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SELF-DECISIVE TRAFFIC MONITORING AT CROSSROAD JUNCTION

Suhas Chandansing Solanke[1], Sujal Anil Patil[2], Zainuddin Deshmukh[3], Gaurav Anil Desale[4], Dr. Vijay D. Chaudhari[5], Prof. S. K. Chaudhari[6]

[1,2,3,4] UG students, [5]Associate Professor

1,2,3,4,5 E&TC Engg dept, GF's Godavari College of Engineering, Jalgaon, Maharashtra, India, 425001

Abstract – *Urban traffic congestion significantly impacts emergency response times and public transport efficiency. Traditional fixed-time and semi-actuated signal systems fail to adapt dynamically to such priority needs, resulting in delayed emergency services and unreliable bus schedules. This project presents a Self-decisive traffic monitoring at crossroad junction system that integrates vehicle-in-urgency and public transport first preference mechanisms using IoT, sensors and vehicle-to-infrastructure (V2I) communication. The system detects approaching vehicle-in-urgency vehicles or buses via RFID, GPS, or camera-based sensing, predicts their arrival, and temporarily overrides normal signal cycles to grant a green corridor while ensuring pedestrian and cross-traffic safety. Conditional preference is also provided to delayed public transport vehicles to enhance schedule that follows. The system is assembled using Raspberry Pi 5 and the program code is executed using Thonny.*

Keywords – *Smart Traffic Monitor and Control, Emergency Vehicle Pre-emption, Public Transport Priority, IoT and V2I Communication, Adaptive Signal Control, Intelligent Transportation System (ITS), Crossroad junction*

INTRODUCTION

Urbanization and increasing vehicle numbers lead to frequent congestion, delays, and stress on traffic infrastructure. Traditional traffic signals typically use fixed timers or simple cyclic phases, which are inefficient under varying traffic demands. Self-decisive traffic monitoring at crossroad junction System, combining sensors, data analytics, and adaptive control, aim to optimize signal timing and reduce congestion. Furthermore, emergency response is often hampered by traffic signals. To reduce response times and improve safety, preference mechanisms or pre-emption systems have been studied, where signals adjust in favour of vehicles-in-urgency. We are working on Self-decisive traffic monitoring at crossroad junction system fits into this domain: it combines adaptive control based on vehicle density with emergency vehicle priority (via hospital-traffic police communication). A modern traffic control uses machine learning to give preference to their move, adjust traffic signals early and provide current traffic updates. This integration ensures emergency responders reach their destinations quickly while keeping all road users safe. More than just a technological upgrade, this system is a vital tool for public safety – empowering vehicle-in-urgency to serve with the speed and precision needed to save lives during critical moments.

PROJECT OBJECTIVES

1. Implement a base automatic signal control with default 25 seconds cycles, modifiable by real life traffic data.
2. Develop an Emergency Alert Portal (web app) for hospitals/emergency services to notify traffic authorities (or signal controllers) about an incoming emergency.
3. Enable emergency pre-emption: override normal signal operation in the direction of the vehicle-in- urgency, making availability of a "safe life corridor".
4. Adapt signal durations dynamically at intersections based on real-time vehicle density measurement (sensors).

LITERATURE REVIEW

EXISTING SYSTEMS-

1. A Survey on Traffic Management and Control System for Emergency Vehicles

   Emergency response is critical to public safety, with timely emergency vehicle deployment essential to saving lives and protecting property. This survey paper reviews key strategies, technologies, and approaches used to optimize traffic flow for emergency vehicles. It highlights the importance of rapid response in medical and law enforcement scenarios, then examines challenges like congestion, infrastructure limits, and communication gaps. The paper also presents real-world case studies to assess the effectiveness of various solutions while addressing ethical, privacy, and societal concerns related to prioritizing emergency vehicles. [1].

2. Traffic Management for Emergency Vehicles Based on Visual Sensing and AI
   Timely emergency vehicle response is vital for public safety, but traffic congestion and poor signal control often cause critical delays. To tackle this, we purpose a smart traffic management system using visual sensing and AI. By combining computer vision and machine learning, the system detects emergency vehicles in real-time and optimize traffic signals to prioritize their movement. Tested through simulations and real-world trails, the systems reduce emergency response times by up to 30% while minimizing disruption to regular traffic. With its real-time optimization, scalability, and adaptability, this solution holds strong potential for improving public health and safety as part of smart city infrastructure. [2]

3. Traffic View: A Scalable Traffic Monitoring System
   Vehicles are part of people's life in modern society, into which more and more high-tech devices are integrated, and a common platform for inter-vehicle communication is necessary to realise an intelligent transportation systems supporting safe driving, dynamic route scheduling, emergency message dissemination, and traffic condition monitoring. Traffic View, which is a part of the e-Road project, defines a framework to disseminate and gather information about the vehicles on the road. Using such a system will provide a vehicle driver with road traffic information, which helps driving in situations as foggy weather, or finding an optimal route in a trip several miles long. This paper describes the basic design of Traffic View and different algorithms used in the system.[3]

4. Priority of Emergency Vehicle Dynamic Right-of-Way Control
   A dynamic right-of-way priority control method for emergency vehicles (PDR-EVs) using a vehicle-infrastructure system to improve emergency vehicle (EV) efficiency. A movable area ahead of the EV manages connected vehicles (CVs) via lane restrictions and merge guidance. Simulations show EV delay drops over 70% with minimal CV impact (<8%), with buffer length optimized for traffic volume, enhancing overall road efficiency.[4]

5. A survey on deep reinforcement learning approaches for traffic signal control
   Deep Reinforcement Learning (DRL) is increasingly used to optimize complex, multi-intersection Traffic Signal Control (TSC). However, rapid progress has left a gap in timely and comprehensive reviews of recent methods. This paper analyzes the latest DRL-based TSC research from the past five years, categorizing work by its models, algorithms, and applications. It concludes by outlining key challenges and future research directions.[5]

PROBLEM STATEMENT

Traffic congestion and delay in emergency response are critical challenges in urban areas. Conventional traffic light systems operate on static timers and fail to adapt to real-time conditions. Moreover, there is no efficient communication link between hospitals, emergency services, and traffic control units. This results in delayed medical aid, fuel wastage, and increased travel time. Hence, there is a need for a smart, automated, and adaptive traffic signal control system that prioritizes emergency vehicles and optimizes traffic flow.

Now, from literature we have studied, the key issues pointed out are:

- Fixed-timer traffic signals do not adapt to changing traffic loads, leading to inefficiency and congestion.
- When emergency vehicles need to pass, existing systems may not provide effective pre-emption or priority, resulting in delayed response times.
- Many smart signal systems propose emergency priority, but their real-world implementations are complex, costly, or suffer from communication delay or coordination issues.

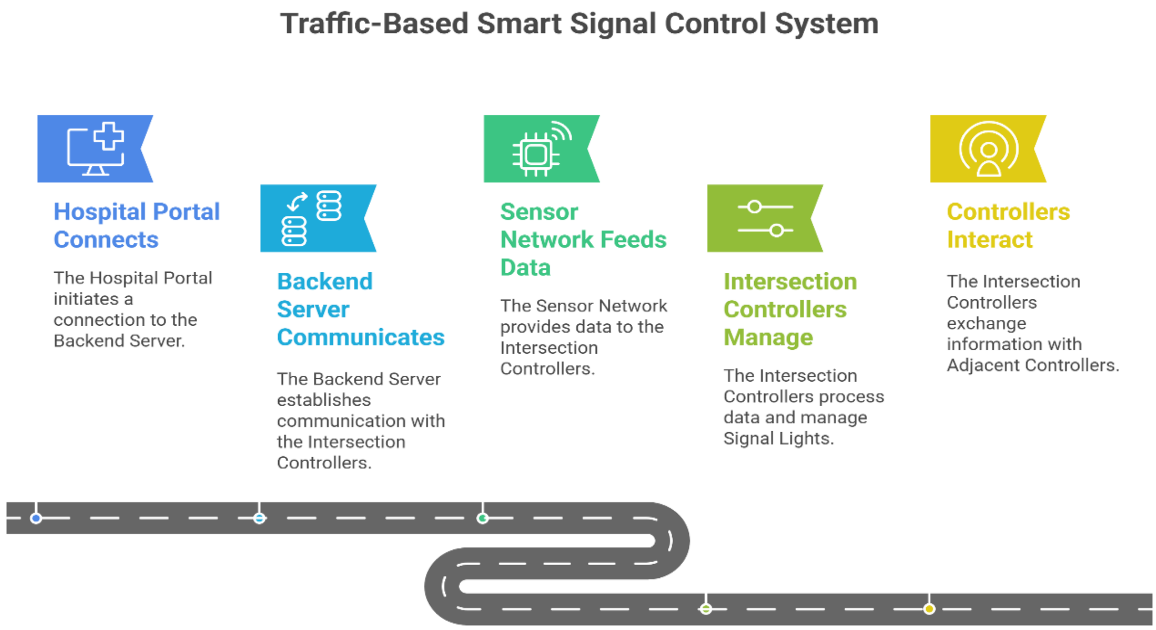

Fig.1Traffic based smart signal control system

METHODOLOGY (SYSTEM DESIGN)

System Flow: This system follows a sequence of logical operations that enable automatic traffic control, emergency pre-emption, and density-based signal adjustment.

Step-by-Step Flow:

1. System Initialization
   Raspberry Pi 5 boots.
   GPIO pins, sensors, and communication modules are initialized.
   Default timing values (25 seconds) are loaded.
2. Sensor Activation
   Ultrasonic/IR sensors at each lane become active.
   Raspberry Pi starts reading continuous vehicle density values.
3. Emergency Alert Check
   System regularly checks the Emergency Alert Portal.
   If an alert is received, system switches to *emergency mode.*
4. Emergency Mode Execution
   Traffic lights on emergency route are set to GREEN**.**
   All other directions are set to RED**.**
   System waits until emergency vehicle passes or timeout expires.
5. Normal Mode
   If no emergency alert is present, system reads the density of vehicles.
   Adjusts GREEN timer depending on congestion.
   Executes adaptive cycle: GREEN → YELLOW → RED for each direction.
6. Logging & Monitoring
   Vehicle density, green duration, and system status are logged.
   Data can be used for performance evaluation.
7. Continuous Loop
   Steps repeat indefinitely to ensure real-time operation.

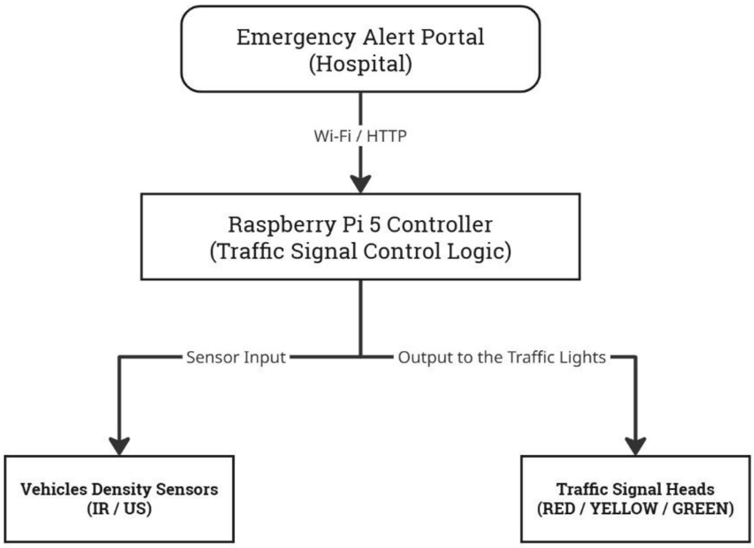

Fig.2 System architecture

ALGORITHM

1. Start system.
2. Initialize Raspberry Pi GPIO, sensors, Wi-Fi, variables.
3. Loop forever:
    a. Read emergency alert from portal.
    b. If alert = TRUE → emergency mode:
        - Identify route.
        - Set respective lanes to green.
        - Freeze other lanes.
    c. Else → normal mode:
        - Read vehicle-in-urgency by sensors.
        - Compute green duration.
        - Run signal cycle for each direction.
    d. Log sensor values, timings, emergency events.
4. Repat loop.

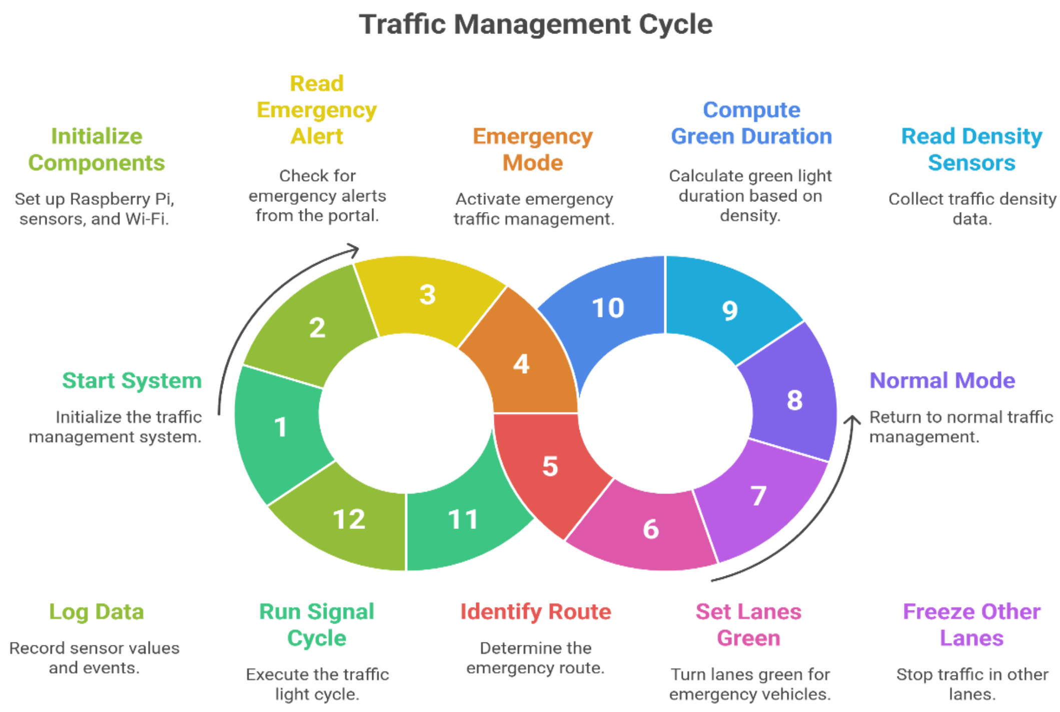

Fig.3 Traffic management cycle

DISCUSSION & EXPECTED RESULTS

The emergency alert feature will provide a safe life corridor for vehicle-in-urgency, reducing their delay whereas maintaining safety for other traffic. Improved traffic flow, reduced idle time of vehicles at intersections, and better resource utilization. Logging data will allow us to compare performance before and after system implementation (e.g., default 25 seconds vs adaptive timing, emergency vs no emergency). If we capture photos / stages during testing us can show - sensor detection in action, green corridor activation, normal adaptive cycle operation, emergency override triggered, data logging interface, etc.

Thus we'll going to observe how the results align with literature for instance; emergency-vehicle priority can reduce travel time significantly. Sensor accuracy, communication latency, coordination across many intersections needs to take care. We can go for the metrics to study further like, average waiting time of vehicle-in-urgency, number of vehicles passed during green light, vehicle-in-urgency travel time, interruptions to normal traffic, etc.

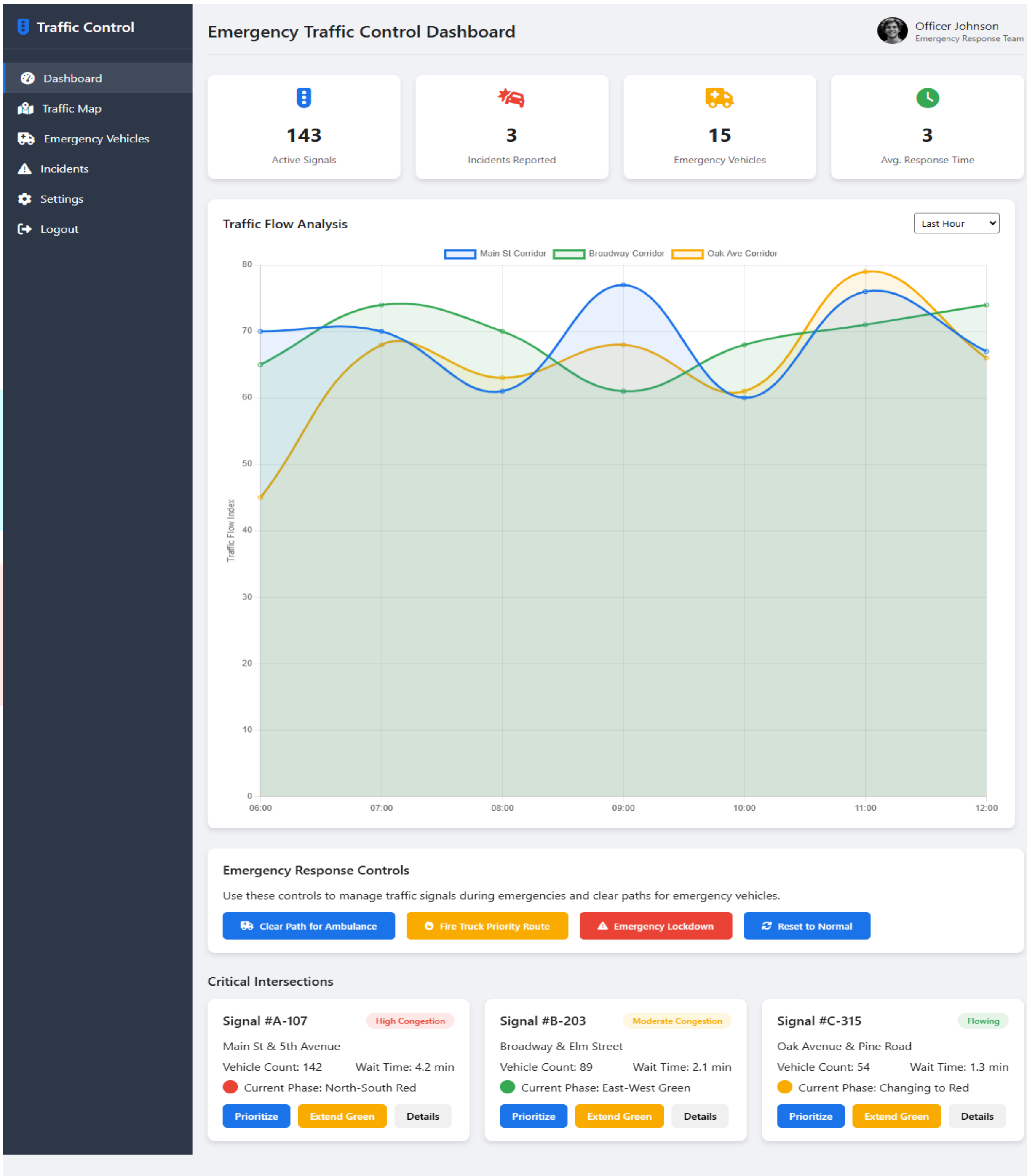

Fig.4 Proposed sample of dashboard

CONCLUSION

In this project, we have tried to design and partially implemented a Self-decisive traffic monitoring at crossroad junction system that uses real-time vehicle density sensing and integrates an Emergency Alert Portal to give priority to emergency vehicles. The methodology, hardware and software requirements, budget, and expected results have been laid out. The prototype code and system design demonstrate the feasibility of our approach. With successful implementation, the system has the potential to reduce waiting times, improve emergency response, and contribute to smarter urban traffic management.

REFERENCES

[1] Ruturaj Patil, Divya Lambhate, Rushikesh Khiste, Vaishnavi Khade, Prof. Madhuri Mane (June 2024), A Survey on Traffic Management and Control System for Emergency Vehicles, pp. 9,10.

[2] Sudip Das, Rupsa Sen, Poulami Saha, Soumi Saha, and Udita Sarkar (September 2024), Traffic Management for Emergency Vehicles Based on Visual Sensing AI, pp. 9,10.

[3] Tamer Nadeem, Sasan Dashinezhad, Chunyuan Liao, and Liviu Iftode, Traffic View: A Scalable Traffic Monitoring System, pp. 9,10.

[4] Zhihui Kuang, Xin Zhao and Lei Feng, (May 2023), Priority of Emergency Vehicle Dynamic Right-Of-Way Control Method in Networked Environment, pp. 9,10.

[5] Haiyan Zhao, Chengcheng Dong, Jian Cao, Qingkui Chen, (July 2024), A survey on deep reinforcement learning approaches for traffic signal control, pp. 9.10.