

Smart Traffic Signal Model for Reducing Vehicular Pollution

Mr. Rohit sanjay Chougule¹, Mr. Ram Manohar Bandgar²

*1-Lecturer, Department of Civil Engineering & DKTE Society's Yashwantrao Chavan Polytechnic,
Ichalkaranji*

*Srushti Rayappa Pujari³, Snehal Ravsaheb Aparaj⁴, Sadiya Riyaj Golandaj⁵, Shruti Shekhar Biranje⁶,
Sneha Popat Bandgar⁷*

*3, 4, 5, 6, 7-Students, Department of Civil Engineering & DKTE Society's Yashwantrao Chavan
Polytechnic, Ichalkaranji.*

Abstract - Vehicular emissions are a major contributor to urban air pollution, traffic congestion, and associated health hazards in rapidly growing cities. Conventional traffic signal systems operate on fixed timing schedules that do not adapt to real-time traffic density, leading to unnecessary idling, increased fuel consumption, and elevated carbon emissions. This paper proposes a Smart Traffic Signal Model designed to reduce vehicular pollution through adaptive signal control based on real-time traffic conditions.

The proposed system integrates Internet of Things (IoT) sensors, cameras, and artificial intelligence (AI) algorithms to monitor traffic flow, vehicle density, and waiting times at intersections. Using machine learning techniques, the system dynamically adjusts signal timings to optimize traffic movement, minimize idle time, and reduce stop-and-go patterns. Additionally, the model prioritizes emergency vehicles and promotes smoother traffic dispersion during peak hours

1.Introduction

Rapid urbanization and the exponential growth of motor vehicles have significantly increased traffic congestion and air pollution in cities worldwide. Vehicular emissions, including carbon dioxide (CO₂), carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter (PM), are major contributors to environmental degradation and public health problems. According to the World Health Organization, air pollution is one of the leading environmental risks to human health, with urban traffic being a primary source.

Traditional traffic signal systems operate using fixed-time control mechanisms that do not account for real-time traffic conditions. These static systems often result in unnecessary vehicle idling at intersections, longer waiting times, increased fuel consumption, and higher emission levels. During peak hours, inefficient signal timing further aggravates congestion, while during off-peak hours; vehicles experience avoidable delays despite low traffic density.

2.Literature Survey

1.Pollution Based Traffic Control System using IoT-

Suggested the “*Atmosphere and Sound Pollution Prevention Scheme*”. There's another step forward seeking a solution to the world's most important problem. The air and noise control system is intended to solve the issue of highly polluted areas, which is a big issue. The significant source of concern It promotes the use of modern innovation while also recognizing the role of traditional values. The value of keeping a balanced lifestyle. This system has functions that allow consumers.

3. Methodology

1. Site Selection & Analysis

- Identify traffic intersections with high congestion and pollution levels.
- Record vehicle count, waiting time, and emission patterns.

2. Data Collection

- Install air quality sensors (CO, NOx, PM2.5, PM10) near the site.
- Collect real-time traffic data (vehicle flow, peak hours).
- Record environmental parameters like temperature and wind.

3. System Design

- Design the continuous air purification unit:

Air intake → Pre-filter → Activated carbon filter → Fan → Clean air output.

- Select appropriate fan capacity and filter size based on traffic volume.
- Integrate microcontroller or IoT module for monitoring and automation.

4. Integration with Smart Traffic Signals

- Connect pollution sensors to the traffic control system.
- Program the system to adjust signal timings based on pollution and congestion levels.
- Example: Extend green light duration for congested lanes to reduce idling emissions.

5. Testing & Data Analysis

- Monitor pollution levels before and after activation of the system.
- Analyze reduction in CO, NOx, and PM levels.
- Measure improvements in traffic flow and vehicle idle time.

6. Optimization

- Adjust fan speed, filter layers, and signal timing algorithms based on results.
- Ensure continuous operation without compromising air quality or traffic efficiency.

7. Reporting & Evaluation

- Compare conventional vs. smart system performance.
- Prepare data-supported reports on:
 1. Pollution reduction.
 2. Fuel savings.
 3. Improved traffic flow

4. Results

A smart traffic signal system designed to reduce vehicular pollution typically uses sensors, cameras, and real-time data processing to dynamically control traffic flow. By applying concepts from Artificial Intelligence and Internet of

Things, the system can detect vehicle density, waiting time, and congestion levels at intersections. Based on this data, signal timings are automatically adjusted to minimize idle time, which directly reduces fuel consumption and emissions from vehicles stuck at red lights.

The results of implementing such a model show a significant decrease in traffic congestion and vehicular pollution. Reduced idle time leads to lower emissions of harmful gases such as carbon monoxide and nitrogen oxides, contributing to improved air quality. Additionally, smoother traffic flow enhances travel efficiency and reduces driver frustration. Overall, a smart traffic signal system proves to be an effective and sustainable solution for managing urban traffic while addressing environmental concerns.

5.Observations:

- The smart traffic signal adjusted timings based on vehicle density.
- More vehicles on a lane resulted in a longer green signal.
- Less crowded lanes received shorter signal time.
- Traffic congestion was reduced compared to fixed-timing signals.
- Vehicles spent less time waiting at signals.
- The gas sensor detected higher pollution during longer idle times.
- Pollution levels decreased when traffic flow improved.
- Fuel wastage was reduced due to less stopping and waiting.

6. Future Scope :

Smart Home Integration – Connects with IoT devices to allow remote monitoring and control of air quality in real time. AI-Based Air Quality Prediction – Uses artificial intelligence to forecast pollution peaks and adjust purification automatically. Energy-Efficient Designs – Optimized fans and sensors reduce electricity usage while maintaining continuous purification. Advanced Filtration Materials – Incorporates graphene, nanofiber, or photocatalytic filters for higher pollutant removal efficiency. Portable & Modular Units – Compact and mobile designs allow personal or multi-room air purification flexibility.

7 .Conclusion:

CO and pollution levels increase as the number of vehicle increases, generating heat and limiting the moisture at the environment. To resolve this issue, the signals slowdown must be decreased. This road traffic pollution scanning can be used to figure out how much smoke is present. At stoplights, the heat is monitored. The red and green indicators could be set for the different times. The quantity of flame, heat, and moisture in the traffic signal are controlled automatically .The real-time data on pollution, relative humidity, and water temperatures is provided by the air quality monitoring system. Using gasoline as well as moisture sensors, the developed technique converts toxic gases such as carbon monoxide(CO), carbon dioxide(CO₂), smoke, ammonia(NH₃), and moisture in the environment

8.Referance:

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