ADVANCED TRAFFIC CONTROL SYSTEM

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Abstract

As urban population and car ownership in cities continue to rise, traffic congestion emerges as a major problem. Gridlock in the road inconveniences everyone. Despite appearing to be widespread, big cities seem particularly vulnerable. One of the key elements in traffic management is a traffic controller. This project aims to reduce traffic congestion, leading to less fuel consumption and minimizing air pollution. It can be achieved by making use of live data collected from CCTV cameras placed at the junction to calculate traffic density using image processing and AI. YOLO algorithm is used to detect vehicles and estimate traffic density. The smart traffic control system switches traffic lights based on the traffic density to reduce congestion thus allowing people to move faster and thus reducing air pollution.

Keywords: Image processing, Artificial Intelligence, Traffic signal, Computer Vision, YOLO, Traffic management, Traffic congestion, vehicle detection

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1. SCOPE

The idea of proposed system is to combine computer vision and artificial intelligence to minimize traffic congestion. The YOLO algorithm is utilized to create a sophisticated traffic control system. Various researchers are working on developing a system that demonstrates how the application of AI may make traffic control systems more dynamic and responsive. They are currently employing simulations that increase in complexity and evolve, assisting their algorithms in learning how to predict traffic shifts to manage traffic.

2. INTRODUCTION

The increasing number of vehicles in metropolitan areas is causing capacity cuts and corresponding Levels of Service on a number of road network systems. Mainly Fixated signal timing in traffic management systems is a common source of gridlock. Rising traffic volumes necessitate innovative traffic management methods, and that's where Intelligent Transport Systems come in. According to recent studies, four Indian cities stand in the list of top 10 cities in the world with worst traffic congestion. As per a recent TomTom report on 2022’s traffic trends, the slowest city to drive in India is Bangalore, Pune stands in second place in India, New Delhi stands in third place and Mumbai stands in fourth place in India where there is heavy traffic. Real time road traffic density calculations are necessary to ensure better signal control and effective traffic management, because of the constantly growing volume of traffic. One of the most important factors affecting traffic flows is traffic controllers. There are now three widely established traffic flow management techniques: The first approach, known as "manual controlling," requires the employment of human labor to handle traffic flow. The police utilize a combination of signboards, signal lights, and whistles to direct traffic. The second type of traffic signal is based on classic traffic lights which use static timers. The fixed number is what causes the lights to change from red to green. Third, along the highway, electronic sensors such as sensing devices or proximity sensors may be deployed. These sensors provide information about road traffic. The traffic lights are controlled using data from sensors. These traditional approaches have limitations. The manual control mechanism comes with significant labor expenses. As a result, a more effective form of dynamic traffic control is required. The primary goal of our system is to allow traffic signals to be changed as traffic moves. Our system employs Computer Vision to create a traffic signal controller that can change depending on the flow of traffic. By live video from the security cameras that are installed at busy intersections, determining the amount of traffic in that area can be done in real time and adjusting the green lights suitably. Vehicles are classified into five categories to obtain a reliable estimate of the duration of the green light: automobile, bike, bus, truck, or rickshaw. The system relies on YOLO to calculate the volume of traffic moving in a specific direction and adjust the light cycle accordingly. It enables significantly faster congestion clearance than a static system by minimizing the likelihood of delays, gridlock, and lengthy waits and reducing the requirement for more energy to keep vehicles moving.

3. RELATED WORK

"Intelligent Traffic Light Management using Picture Processing"
With an ever-increasing city population and a number of cars, traffic congestion has emerged as a major problem. In addition to causing delays and stress for drivers, traffic congestion also raises transportation costs, releases more carbon dioxide into the atmosphere, and wastes gasoline. The controller is an essential cog in the wheel of traffic management. Traditional traffic patterns are complicated, nonlinear, and based on time rather than traffic. This research suggests an image processing based traffic management system implemented in MATLAB, where the duration of each color's light depends on the volume and speed of approaching vehicles. The green and yellow lights are controlled by one Arduino UNO, while the red light is managed by a second. This is an ongoing procedure.

"Fuzzy Logic-Based Traffic Signal Timing Improvements,"
The annual traffic increase in metropolitan areas is directly linked to the rising number of cars on the road. The result is congestion, longer commute times, higher fuel costs, and other transportation woes as road capacities decline. To increase the efficiency of flow of traffic at a single junction, this research introduces a fuzzy-logic based adaptive traffic signal controller. Using data gathered from road sensors (queue duration, arrival flow, and departure flow), a set of fuzzification have been developed to determine if the following phase should be reduced or prolonged. Both the principal driveway (which sees more traffic) and the secondary driveway (which sees fewer cars) are covered by the fuzzy based control scheme. The generated decision criteria are validated by comparing the proposed controller to a preset signal programme in three situations with varying traffic demands.

"Intelligent Timing Control for Traffic Lights,"
In densely populated urban areas, traffic congestion and related accidents are major cost centers. While

traffic lights are essential for regulating vehicular movement by indicating when vehicles are permitted to enter and exit, those who use a set timer to determine when each signal turns green are doing so for the wrong reasons. This study creates an autonomous algorithm to regulate traffic lights based on artificial intelligence methods and images of automobiles at intersections and then verifies its efficacy by contrasting its findings with those obtained manually as part of an intelligent transportation system. Incorporating the suggested algorithm into the transportation system would improve the flow of traffic.

4. METHODOLOGY

Our suggested system uses image analysis and object recognition to determine the density of traffic in real time utilizing information from CCTV cameras placed at intersections. The YOLO based vehicle identification system is then fed this input image, as seen in Fig 1. To determine the traffic density, the proposed system counts how many cars, bikes, buses, and trucks are on the road at any one time. The algorithm to switch traffic signal considers this density in conjunction with other parameters to determine the green light period for each lane. The red alert's duration has been adjusted appropriately. To ensure that no single lane remains green for an extended period of time, both maximum and minimum values have been established for this period. To depict how effective the system is and to allow for comparison with the current static system, a simulator is also constructed.

Detection Module for Motorized Vehicles:

The suggested system uses YOLO (You only look once) for vehicle detection, which achieves the required accuracy and processing speed. Vehicles of all sizes and weights (cars, motorcycles, buses, trucks, and rickshaws) can all be identified thanks to a bespoke YOLO model trained for the purpose.

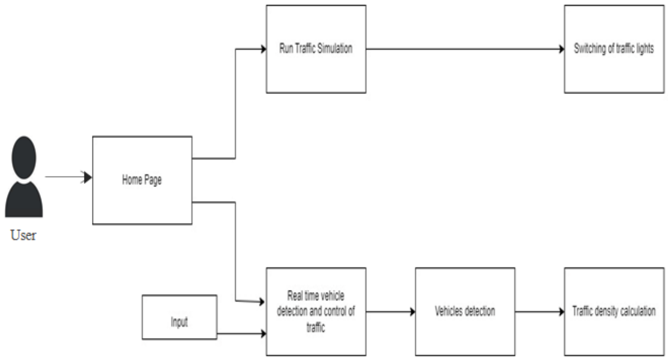

Figure 1 System design architecture

5. RESULTS

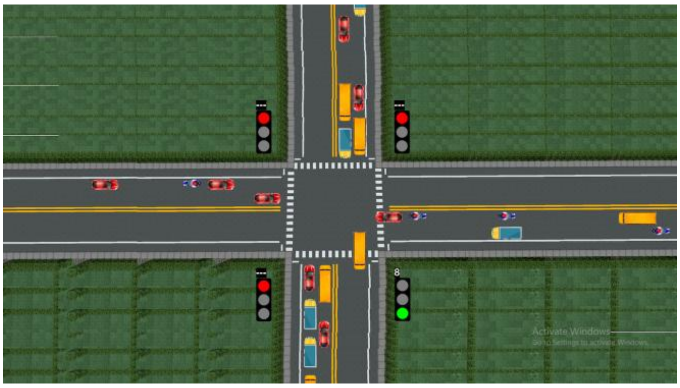

Figure 2 Traffic simulation

The accompanying image is the result of a pygame simulation; note how the green and red lights change as the traffic density in each lane is computed. To execute the second module, exit from current traffic simulation and restart the program.

Figure 3 YOLO vehicle detection

The screen above shows traffic in real-time. YOLO algorithm guesses how many vehicles are on the road and changes the traffic signal accordingly. Let YOLO algorithm finish the processing of all the frames before waiting for the final output.

6. CONCLUSION

In conclusion, the suggested system dynamically switches to green signal based on the amount of traffic coming towards the signal, giving priority to the route with the most vehicle throughput for longer than the route with less traffic. As a result, less traffic will result in shorter wait times, less need for more fuel, and less air pollution. Based on the simulation results, the junction will see a 23% increase in vehicle throughput compared to the current system. With additional calibration and the use of data from real CCTV systems for model training, this technique has the potential to become even more effective. Furthermore, compared to currently used intelligent traffic management systems like Pressure Mats and IR Sensors, the suggested system has certainly good enough to take. As the system relies on existing CCTV videos from traffic signals, it takes very little extra hardware to be installed, even at busy junctions. Little adjustments to the alignment could be all that's needed. As a result, the suggested system can be utilized in conjunction with existing citywide surveillance systems to enhance traffic flow management. To reduce congestion and improve traffic management, the project may be extended to incorporate the following features:

1) You can spot red light runners in a still image or live video by creating a red light violation line and picking up the plate of the vehicle that crossed the line while the light was red. It may be possible to detect lane changes as well by various image processing techniques.

2) Accident or failure detection: Intersections are typical places for a variety of dangerous collisions. One way to minimize accidents is to separate parked cars from those that are just motionless for an extended period in an unsafe location, such as the center of the road.

3) Real-time traffic prediction and route optimization: By analyzing real time traffic data and considering individual drivers' destinations, system suggests alternate routes to reduce delays.

4) Integration with other data sources: The project can be integrated with other data sources such as weather data, public events, and construction work to further optimize traffic flow.

5) Integration with emergency services: The project can be integrated with emergency services to provide priority passage to emergency vehicles in real time.

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