Utilizing Artificial Intelligence to Provide Intelligent Control of Traffic Lights

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Abstract

Mathematical programming can express competency concepts in a well-defined mathematical model for a particular. As both the population and the number of cars in cities continue to grow, one of the most pressing problems is the resulting increase in congestion. Not only can traffic jams make drivers' trips longer and more stressful, but they also increase the amount of gasoline they use and contribute to pollution in the air. Despite the fact that it appears to be present everywhere, the megacities are the ones that are most negatively impacted by it. In addition, the fact that it is always growing makes it essential to compute the road traffic density in real time in order to achieve more accurate signal control and more efficient traffic management. One of the most important aspects that determines how well traffic moves is the traffic controller. As a result, there is a growing requirement for improved traffic control that should be optimized to better meet these rising expectations. For the purpose of determining the volume of traffic at intersections, the system that we have designed will use image processing and artificial intelligence to analyze live footage captured by cameras installed there. In addition to this, it places an emphasis on the algorithm that determines when to change the color of the traffic lights based on the number of vehicles in an area. This helps to ease congestion, which in turn speeds up transit for pedestrians and reduces air pollution.

Keywords: Traffic control; Traffic light system; Traffic management; Intelligent transport systems; Smart surveillance; Computer Vision; Machine Learning; Object detection; YOLO.

1. Introduction

As a result of an increase in the number of cars found in urban areas, many road networks are currently experiencing issues with the capacity decrease of roads and the Level of Service that corresponds to this decline. At intersections, traffic management systems that use fixed signal timers are the root cause of many of the problems that arise with the flow of traffic. They keep cycling through the exact same phase sequence for the exact same amount of time.

Because of rising demand for road capacity, there is a growing need for innovative approaches to traffic control, such as those that are offered by the field of Intelligent Transport Systems.

Let us take the example of Mumbai and Bangalore as our case study. According to a survey that examined the state of traffic in 416 cities located in 57 different nations, the flow of traffic in Bangalore was found to be the worst in the world, with Mumbai following closely behind in fourth

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place. When traveling in Bangalore during rush hour, expect your trip to take 71% longer. In Mumbai, it is around 65% more drawn out [1].

There are currently three standard approaches that are utilized for the management of traffic, and they are as follows:

1) Manual Controlling: This method, as its name suggests, involves the use of human labor to manage the flow of traffic. The officers of the traffic police are designated space for a necessary component of the traffic control system. In order to maintain order and control the flow of traffic, the police are equipped with signboards, sign lights, and whistles.

2) Conventional traffic lights with fixed timers These are the lights that are regulated by timers that are always the same. The timer is set to a fixed numerical value that is loaded into it. The value of the timer causes the lights to alternate between a red and green configuration automatically.

3) Electronic Sensors One further cutting-edge strategy is to install some loop detectors or proximity sensors on the roadway. This sensor provides information regarding the flow of vehicles along the route. The traffic signals are managed using the information gathered from the sensors.

These more traditional approaches do come with a few limitations. The manual control method calls for a significant amount of labor from human operators. Because there are not enough members of the traffic police force, we are unable to have them manually control the flow of traffic in all regions of a city or town. Therefore, a more effective method of traffic control is required.

When controlling traffic in a static manner, a traffic light with a timer for each phase is utilized. This timer is permanent and does not adjust itself in response to the actual volume of traffic on the road. When using electronic sensors, such as proximity sensors or loop detectors, accuracy and coverage are frequently at odds with one another. This is due to the fact that the collection of high-quality information is typically based on complex and pricey technologies, and as a result, having a limited budget will result in a reduction in the number of facilities. In addition, because the majority of sensors have a limited effective range, the overall coverage of a network of facilities typically calls for a large number of sensors to be installed.

In recent years, video monitoring and surveillance systems have seen increased use in traffic management for a variety of purposes, including security, ramp metering, and providing travelers with information and updates in real time. The calculation of the traffic density and the classification of the vehicles may also be accomplished with the help of video monitoring systems. These systems can then be used to manage the timers of the traffic signals in order to maximize the efficiency of the flow of traffic and reduce the amount of congestion that occurs. The goal of the system that we have proposed is to create a traffic signal controller that is based on computer vision and has the ability to adjust itself to the current traffic scenario. Real-time traffic density calculations are performed with live images obtained from CCTV cameras installed at intersections. This is done by counting the number of vehicles waiting at the signal and adjusting the length of time the green light is illuminated. The cars, bikes, buses and trucks, and rickshaws are the several categories under which vehicles fall. obtain a precise estimate of the amount of time left till the green signal. YOLO is utilized in order to ascertain the total number of automobiles, after which it sets the timer of the traffic light will adjust itself in accordance with the number of vehicles traveling in the respective direction. This helps to optimize the green signal periods, and traffic is cleared at a much faster rate than a static system, so unnecessary delays, congestion, and waiting time are reduced. This, in turn, will minimize the amount of fuel consumed and pollutants produced.

2. Related Work

It is well known that to get an optimal solution for any linear programming problem using the direct simplex algorithm should be processed to be in standard form, the simplex method for solving an LP problem requires the problem to be expressed in the standard form. But not all LP problems appear in the standard form. In many cases, some of the constraints are expressed as inequalities rather than equations.

A solution that makes use of video processing is suggested in Reference [2]. The video coming from the live feed is processed before it is uploaded to the servers, where it is then analyzed using an

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algorithm written in C++ to produce the results. Methodologies that are hard coded and those that use dynamic coding are compared; the results showed that the dynamic algorithm was 35% more effective. In reference [3,] a system that is based on Arduino-UNO is proposed with the goal of reducing traffic congestion as well as waiting time. This system collects photographs using the camera, which are then processed in MATLAB. During this processing, the image is changed into a threshold image by reducing saturation and colours, and the system then calculates the traffic density. The connection between Arduino and MATLAB is made through the use of USB and several simulation programs that come preloaded. The duration of the green light at each lane is determined by the Arduino, taking into account both the total number of vehicles and their density. But there are a few problems with this approach. Due to the fact that the automobiles frequently collide with one another, it is difficult to gain an accurate count of the number of vehicles currently on the road. In addition, many things hampered the detecting process because they, too, were transformed into black and white. Furthermore, there was no method to differentiate between automobiles and everyday objects such as billboards, poles, and trees.

The idea presented in reference [4] for a traffic signal managed by fuzzy logic that is able to adapt to the existing traffic conditions is intriguing. The major and secondary driveways are each managed by their own separate fuzzy controller in this system, each of which has three inputs and one output. A simulation was carried out with VISSIM and MATLAB, and the results showed that the traffic conditions were improved for low traffic densities. A smart traffic signal system that makes use of artificial neural networks (ANN) and fuzzy controllers is proposed in reference [5]. This system makes use of photos obtained from cameras that have been installed at various traffic locations. Before continuing with the normalization process, the image is first transformed into a grayscale image. After that, segmentation is carried out by utilizing the sliding window technique in order to count the cars regardless of their size. Next, ANN is applied to the segmented image, and the output of this application is utilized by the fuzzy controller in order to set durations for the red and green lights utilizing crisp output. The results had an error rate that was an average of 2%, and the execution duration was 1.5 seconds.

A support vector machine method and several image processing techniques are utilized in the research referred to in Reference [6]. The algorithm is applied after images taken from live video are collected in small frames. OpenCV is used to perform image processing, and the resulting images are then transformed to grayscale images before the SVM algorithm is implemented. This device not only detects the volume of traffic, but it also identifies drivers that disobey the traffic lights. The use of adaptive light timer control is suggested in reference [7], which makes use of image processing techniques in conjunction with traffic density. This system is made up of a traffic light timer that is controlled by a microcontroller, high image sensing devices, MATLAB, and transmission that is based on the UART principles. Having said that, this system neither the authorized emergency vehicles nor any accidents that may have occurred at the intersection are given priority by the system.

The following reference (number 8) discusses a variety of methods that are utilized for traffic light control systems. In this research, it is observed that each method shares a similar design, which includes the following steps: selecting the input data, acquiring the traffic parameters from the input data, processing the data, determining the density, and updating the parameters.

• In the first technique, vehicle area networks, or VANETs, are used to obtain information about each car, including its location. This data is then sent to the nearest intelligent traffic light with the assistance of any installed GPS. Additionally, these ITLs will update the statistics and send the information to vehicles that are close. The information would be transmitted to drivers in the event of accidents, allowing them to select an alternative route to use in order to avoid congestion. However, because the implementation of this method requires a significant investment, it is not a viable option.

• In the second approach, infrared sensor-based microcontrollers are utilized. These microcontrollers capture the one-of-a-kind identification number of each vehicle by utilizing a transmitter and a receiver. In the event of a critical circumstance, the radio frequency tags on a car can be utilized to identify the vehicle and clear the way for other vehicles to proceed. Using this strategy, infractions of the red light can be found. However, due to the necessity of visible light for the infrared sensors, this method does not lend itself well to flexibility.

• The fuzzy logic technique is employed in the third method. Within this method, there are two fuzzy logic controllers that are used. One controller is used to optimize the signal, and the other controller is used to lengthen the green phase of a road within an intersection. The video cameras that are

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positioned at both the incoming and the outgoing lines serve as the sensors that are used to capture input data. After then, the controller will use the data obtained from these sensors in order to arrive at the best possible decisions and achieve the greatest possible reduction in the goal function.

• The fuzzy logic approach is employed in the fourth method, and the input parameters for the system are the number of cars and the average speed of traffic flow in each direction. With sensors strategically positioned along the roadway, it is possible to ascertain both the total number of cars and the typical flow rate of the flow of traffic.

• In the fifth approach, photoelectric sensors are employed. These sensors are spaced a certain distance apart from one another, and they collect data that is then sent to a traffic cabinet. The traffic cabinet then calculates the weight of each road, and it adjusts the traffic light accordingly. On the other hand, the expense of upkeep is relatively considerable. The sixth approach involves the use of video imagery to accomplish the task of data collection. In order to obtain a clear picture of the vehicle, a dynamic backdrop subtraction as well as a number of different morphological processes are carried out. A fresh rectangle is drawn and the total number of vehicles in the area of interest is increased whenever a new vehicle enters the zone of interest. Although the approach is simple to build, it does not take into account occlusion or the overlapping of shadows.

3. Proposed System

A. Overview

The image captured by the CCTV cameras installed at intersections is used as the basis for the real-time estimate of traffic density that our system is designed to perform using image processing and object recognition. This image is then sent on to the vehicle detection algorithm, which makes use of the YOLO algorithm, as illustrated in Figure 1.

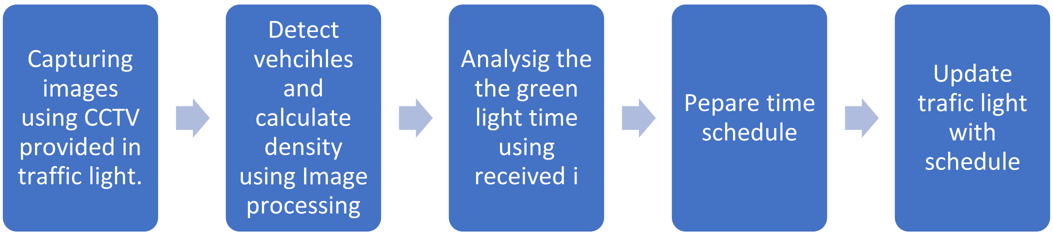

Figure 1: Flow chart of control system for traffic lights

The quantity of automobiles, bicycles, buses, and trucks can be broken down into the following categories: identified, which is to compute the volume of the traffic that was found. The algorithm that controls the switching of signals makes advantage of, among other things, this density.

Factors, in order to establish the timer for the green signal for each lane. The times for the red signal have been adjusted accordingly. In order to prevent one lane from becoming abandoned, the amount of time that the green light is active is limited relative to both a maximum and a minimum value. A simulation is also constructed so that the effectiveness of the system can be demonstrated and contrasted with the effectiveness of the present static system.

B. Vehicle Detection Module

The suggested system uses a method known as YOLO, which stands for "You only look once." This method gives the level of accuracy and processing speed that are sought. A specialized YOLO model was developed and trained for the purpose of detecting vehicles. This model is capable of detecting a wide variety of vehicles, including automobiles, bikes, big vehicles (such buses and trucks), and rickshaws. The YOLO convolutional neural network (CNN) is an innovative tool for detecting objects in real time when they are being searched for. After applying a single neural network to the entirety of the image, the algorithm continues.

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forecasts bounding boxes and probabilities for each of the image's areas after first dividing it up into those regions. The projected probabilities are used to provide a weight to each of these bounding boxes. YOLO's widespread use can be attributed to the fact that it not only maintains a high level of precision but also operates in real time. The method "only looks once" at the image in the sense that it only needs one forward propagation pass through the neural network in order to create predictions. In other words, "only looks once" at the image. After non-max suppression, it then outputs the recognized objects along with the bounding boxes. This step ensures that the object detection algorithm will only ever discover each object once. Using YOLO, a single CNN can make simultaneous predictions of multiple bounding boxes as well as the class probabilities for those boxes [9].

It is possible to further simplify the backbone CNN that is utilized in YOLO in order to improve processing time. Darknet is a framework for developing neural networks that is open source and built in C and CUDA. It is quick, has a straightforward installation process, and is compatible with both CPU and GPU computing [11]. Using Dark Net, YOLO was able to reach 91.2% accuracy in the top-5 on ImageNet and 72.9% accuracy in the top-1. The majority of Darknet's feature extraction is done with 3 3 filters, while the rest is done with 1 1 filters. decrease the number of output channels. In addition to that, it employs pooling based on the worldwide average. Make some educated guesses [10].

The training dataset was produced by extracting photos from Google and manually labeling them using LabelIMG, which is a graphical image annotation tool [12]. This allowed the model to be trained using accurate data. After that, the model was trained with the pre-trained weights that were obtained from the YOLO website and downloaded. The.cfg file that was utilized for training had its configuration altered so that it better matched the requirements of our model. By modifying the 'classes' variable, it was possible to ensure that the number of output neurons in the final layer were proportional to the number of categories that the model was designed to identify.

According to our records, these were the following: car, bike, bus or truck, and rickshaw. It is also necessary to adjust the number of filters by applying the formula 5*(5+number of classes), which results in 45 in our scenario. Following the implementation of these configuration adjustments, the model was trained until the loss was greatly reduced and no longer appeared to be decreasing. This signaled the conclusion of the training, and at this point, the weights were adjusted so that they better suited our needs. After that, these weights were brought into the code and put to use for the detection of vehicles with the assistance of the OpenCV library. A threshold is the level of confidence that must be reached before a detection may be considered successful.

After the model has been loaded and an image has been given to it, the output is returned in the JSON format, which means that it is in the form of key-value pairs. Labels serve as the keys, while the confidence and coordinates of the labels serve as the values. Once again, OpenCV may be utilized to draw the bounding boxes on the photos based on the incoming labels and locations. The results of our vehicle detection model being applied to some test photos may be shown in Figure 2.

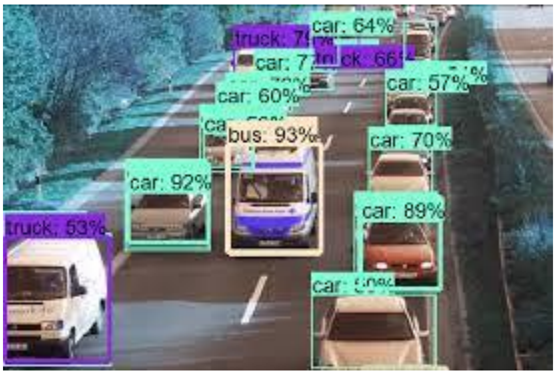

Figure 2: The output includes bounding boxes and labels that correspond to the boxes

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C. Signal Switching Module

The Signal Switching Algorithm is responsible for adjusting the red signal timers of other lights in accordance with the traffic density that is given by the vehicle detecting module and setting the green signal timer in accordance with that information. In addition to this, it toggles between the signals in a cyclical manner in accordance with the times. The algorithm utilizes the data regarding the automobiles that are present. were picked up by the picking up module as detection output, as was covered in the part before this one, as input. The format is JSON, and the following elements are:

The label of the object that was found will serve as the key, and the confidence level and coordinates will serve as the values. After receiving this input, it is then subjected to parsing so that the total number of vehicles in each class may be determined. After this, the green signal time for the signal is calculated and assigned to it, and the red signal times for the other signals are changed correspondingly to reflect the new information. The approach is scalable, meaning that it can be used to an any number of signals at an intersection. During the process of designing the algorithm, several considerations were taken into account:

1) The amount of time it takes for the algorithm to complete its calculations in order to determine the traffic density and then the length of time the green light is on determines when the image needs to be acquired.

2) The number of available lanes

3) The total number of vehicles that fall into each category, including automobiles, lorries, motorbikes, and so on.

4) The number of vehicles per hour determined by considering the preceding elements

5) Time added because of the delay that each vehicle has at start-up, as well as the non-linear rise in delay that the vehicles that are farther in the back experience. [13]

6) The average speed of each category of vehicles when the green light begins to flash, also known as the average amount of time needed by each category of vehicles to pass the signal [14]

7) The minimum and maximum time limits for the length of the green light, to prevent people from starving to death

When the algorithm is first executed, the default time that will be used for the first signal of the first cycle is established. The times that will be used for all of the other signals that occur during the first cycle as well as all of the signals that occur during following cycles are set by the algorithm. A new thread is initiated that is responsible for the detection of cars in each direction, and the primary thread is the one that manages the timer for the signal that is currently active. When the red-light timer of the next green signal reaches 5 seconds, the detecting threads take a snapshot of the next direction. This occurs when the green light timer of the current signal reaches 5 seconds. Following this, the result is analyzed, and the timer for the subsequent green signal is set. All of this activity takes place in the background as the primary thread works to reduce the remaining time on the timer for the currently active green signal. Because of this, the assignment of the timer can take place without any interruptions, which eliminates any possibility of lag. As soon as the green timer of the current signal reaches its end, the following signal will become green for the amount of time that was determined by the algorithm.

The picture is taken at the point in time when the time remaining until the signal turns green again is five seconds. This provides the system a total of ten seconds to process the image, detect the number of cars of each class present in the image, calculate the green signal time, and set the times of this signal as well as the red signal time of the following signal accordingly. In other words, the system has 10 seconds to do all of these things. We used the average speeds of vehicles at startup as well as their acceleration times to get an estimate of the amount of time it takes for each class of vehicle to travel through a junction [14]. With this information, we were able to determine the optimal length of time for a green signal based on the number of vehicles in each category that were stopped at a signal. After that, the time for the green signal is determined by utilizing (1).

$$GST = \frac{\sum_{Vehhicles\ class} (No.of\ vehicles * Average\ time)}{(No.of\ Lanes + 1)} \quad (1)$$

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where:

• The Goods and Services Tax is the go-ahead signal

• no. of Vehicles of Class is the number of vehicles of each class of vehicle that were detected by the vehicle detection module at the signal;

• average Time of Class is the average amount of time it takes for vehicles of that class to travel through an intersection; and

• no. of Lanes is the number of lanes that were present at the intersection.

To improve the efficiency of traffic management, the amount of time that it takes each type of vehicle, on average, to travel through an intersection can be regulated according to its location. This can be done in terms of the area, the city, the locality, or even the intersection itself, depending on the particulars of the site in question. The information provided by the relevant transportation agencies can be evaluated for this purpose.

The signals change in a cyclical manner rather than going in the direction with the highest density initially as one might expect. This is in conformity with the current system, in which the lights turn green one after the other in a regular pattern. This does not require the people to alter their ways or cause any confusion as it does not require the people to change their ways. In addition, the order of the signals is the same as it is in the existing system, and yellow signals have been taken into consideration as well. The order of the signals is as follows: red→ green→ yellow→ red.

D. Simulation Module

For the purpose of simulating traffic in real life, a simulation was built from the ground up using Pygame. It helps in visualizing the system and comparing it to the static system that is already in place. It includes a four-way intersection that is served by four traffic signals. On the top of each signal is a timer that indicates how much time is left until the signal changes from green to yellow, yellow to red, or red to green, respectively. Alongside each signal is a counter that indicates how many cars have successfully navigated the intersection since it was activated. There is traffic coming from every way, consisting of automobiles, bicycles, buses, and trucks, as well as rickshaws. To further the realism of the simulation, we've made it such that some of the cars in the far-right lane are now turning left to go through the intersection. During the process of generating a vehicle, random number generation is also used to determine whether or not the vehicle will turn. In addition to that, it has a timer that shows the amount of time that has passed since the beginning of the simulation. A screenshot of the complete results of the simulation can be found in Figure 3.

Figure 3: Simulation output

Pygame is a suite of Python modules that can be used across several platforms and was developed specifically for the purpose of building video games. The computer graphics and sound libraries included in this package were developed specifically for use with the Python programming language. Pygame is an extension that adds capabilities to the already powerful SDL library. Python users are

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given the ability to construct games and programs with a full complement of features thanks to this. language. Pygame is extremely portable software, as it is capable of running on the vast majority of platforms and operating systems. It can be used without charge and is licensed under LGPL [15].

4. Results

A. Evaluation of vehicle detection module

The accuracy of the vehicle detection module was measured using a variety of test photos including a different number of cars, and the results showed that it had a detection accuracy of between 75 and 80 percent. A few of the findings from the tests are displayed up there in Figure 3. This is good enough, but it's not the best possible. The absence of an adequate dataset is the key contributor to the poor level of accuracy. The accuracy of the system can be increased by training the model with real-world footage captured by traffic cameras. This will allow for greater precision in the system's predictions.

B. Evaluation of the proposed adaptive system

15 simulations of both the proposed adaptive system and the existing static system were run, each for a period of five minutes and with various traffic distributions across all four directions. This was done so that the performance of the proposed adaptive system could be compared to that of the existing static system. The effectiveness of the solution was evaluated according to the number of vehicles that were able to navigate the intersection in a given amount of time. In other words, the idle time of the signal, which refers to the period of time when the light at the intersection is green but no vehicle travels through it, is compared. This has an effect on the amount of time that vehicles have to wait, as well as the length of the lines at the other signals.

The chance of a vehicle being in lane 1, lane 2, lane 3, or lane 4 is denoted by the fractions a/d, (b-a)/d, (c-b)/d, and (d-c)/d, respectively, while the distribution is denoted by the letters a, b, c, and d. For illustration purposes, the distribution in simulation 1 is [300,600,800,1000], which translates to probabilities of 0.3, 0.3, 0.2, and 0.2, respectively. The data that was collected was categorized into the following categories: number of cars passed lane-wise; total number of vehicles passed; and total number of vehicles passed.

As can be shown in figure 4, the performance of the proposed adaptive system is always superior to that of the existing static system, regardless of the distribution. The degree of unevenness in the distribution of traffic across the lanes will determine how much of an improvement in performance may be expected. The skewness of the distribution of traffic has a direct correlation to the level of performance improvement.

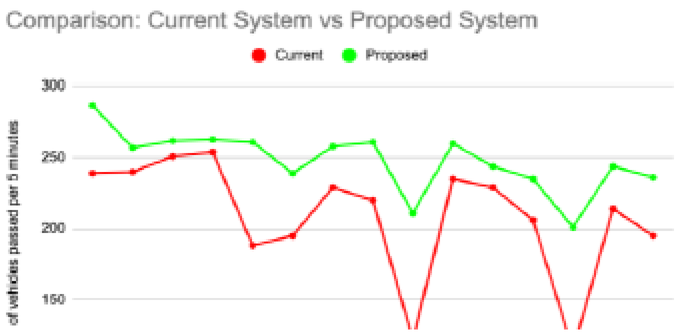

Figure 4: Comparison of current static system and proposed adaptive system

• The performance of the proposed system is only marginally superior to that of the existing system in situations in which the distribution of traffic among the four lanes is equal or nearly equal.

This is the situation in simulations 1, 2, 3, and 4, respectively.

The performance has improved by approximately 9% in this case.

• When there is a moderately skewed distribution of traffic, the performance of the proposed system is much better than the performance of the existing system. The simulations numbered 5, 6, 7, 8, 14, and 15 all exhibit this behavior. The performance has been improved by approximately 22% here. This form of traffic distribution is typically observed in situations that take place in real life.

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• When there is a significant imbalance in the distribution of traffic, the suggested system shows a significant improvement in performance in comparison to the system that is already in place. This occurs in simulations number 9 and 13, when there is a significant disparity between the red line and the green line after the red line experiences a severe decline. The performance has improved by around 36% in this regard. Keeping all of the simulation conditions, such as the distribution of, the same simulations were ran for a variety of factors, including traffic, speeds of cars, the chance of vehicles turning, the spacing between vehicles, and so on. A total time period of 1 hour and 15 minutes, with 300 seconds, which is equivalent to 5 minutes for each distribution, and it was discovered that the suggested system, on average, boosted the performance by approximately 23% when compared to the existing system which has fixed times.

This means a reduction in the amount of time that the green signal remains inactive, as well as the amount of time that vehicles wait. When compared with the outcomes of other adaptive systems, it was discovered that the performance of the suggested system is superior than that of some of the other adaptive systems. As an illustration, [2] provides an accuracy of 70%, whereas the proposed approach provides an accuracy of 80%. When compared to static systems, Reference [3] achieves an improvement in performance that is an average of 12%, while the suggested system achieves an improvement that is an average of 23%.

5. Conclusion

In conclusion, the system that has been presented adjusts the length of time that a green light is displayed dynamically in accordance with the volume of traffic that is present at the signal. This guarantees that the direction that has a greater volume of traffic is given a green signal for a longer period of time in comparison to the direction that has a lesser volume of traffic. Because of this, there will be fewer unwelcome delays, less congestion, and shorter wait times, all of which will, in turn, result in less pollution and use of fuel.

The results of the simulation demonstrate that the system shows a significant improvement over the present system in terms of the number of vehicles crossing the intersection. Specifically, the system shows an improvement of roughly 23% over the current system. This system is capable of being upgraded to perform even better if it undergoes additional calibration utilizing real-life CCTV footage for the training of the model.

Additionally, in comparison to the existing intelligent traffic control technologies that are now in use, such as Pressure Mats and Infrared Sensors, the system that has been developed has a few distinct advantages. Because the footage from CCTV cameras located in traffic signals is used, the costs associated with deploying the system are insignificant. This eliminates the need for any extra hardware in the majority of instances, as junctions that experience considerable traffic are typically already equipped with such cameras.

It's possible that only some minor alignment will be required. When compared to the costs of maintaining other traffic monitoring systems, such as pressure mats, which generally experience wear and tear as a result of their installation on roadways where they are constantly subjected to intense pressure, the cost of maintaining the radar system is far lower. Therefore, the suggested system is capable of being connected with the closed-circuit television cameras that are already present in large cities in order to assist improved traffic control.

This project has the potential to be expanded further to include the following functions, which, when combined, will improve traffic management and reduce congestion:

1) The identification of vehicles that are breaking the laws of the road: By establishing a violation line in an image or a video stream and taking a picture of the vehicle's license plate whenever the line is crossed when the light is red, it is possible to determine which vehicles have disobeyed the law and take appropriate action. Alternating lanes is another behavior that can be recognized in this manner. These effects can be created by subtracting the backdrop from a picture or by using other image processing techniques.

2) Detection of accidents or mechanical failures: Additionally, intersections have a propensity to be the sites of serious collisions due to the fact that multiple types of accidents that can cause serious injuries, such as angle and left-turn collisions, frequently take place there. Consequently, due to the need of precise and timely accident detection at intersections provide enormous benefits, including the prevention of property damage and loss of life, as well as the reduction of traffic congestion and travel time. This can be accomplished by recognizing the vehicles that remain motionless for an

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extended period of time in an improper place, such as in the middle of the road. This will ensure that parked vehicles are not counted toward the total number of vehicles in this category.

3) The synchronization of traffic lights at several intersections: The synchronization of traffic signals along a street can be of value to commuters since, once a vehicle enters the street, it may proceed with minimum halting if the signals are synchronized.

4) Making accommodations for emergency vehicles The traffic signals should be modified to allow emergency vehicles, such as ambulances, to move through the intersection more quickly. The model is capable of being trained to not only detect cars, but also be able to recognize that it is an emergency vehicle and consequently alter the timers in such a way that the emergency vehicle is given precedence and is able to cross the signal at the earliest possible moment.

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