PROJECT ABSTRACT

Density-Based Smart Traffic Signal Controller with Monitoring Dashboard

A density-based traffic signal controller with IR vehicle counting, adaptive green timing and a live junction dashboard. Delivered built-to-order with junction model, firmware, dashboard, report, PPT and viva kit.

01. Title

Density-Based Smart Traffic Signal Controller with Monitoring Dashboard — adaptive signal timing from measured approach density.

02. Introduction / Background

Fixed-time traffic signals waste green time on empty approaches while vehicles queue on the busy ones. The fix is density-responsive control: measure the actual vehicle count per approach and allocate green time where the queue is. This project demonstrates it on a 4-way junction model: IR sensor pairs count vehicles on each approach, an Arduino Mega runs an adaptive timing state machine with minimum/maximum green bounds and amber clearance, and LED signal heads show the live phases. A dashboard mirrors the junction schematically with live signal states, per-approach counts, the phase timer and a log of timing decisions, plus pedestrian handling and an emergency override input.

03. Problem Statement

The project addresses inefficient fixed-time signals by demonstrating density-adaptive control with honest scope: the control logic and sensing method at model scale, with real-deployment additions — loops or cameras, conflict monitoring, fail-safe design — discussed as deployment notes, not claimed.

04. Objectives

- Count vehicles per approach with IR sensor pairs on a 4-way junction model.
- Adapt green times between configured min/max bounds from measured density.
- Implement a full phase state machine: green, amber, all-red clearance, pedestrian phase.
- Mirror the junction live on a dashboard schematic with counts and decision log.
- Service pedestrian demand and an emergency-override priority input.
- Demonstrate fixed-time vs adaptive behaviour with scripted traffic scenarios.

05. Proposed Methodology

IR pairs detect passing model vehicles with debounced counting. At each phase decision, the controller compares approach densities and computes green times within bounds; the Mega drives the LED signal heads through the phase sequence. Counts, phase state and decisions stream to the dashboard, which renders the live schematic and decision log. A pedestrian button queues a crossing phase; the emergency input holds the priority approach green with preemption logging. Scripted scenarios (rush, balanced, night) demonstrate the adaptation.

06. System Architecture / Working

The Arduino Mega handles timing-critical sensing and signal outputs; a telemetry link (serial/Wi-Fi) streams state to the dashboard backend, which serves the junction schematic, counts, phase timer and decision log. The 4-way junction model carries signal heads, IR sensors and the pedestrian crossing.

07. Hardware / Software Requirements

- Hardware: Arduino Mega 2560, 8x IR sensor modules (approach pairs), 4-way LED signal head model, pedestrian button with indicators, telemetry link, 4-way junction demonstration model, emergency override switch.
- Software: Arduino IDE (C/C++ firmware), web dashboard (HTML/CSS/JS) with junction schematic.

08. Expected Outcomes

- A working 4-way junction model with adaptive signal control.
- A live dashboard mirroring signal states, counts and timing decisions.
- Scripted scenarios showing fixed-time vs adaptive behaviour.
- Documented timing bounds and phase structure.
- Complete documentation: report, PPT, viva Q&A and setup guide.

09. Applications

Traffic engineering coursework, smart-city demonstrations, and the adaptive-timing pattern transfers to any shared-resource scheduling problem.

10. Future Scope

Camera/radar detection, certified conflict monitors and fail-safes, coordination of adjacent junctions (green waves), and validation against traffic simulation.