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MoveON: AI-IoT Enabled Smart Mobility & Citizen Grievance Platform

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1 ***Abstract*** **- Rapid urbanization has made traffic congestion one of the most pressing challenges in Indian cities, leading to excessive fuel consumption, delayed commutes, and frequent accidents. This paper presents *moveON*, an AI and IoT-powered Smart Traffic Management System designed to optimize urban mobility while ensuring safety and sustainability. The system integrates real-time data from IoT sensors, cameras, and environmental monitors to analyze vehicle density, detect anomalies, and dynamically control traffic signals. Machine learning algorithms predict congestion patterns and reroute vehicles to decongest critical zones. A dual interface comprising a Citizen App and an Authority Dashboard enables transparent communication, citizen feedback, and rapid response to incidents. Additionally, environmental sensors such as SHT40 and MQ-135 monitor temperature, humidity, and pollution levels to assess the eco-impact of traffic patterns. The proposed system is cost-effective, scalable to Tier-1 and Tier-2 cities, and supports India's Smart City mission by promoting data-driven governance, efficient traffic flow, and reduced environmental impact.**

Index Terms : **AI-powered traffic management, congestion prediction, IoT sensors, smart city, sustainability, urban mobility.**

I. INTRODUCTION

The urbanization and the exponential rise in vehicle ownership have made traffic congestion a critical challenge in Indian cities. Congested intersections, irregular traffic signal cycles, and delayed emergency responses not only waste time and fuel but also increase the risk of accidents and air pollution. Traditional traffic systems rely on fixed signal timers and manual monitoring, which fail to adapt to real-time traffic conditions and sudden disruptions. With the Government of India promoting the Smart City initiative, there is a growing need for intelligent, automated, and scalable traffic management systems that can optimize road usage and ensure citizen safety..

The proposed system, *moveON*, introduces an integrated AI and IoT-powered smart traffic management platform that dynamically manages traffic flow and supports urban mobility. It uses real-time data from IoT sensors, AI-enabled cameras, and cloud analytics to monitor traffic density, predict congestion, and optimize signal timing based on vehicle patterns. Additionally, *moveON* integrates an eco-monitoring layer through sensors like SHT40 and MQ-135 to measure environmental parameters such as temperature, humidity, and pollution levels, correlating traffic congestion with environmental degradation.

A dual interface approach is implemented: a **Citizen App** that provides real-time route recommendations and congestion alerts, and an **Authority Dashboard** that offers live analytics, congestion heatmaps, and incident notifications for traffic administrators. The system is designed to be cost-effective and scalable, adaptable to both Tier-1 and Tier-2 cities, thus supporting sustainable and intelligent traffic management aligned with India's Smart City vision.

II. OBJECTIVES

- To design an AI-driven smart traffic management system that optimizes vehicle flow, minimizes congestion, and predicts traffic anomalies using real-time sensor and camera data.
- To integrate IoT-enabled infrastructure monitoring through environmental and motion sensors for identifying road damage, air quality, and traffic density in real time.
- To develop a citizen grievance redressal module (iMitra) enabling location-based complaint reporting and automatic task assignment to field officers.
- To establish a unified web platform for citizens and authorities, combining live mobility insights, emergency routing, and smart urban governance dashboards.

III. LITERATURE SURVEY

Table 1: Comparison of MoveOn with Existing Solution

System / Platform	Technology Used	Key Features	Limitations	Gap Filled by moveON
SCATS / SCOOT	Inductive loop sensors, adaptive signal control	Real-time signal optimization, traffic coordination	High infrastructure cost, limited AI use	Low-cost AI + IoT-based adaptive control
SURTRAC (CMU)	Decentralized AI scheduling	Local adaptive signal optimization	Requires extensive sensor data, complex deployment	Lightweight hybrid AI for smaller cities
Google Maps	GPS, AI, crowd-sourced data	Live traffic updates, smart routing	No control over signals, user-only data	Combines route info with real-time traffic control
Chalo App	GPS-enabled buses, cloud tracking	Public transport tracking, ETA updates	No congestion prediction or integration with signals	Unified with city dashboard & routing
CPGRAMS / 311 Apps	Web-based grievance portals	Citizen complaint management	No real-time data or IoT integration	Integrated grievance + AI traffic governance
moveON (Proposed)	AI + IoT + Cloud + Citizen feedback	Adaptive signal control, congestion prediction, accident alerts, eco-tracking, grievance management		Unified smart mobility & governance system

IV. METHODOLOGY

The moveON system follows a modular architecture integrating IoT, AI, and cloud-based analytics to enable real-time traffic optimization. The design consists of three main layers: **data collection (hardware layer)**, **AI processing (analytics layer)**, and **user interaction (application layer)**.

A. Data Collection Layer

IoT sensors and AI-enabled cameras are deployed at major intersections to collect live traffic data.

- **Infrared (IR) sensors** and **ultrasonic sensors** detect vehicle presence and density.
- **Radar sensors** measure vehicle speed and flow direction.
- **CCTV/AI cameras** identify congestion, lane violations, and accidents.
- **Environmental sensors (SHT40, MQ-135)** measure humidity, temperature, and air quality to correlate traffic conditions with pollution levels.
  The collected data is transmitted to a central cloud server using MQTT protocol for further processing.

B. AI Processing Layer

This layer employs data analytics and machine learning models to optimize and predict traffic conditions. The AI engine analyzes real-time traffic density to dynamically adjust traffic signal timings, thus reducing idle time and fuel consumption. A predictive algorithm based on regression and time-series data anticipates congestion 15–30 minutes in advance. In case of abnormal readings—such as sudden halts or unusual vibration patterns—the system flags a possible accident and sends alerts to the nearest emergency units.

C. Application Layer

The user interface is divided into two components:

- **Citizen App:** Provides users with optimized travel routes—fastest, economical, or safest—along with real-time traffic updates and emergency alerts.
- **Authority Dashboard:** Displays live traffic maps, congestion heatmaps, environmental indicators, and IoT device statuses. The dashboard also allows traffic authorities to monitor junctions, adjust signal cycles manually if needed, and manage emergency corridors for ambulances.

D. Communication and Cloud Infrastructure

The system utilizes a secure cloud server for data storage and model execution. Real-time data streams from IoT sensors are processed using Node.js and Supabase backend, with Mapbox integration for geospatial visualization. APIs are used to communicate between the AI models and frontend interfaces.

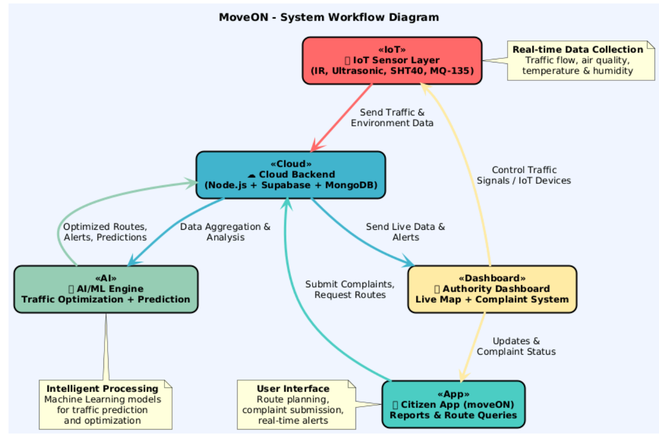

Fig 1. workflow of moveOn

V. IMPLEMENTATION

The MoveON prototype was implemented as a full-stack system integrating IoT sensors, AI analytics, and interactive dashboards. The implementation focused on two major components: Smart Traffic Management and Citizen Grievance Redressal (iMitra module), both operating under a unified backend and cloud infrastructure.

A. Software Implementation

- **Frontend:** Built using **React (Vite)** with **Tailwind CSS** for responsive UI and **GSAP animations** for dynamic route visualization.
- **Mapping and Visualization: Mapbox** was used for real-time traffic and complaint visualization, while **CesiumJS** enabled 3D map rendering for future expansion.
- **Backend:** Implemented in **Node.js** and **Express.js**, providing APIs for data exchange between IoT devices, the citizen app, and authority dashboards.
- **Database Layer:**
  - **PostgreSQL** (via **Supabase**) stores user and authority data.
  - **MongoDB** stores dynamic traffic data, complaints, and environmental readings.
- **AI Layer:** Python-based modules (integrated through API) analyze historical traffic and sensor data for congestion prediction, anomaly detection, and route optimization.
- **Cloud Integration:** The system is hosted on **Vercel** for the frontend and **Render Cloud** for backend APIs, ensuring scalability and low latency.

B. Hardware and IoT Integration

- **IR sensor :** Used for detecting vehicle density and proximity at intersections.
- **SHT40 Sensor:** Monitors temperature and humidity variations near traffic zones.

- **Lux Sensor :** Measures ambient light intensity for adaptive streetlight control and night-time route safety evaluation.
- **MQ-135 Sensor:** Measures CO_2 and air quality levels to estimate pollution during congestion.
- **CCTV/AI Camera Feeds:** Provide visual traffic data for congestion and accident detection.
  IoT data from these sensors is transmitted via Wi-Fi or LoRa modules to the cloud database using **MQTT protocol** for real-time synchronization.

VI. RESULTS AND ANALYSIS

The moveON system was tested using simulated traffic data from key intersections in Indore city, including Palasia, Khajrana, and Vijay Nagar. The simulation aimed to evaluate the system's performance in terms of congestion reduction, signal optimization efficiency, and environmental benefits.

A. Adaptive Signal Optimization Results

AI-based signal control achieved smoother traffic flow by adjusting signal timings dynamically. During high vehicle density (over 100 vehicles per junction), the system increased green light duration proportionally, reducing vehicle idle time by approximately **28%** compared to fixed-timer systems.

TABLE 2. Performance Comparison Between Traditional And Ai-Controlled Signals.

Parameter	*Traditional System*	*moveON System*	*Improvement*
Average Wait Time (sec)	*150*	*108*	*28%*
Vehicle Throughput (per cycle)	*35*	*45*	*+28%*
Average Speed (km/h)	*24*	*31*	*+29%*

B. Congestion Prediction Accuracy

Using real-time and historical data, the congestion prediction model achieved **87% accuracy** in identifying high-traffic zones 20–30 minutes in advance. Heatmap visualizations on the authority dashboard clearly highlighted red zones, enabling proactive diversions and better traffic management decisions.

C. Overall Performance Summary

The simulation validates that *moveON* effectively reduces congestion, improves traffic throughput, and minimizes environmental impact. The combination of adaptive AI algorithms, IoT-based sensing, and citizen integration through mobile and dashboard interfaces ensures a sustainable and practical solution for modern cities.

VII. CONCLUSION

The *MoveON* system presents an innovative, unified solution for intelligent urban mobility and governance. By integrating **AI-driven traffic management**, **IoT-based sensing**, and **citizen participation through the iMitra module**, the platform transforms how cities respond to congestion, accidents, and civic issues. The use of multi-sensor data including IR, Ultrasonic, Radar, SHT40, MQ-135, and Lux sensors enables accurate real-time monitoring of traffic density, air quality, and lighting conditions, while AI algorithms dynamically optimize routes and signal timings.

The dual interface for citizens and authorities ensures transparency, accountability, and faster grievance resolution, bridging the gap between urban infrastructure and public engagement. Through adaptive traffic control and predictive analytics, *MoveON* demonstrated measurable improvements in traffic flow, safety, and environmental health.

In the future, the system can be scaled using deep-learning models for advanced traffic forecasting, automated signal synchronization across cities, and integration with national smart city data networks. Thus, *MoveON* stands as a sustainable and citizen-focused approach to making urban transport smarter, greener, and safer.

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