ISSN: 2249-7196
IJMRR/April. 2025/ Volume 15/Issue 2s/425-431
Dunna Nandi Vardhan/ International Journal of Management Research & Review

Smart Control of Traffic Light Using Artificial Intelligence

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Abstract ***The rapid growth of urbanization has led to increased traffic congestion, making efficient traffic management a critical challenge for smart cities. Traditional traffic light systems operate on fixed timers, which often fail to adapt to real-time traffic conditions, resulting in unnecessary delays and fuel consumption. This project proposes an intelligent traffic light control system powered by Artificial Intelligence (AI) to dynamically manage signal timings based on real-time traffic flow data. By leveraging AI techniques such as machine learning and computer vision, the system analyzes traffic density through camera feeds or sensor data and optimizes signal duration accordingly. The model continuously learns from historical traffic patterns to improve decision-making over time. The implementation of such an AI-based solution aims to reduce waiting time, fuel consumption, and traffic congestion, ultimately enhancing road efficiency and commuter satisfaction. This project demonstrates the potential of AI in building adaptive, responsive, and efficient urban traffic control systems.***

1. INTRODUCTION With the increasing number of vehicles in urban areas, many road networks are facing problems with the capacity drop of roads and the corresponding Level of Service. Many traffic-related issues occur because of traffic control systems on intersections that use fixed signal timers. They repeat the same phase sequence and its duration with no changes. Increased demand for road capacity also increases the need for new solutions for traffic control that can be found in the field of Intelligent Transport Systems. Let us take the case study of Mumbai and Bangalore. Traffic flow in Bangalore is the worst in the world while Mumbai is close behind in fourth position, according to a report detailing the traffic situation in 416 cities across 57 countries. In Bangalore, a journey during rush-hour takes 71% longer. In Mumbai, it is 65% longer [1]. There are three standard methods for traffic control that are being used currently: 1) Manual Controlling: As the name suggests, it requires manpower to control the traffic. The traffic police are allotted for a required area to control traffic. The traffic police carry signboard, sign light, and whistle to control the traffic. 2) Conventional traffic lights with static timers: These are controlled by fixed timers. A constant numerical value is loaded in the timer. The lights are automatically switching to red and green based on the timer value. 3) Electronic Sensors: Another advanced method is placing some loop detectors or proximity sensors on the road. This sensor gives data about the traffic on the road. According to the sensor data, the traffic signals are controlled. These conventional methods face certain 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. While using electronic sensors i.e., proximity sensors or loop detectors, the accuracy and coverage are often in conflict because the collection of high-quality information is usually based on sophisticated and expensive technologies, and thus limited budget will reduce the number of facilities. Moreover, due to the limited effective range of most sensors, the total coverage on a network of facilities usually requires a lot of sensors. In recent years, video monitoring and surveillance systems have been extensively used in traffic management for security, ramp metering, and providing information and updates to travellers in real-time. The traffic density estimation and vehicle

classification can also be achieved using video monitoring systems, which can then be used to control the timers of the traffic signals so as to optimize traffic flow and minimize congestion. Our proposed system aims to design a traffic light controller based on Computer Vision that can adapt to the current traffic situation. It uses live images from the CCTV cameras at traffic junctions for real-time traffic density calculation by detecting the number of vehicles at the signal and setting the green signal time accordingly. The vehicles are classified as a car, bike, bus/truck, or rickshaw to obtain an accurate estimate of the green signal time. It uses YOLO 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.

2. LITERATURE SURVEY

“Smart Control of Traffic Light System using Image Processing”

The congestion of the urban traffic is becoming one of critical issues with increasing population and automobiles in cities. Traffic jams not only cause extra delay and stress for the drivers, but also increase fuel consumption, add transportation cost, and increase carbon dioxide air pollution. The traffic controller is one of critical factors affecting the traffic flow. The conventional traffic patterns are nonlinear and complex and time dependent rather than traffic dependent. This paper proposes a traffic control system based on image processing using MATLAB code which changes the time of green, amber and red light with respect to the traffic density and traffic count. Two Arduino UNO is used, one for controlling green and amber lights and other for controlling red light. This is a continuous process.

"Improving Traffic Light Control by Means of Fuzzy Logic,"

In urban areas, the traffic demand grows every year due to the constantly increasing number of vehicles. The consequence is a capacity drop of the roads followed by traffic problems like congestion, reduced travel time, increased fuel consumption, etc. This paper presents an adaptive traffic light controller based on fuzzy logic for improving the traffic flow on an isolated intersection. A set of fuzzy rules has been made that, using the collected information from road detectors (queue length, arrival flow, and exit flow), computes the amount of time for which the next phase should be shortened or extended. The proposed fuzzy control system is constituted of two parts: one for the primary driveway (with a higher volume of vehicles) and for the secondary driveway (with a lower volume of vehicles). The proposed controller is compared with a fixed signal program in three scenarios with different traffic demand proofing the effectiveness of the developed decision rules.

"Smart controlling for traffic light time,"

Traffic jam and traffic accidents become serious problems especially in crowded cities, which wasting time and money. Traffic light is basic element in control traffic flow through specify waiting and going time, fixed traffic light time systems is bad control way, since number of cars is not consistency with each traffic light, thus lead to imbalance system. Intelligent transportation system including smart way to control traffic light time based on number of cars in each traffic light, this paper develops an automatic algorithm to control traffic light time based on artificial intelligent techniques and image for cars on traffic lights, this algorithm is validated by compare its results with manual results. Applying following proposed algorithm in transportation system will regulate traffic flow and reduce traveling and waiting time wasted in roads.

"Traffic Light Control and Violation Detection Using Image Processing”

Now a days as the population increases the transportation demands are increased. The total number of vehicles required to fulfil the transportation needs too are increased just as population have increased. Increase of the vehicle usage leads to heavy traffic in the road. It happens due to the current traffic control method and the road

infrastructure. It will affect the human as well as fuel resources by wasting time in the road because of the heavy traffic. In order to reduce the wastage of time as well as the wastage of fuel in the road traffic an effective and a smart traffic control strategy is required. The traditional way of traffic control provides a time slot for each direction of road. Another advanced method is placing some proximity sensors on the road. This sensor gives the data about the traffic on the road. According to the sensor data the traffic signals are controlled. This project proposes a new way of traffic control. A digital camera installed with traffic signal light used to capture the live road images. Then the captured images are fed into digital image processor to find the traffic density on the road then the traffic signals are controlled. The proposed system helps to use the time and fuel resources efficiently by avoiding the time wasted on the empty road.

"Smart traffic lights switching and traffic density calculation using video processing,"

Congestion in traffic is a serious problem nowadays. Although it seems to pervade everywhere, mega cities are the ones most affected by it. And it's ever increasing nature makes it imperative to know the road traffic density in real time for better signal control and effective traffic management. There can be different causes of congestion in traffic like insufficient capacity, unrestrained demand, large Red Light delays etc. While insufficient capacity and unrestrained demand are somewhere interrelated, the delay of respective light is hard coded and not dependent on traffic. Therefore the need for simulating and optimizing traffic control to better accommodate this increasing demand arises. In recent years, video monitoring and surveillance systems have been widely used in traffic management for traveler's information, ramp metering and updates in real time. The traffic density estimation and vehicle classification can also be achieved using video monitoring systems. This paper presents the method to use live video feed from the cameras at traffic junctions for real time traffic density calculation using video and image processing. It also focuses on the algorithm for switching the traffic lights according to vehicle density on road, thereby aiming at reducing the traffic congestion on roads which will help lower the number of accidents. In turn it will provide safe transit to people and reduce fuel consumption and waiting time. It will also provide significant data which will help in future road planning and analysis. In further stages multiple traffic lights can be synchronized with each other with an aim of even less traffic congestion and free flow of traffic.

'Overview of the YOLO Object Detection Algorithm'

Object detection has been known as the core of computer vision and attracted much research attention in recent years especially because of its close relationship with video analysis and image understanding. According to the abundant research on object detection, many traditional object detection methods have been proposed. This paper introduces some famous traditional methods, which are based on SIFT, HOG, SURF, and ORB. However, due to the characteristics of large amount of computation and simple training structure, the traditional detection method has low detection speed. With the fast rise of deeper learning, stronger devices are implemented to address the problems that exist in conventional architectures. In the architecture of the network, training and optimization functions etc., these models are special. In this paper, we review the frameworks for object detection based on deep learning. We begin our review with the methods based on Convolutional Neural Networks. Then typical methods of object detection and some helpful modification to improve detection performance are introduced. Moreover, the methods based on YOLO and SSD are introduced. In fact, despite of the same basis of algorithm or features, the performance and features of different methods are various. Thus in this paper we analyze the features and architecture of each method. This also offers some research to equate various approaches and draw some concrete conclusions. In this paper, we also introduce some typical datasets used for testing or training the object detection model. This paper made a systematic classification

and summary in the object detection field, which can be meaningful and useful for the scholars who started to learn about it.

'Traffic Signal Synchronization'

The delay, which decides the level of service and gauges the performance of a facility, is one of the most concerned aspects of transport planners and road users in the field of transportation. Because of the issue of rapid urbanization and vehicular growth, urban traffic is getting over congested which increases travel time, fuel utilization, environmental loss etc. It is a severe worry in developing nation like India. Signal Coordination is one of the most cost effective ways to overcome the delay proposed in this research. Signal Coordination improves traffic flow by arranging a green time of downstream traffic signal to coincide with the appearance of the platoon. Different techniques for homogeneous traffic conditions and strict lane conditions have been developed, according to the literature. Very limited studies have been done on heterogeneous traffic conditions and lane change behavior, like in India. The main intension of signal synchronization is to focus on reducing delay experienced by the vehicles while traveling through the signalized intersection corridor and developed a co-ordinate signalized intersection network. The present paper deal with the various aspect of signal synchronization based on the past experience of various researches. It is also tried to identify the appropriate parameters along with the appropriate methodology correlated with Indian traffic scenario. Several important parameters have been found to be traffic composition, cycle length, traffic volume, phase sequence, offsets, saturation flow etc. It has been observed that sign at synchronization and they related aspect should be while designing the signal system in urban areas.

3. SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

In India traffic is enlarge four times faster than population. Nowadays, so many countries suffer from the traffic congestion issues that affect the transportation method in cities and cause serious trouble. Even though replacing traffic officers and custodian by automatic traffic systems, the optimization of the heavy traffic jam is still a big issue to be faced, especially with several junction nodes. Traffic jams also build many other critical issues and problems which straightly affect the human routine lives and sometime reason for death for example if there is an emergency vehicle like ambulance on the roadway going with critical patient. In that situation if an ambulance gets stuck in a large traffic j am then there are high chances that the patient can't reach the hospital on time. It is very key to design an advanced traffic system which controls traffic intelligently to avoid accidents, collisions and traffic jams.

Disadvantage:

1. Less Accuracy

PROPOSED SYSTEM:

Our proposed system aims to present a traffic light controller based on Computer Vision that can adapt to the current traffic situation. It uses live video feed from the CCTV cameras at traffic junctions for real-time traffic density calculation by detecting the vehicles at the signal and setting the green signal time accordingly. The vehicles are classified as car, bus/truck, or rickshaw to obtain a more accurate estimate of the green signal time. We have used object detection like computer vision in order to detect the number of vehicles for each direction. We then set the timers of these traffic signals according to vehicle density in each direction and hence the system becomes adaptive. This helps to optimize the green signal times, and traffic is cleared at a far quicker rate than a static system, therefore reducing the unwanted delays, congestion, and waiting time, which in turn will reduce the fuel consumption and pollution

Advantage:

1. More Accuracy.

MODULES

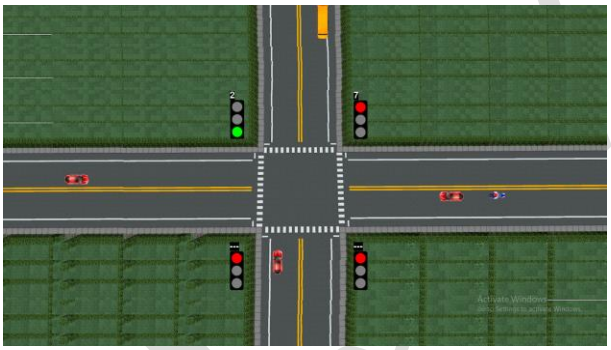
- Run traffic simulation
- Run yolo traffic detection and tracking

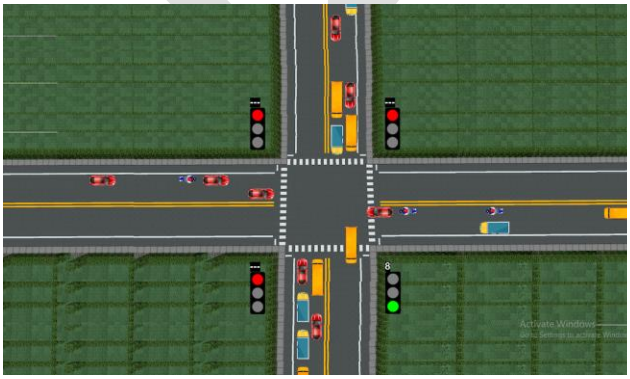
- EXIT

RESULT

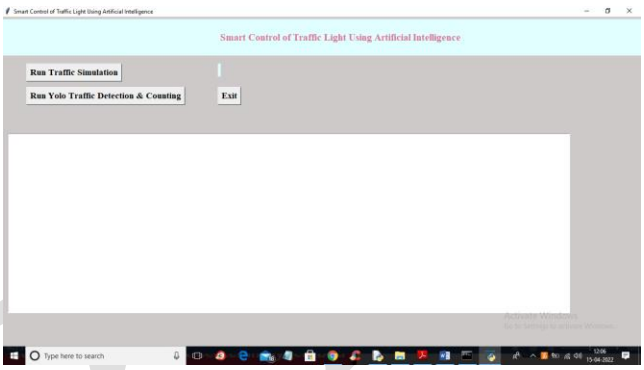
To run project double click on 'run.bat' file to get below output

In above screen click on 'Run Traffic Simulation' button to start PYGAME simulation and get below output

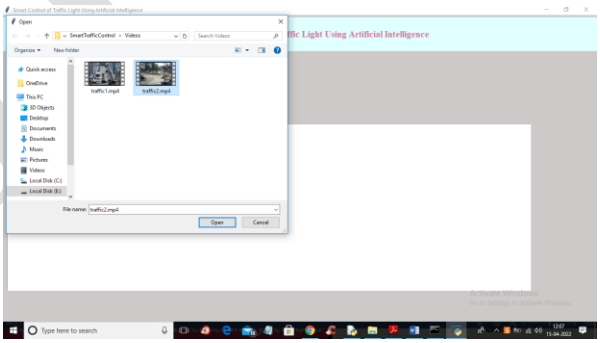




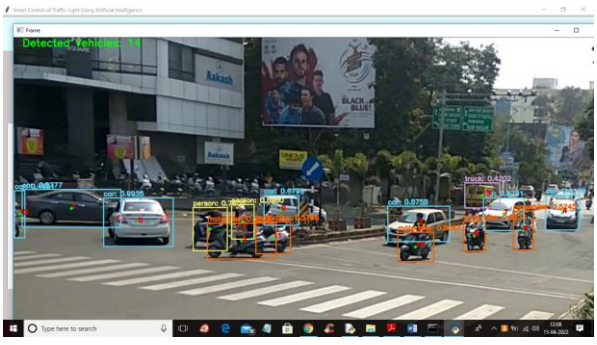
In above screen you can see PYGAME simulation output and at each lane traffic density is calculated and then adjust green and red line. This simulation run in INFINITE loop so you press 'windows' key from keyboard and then close application and then restart and run second YOLO module



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

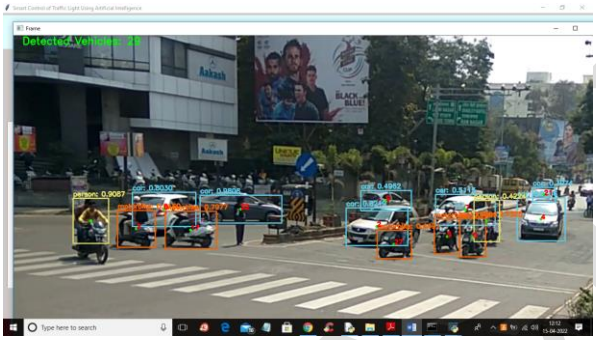


In above screen selecting and uploading 'traffic2.mp4' video and then click on 'Open' button to get below output



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.



8. CONCLUSION

Our method is proposing a solution to lessen down congestion on roads and will also look after to reduce accidents. We proved here the solution of daily traffic and fatal accidents. Thus above proposed theory will make our roads safer place to travel.

In future detectors can be placed in emergency vehicles so our traffic signal can easily detect. Control center can work automated removing all manual help.

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