**Proposed Work**

The adaptive traffic signal timer optimizes green signal durations based on real-time traffic density. The implementation integrates vehicle detection and an algorithm to dynamically set signal timers, ensuring efficient traffic flow and minimizing delays.

**Implementation Steps**

1. **Signal Switching Algorithm**:
   * **Input**: JSON data with vehicle types, confidence, and coordinates.
   * **Process**:
     + Calculates traffic density and sets green signal duration.
     + Adjusts red signal timers for other signals.
   * **Logic**:
     + Factors like vehicle types, average speeds, and startup lags considered.
     + Minimum and maximum limits for green signal duration ensure fairness.
2. **Simulation Module**:
   * **Features**:
     + A 4-way intersection with dynamic signal timers and vehicle movement.
     + Different vehicle types (cars, bikes, buses, etc.) simulated realistically.
   * **Visual Components**:
     + Displays signal statuses, timer countdowns, and vehicles crossing the intersection.
     + Tracks elapsed time and vehicles per signal.
   * **Pygame Integration**:
     + Generates vehicles at regular intervals.
     + Controls vehicle behavior based on signal states.
3. **Green Signal Time Formula**:
   * GST = Σ(noOfVehiclesOfClass × averageTimeOfClass) / noOfLanes
   * Adapts signal time to traffic density for each class of vehicle.
4. **Simulation Realism**:
   * Vehicles follow unique speeds and stopping behaviors.
   * Randomized vehicle turns mimic real-life scenarios.

**Results**

* **Default Scenario**:
  + Initial signal timings set statically.
  + Signal timers adjust dynamically after the first cycle.
* **Adaptive Signal Timing**:
  + Dense traffic: Longer green durations (e.g., 60 seconds for heavy flow).
  + Sparse traffic: Shorter green durations (e.g., 10 seconds for light flow).
  + Reduced idle time at intersections compared to static systems.
* **Key Observations**:
  + Dynamic adjustments prevented signal starvation.
  + Yellow signal timers allowed smooth transitions.
* **Visualization**:
  + Signals with adaptive timers responded effectively to varying traffic densities.
  + The vehicle crossing count accurately reflected real-time conditions.

The adaptive signal timer demonstrated significant improvements over static systems by reducing congestion and optimizing signal timings based on real-time traffic conditions.