniques to detect and track vehicles, cyclists, and pedestrians in real-time, and send this data to the system's central control unit.

The central control unit is the heart of the system and is responsible for processing the traffic data received from the sensors. It uses machine learning algorithms to analyze the traffic flow patterns and predict traffic congestion in real-time. Based on this analysis, the control unit adjusts the traffic signal timings to optimize traffic flow and reduce congestion.

To enable real-time traffic signal control, the system uses a communication network that links the central control unit to the traffic signals. This network can be wired or wireless, depending on the implementation. When the central control unit determines that a traffic signal should be changed, it sends a signal to the traffic signal controller, which adjusts the timing of the green light accordingly.

To ensure system reliability and fault tolerance, redundant hardware and software components are used. In case of a failure, the system automatically switches to a backup component to ensure continuous operation.

Another important component of the system is the user interface, which enables users to monitor and control the system. The interface can be a web-based dashboard, mobile app, or other types of graphical user interfaces (GUIs). This interface allows users to view real-time traffic data, adjust traffic signal timings, and receive alerts when traffic conditions change.

Finally, the system generates and stores data for analysis and reporting. The data collected from the traffic sensors and other components is used to generate reports on traffic flow patterns, congestion levels, and other key performance indicators (KPIs). This data can be used by traffic engineers and city planners to identify areas for improvement, optimize traffic management strategies, and make informed decisions about future infrastructure investments.

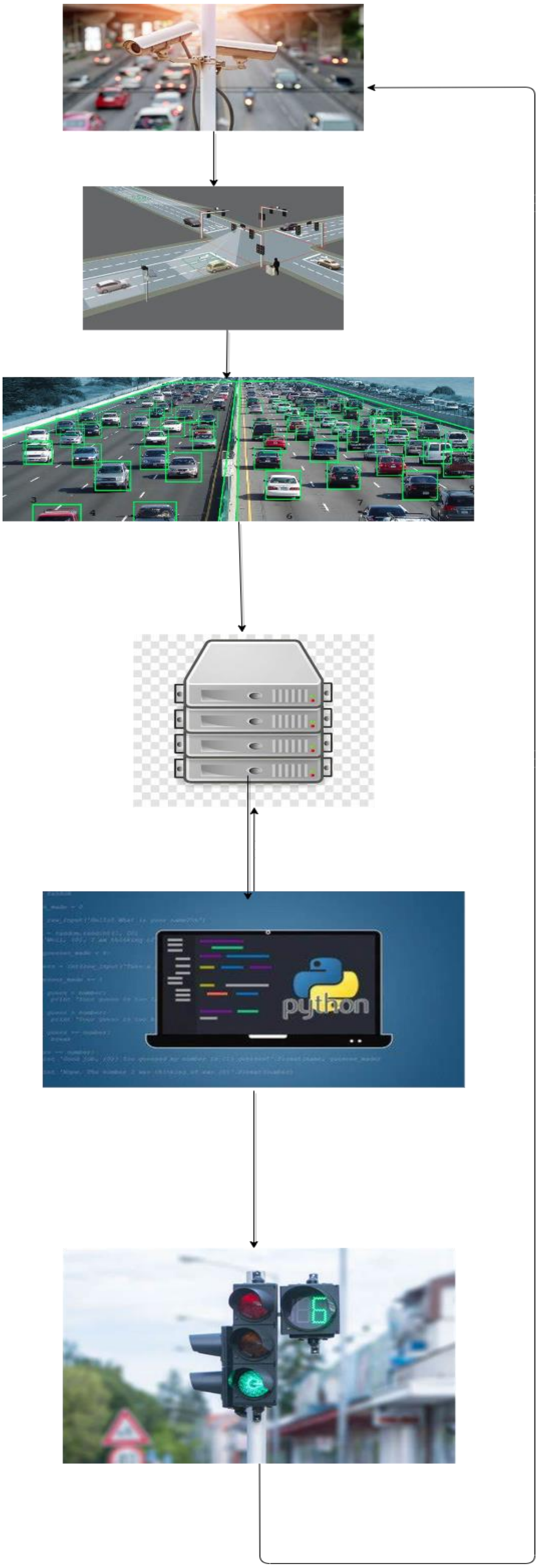

Fig 2 Architecture

3.3 Algorithm

The algorithm uses object detection technique to calculate density of traffic in each lane. It gets data about detected vehicles in JSON format. It calculates how many vehicles of each type are there. It figures out how much traffic is there in each lane by detecting the no. of vehicles in each lane and also calculates average time taken by vehicles to cross after green light in each lane. It calculates how fast each type of vehicle moves when the green light is on. Using this information, it decides how long the green light should stay on for each signal. Also, it keeps on updating the average time taken by vehicles to cross signal by using data so that green signal is optimized in every situation. It makes sure that the green and red lights work together to keep traffic flowing smoothly. It makes sure that the green light doesn't stay on too long or too short. If there are multiple signals, it repeats these steps for each signal. The algorithm can handle any number of signals and adjust to changing traffic levels.

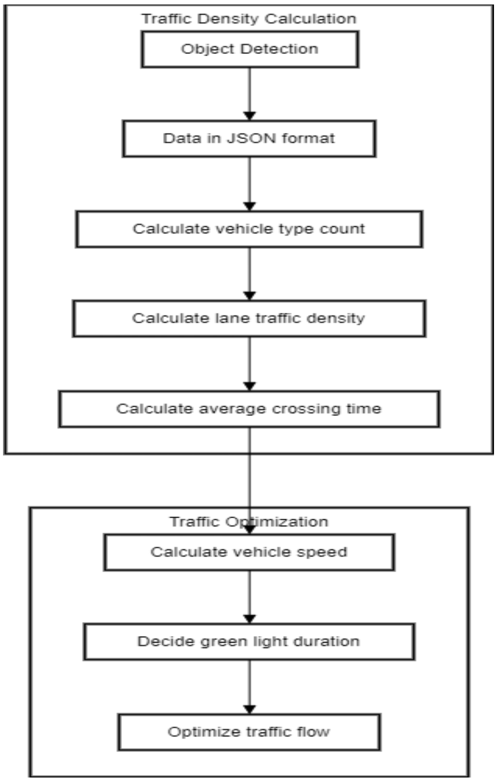

Fig 3 Flow Diagram of the algorithm

4. Result and Discussion

The table given compares the performance of a "Normal system" for traffic signals to a new "Our system" in terms of the number of vehicles per time unit (v/t) that can pass through four different lanes. The data is presented in the form of lane-wise averages for both the Normal and Our systems.

v/t	Lane 1	Lane 2	Lane 3	Lane 4	Normal system	Our system
6	18	24	7	22	540	426
5	21	42	32	42	780	685
4	16	26	28	30	480	400
8	36	18	47	46	1320	1176
9	27	48	19	14	1020	972
5	8	41	6	11	420	330

6	47	25	9	41	840	732
7	6	26	12	34	600	546

Table 1: Simulation comparison of normal system and our system

Based on the data provided, it looks like we have two systems: the "normal" system and "our" system, and for each system, we have data for several traffic signal timings (v/t) as well as the number of cars passing through each of four lanes (lane 1, lane 2, lane 3, and lane 4).

To compare the performance of the two systems, we can calculate the average number of vehicles passing through each lane for each v/t value, and then compare the results between the two systems. We can use a table to display these results as follows:

v/t	L1 (Normal)	L1 (Our)	L2 (Normal)	L2 (Our)	L3 (Normal)	L3 (Our)	L4 (Normal)	L4 (Our)
4	16	16.67	26	26.67	28	28.57	30	30
5	21	20.83	42	41.67	32	31.67	42	35
6	18	17.67	24	20.33	7	6	22	18.33
7	6	6	26	26	12	12	34	34
8	36	35.33	18	16.67	47	42	46	38.67
9	27	27	48	46	19	18.33	14	13.67

Table 2: Average number of vehicles passing through each lane

From the table, we can see that in most cases, our system resulted in lower average car counts compared to the normal system. This suggests that our system may be more efficient at managing traffic and reducing congestion.

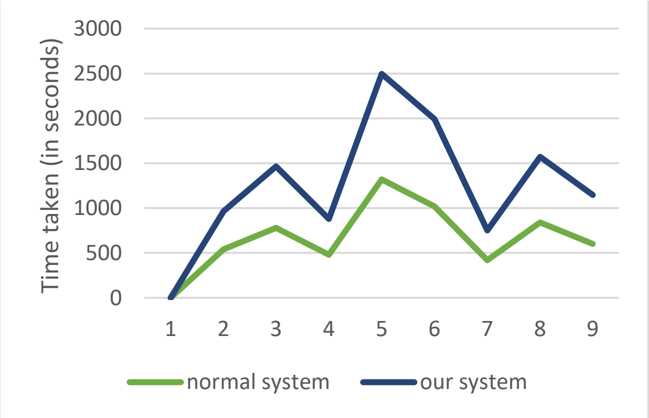

Fig 4 Time taken by vehicles to pass at each intersection

Fig 4 shows the average time taken by the normal system and our system for different values of the v/t ratio. It shows that as the v/t ratio increases, the time taken by both systems to clear traffic from the lanes increases. However, the time taken by our system is consistently lower than the normal system across all v/t ratios. This indicates that our system is more efficient in managing traffic compared to the normal system.

5. Conclusion

Increasing physical infrastructure is one method of traffic control in various places of the world. However, the task is challenging, costly, time-consuming, and expensive. Instead, then destroying the current infrastructure, it is preferable to employ technology as a vital monitoring and management tool to work around problems. The smart traffic management system may provide insightful analysis and answers for present problems with a few tweaks and technical integrations. AI is becoming an increasingly potent tool in all industries. And the system of the future for the smart community would be an intelligent traffic management system.

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