IOT PROJECT

Adaptive Traffic Light

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Literature survey

1. **A Review of the Self-Adaptive Traffic Signal Control System Based on Future Traffic Environment**

2. **Artificial Intelligence-Based Adaptive Traffic Signal Control System: A Comprehensive Review**

3. Smart Urban Signal Networks: Initial Application of the SURTRAC Adaptive Traffic Signal Control System

Paper 1: Self-Adaptive Traffic Signal Control System

- **Main Focus:**
  - Highlights the significance of real-time adaptive traffic signal systems for reducing urban traffic congestion.
  - Investigates technical characteristics of adaptive systems and control methods for heterogeneous traffic, including connected and autonomous vehicles.
  - Emphasizes multiagent reinforcement learning as a promising "model-free" control approach with self-learning capabilities.
- **Strengths:**
  - Demonstrates the integration of data-rich environments (V2V, V2X systems) for enhanced traffic signal efficiency.
  - Advocates the use of multiagent reinforcement learning for its real-time feedback and adaptability.
- **Limitations:**
  - Limited focus on implementation in developing nations with infrastructural challenges.
  - Practical application scenarios of V2X in mixed traffic environments remain unexplored.
- **Future Prospects:**
  - Potential for integrating with autonomous driving and IoT systems for smarter urban traffic control.

Paper 2: SURTRAC – Decentralized Adaptive Traffic Signal Control

- **Main Focus:**

    - Introduces SURTRAC, a scalable, decentralized, schedule-driven traffic signal control system tested in Pittsburgh.
    - Each intersection optimizes its signal schedule independently and asynchronously based on real-time data.
    - Downstream intersections share projected traffic flows for coordinated operation.
- **Strengths:**
    - Demonstrates significant reductions in travel times and vehicle emissions.
    - Utilizes multiagent planning for decentralized decision-making, enhancing scalability.
- **Limitations:**
    - Challenges with sensor reliability and data quality impact effectiveness.
    - Pilot application limited to a nine-intersection road network, leaving large-scale viability untested.
- **Future Prospects:**
    - Expanding to larger urban networks with improved sensor technologies for reliable data acquisition.

Paper 3: AI-Based Adaptive Traffic Signal Control System (Electronics 2024, 13, 3875)

- **Main Focus:**
    - Comprehensive review of AI techniques in Adaptive Traffic Signal Control (ATSC).
    - Explores methods like fuzzy logic, reinforcement learning, metaheuristics, and hybrid approaches for single and multi-intersection environments.
    - Discusses advancements in reducing travel time, emissions, and congestion.
- **Strengths:**
    - Provides a detailed classification of techniques (e.g., DRL, Q-learning) and their application to ATSC.
    - Evaluates the effectiveness of microsimulation tools (SUMO, VISSIM) for testing ATSC systems.
- **Limitations:**
    - Lacks real-world validation for complex urban environments with mixed traffic types.
    - Scalability to large cities with unpredictable traffic conditions remains a challenge.

- **Future Prospects:**
    - Recommends research on multi-agent systems for optimizing multi-intersection ATSC.
    - Integration of external data (e.g., weather, pedestrian activity) to enhance system performance.

Survey Analysis

- **Common Themes:**
    - All three papers emphasize the potential of adaptive traffic control systems in reducing congestion and environmental impact.
    - Reinforcement learning emerges as a recurring theme for real-time adaptability.
    - The shift from fixed-time control to data-driven systems is evident.
- **Comparative Insights:**
    - **Paper 1** is conceptual, focusing on future prospects like V2X integration.
    - **Paper 2** emphasizes decentralized systems with real-world results.
    - **Paper 3** provides a broad review of AI techniques and their experimental evaluations.
- **Applications and Challenges:**
    - The field is advancing toward real-time, scalable, and intelligent systems.
    - Sensor reliability, large-scale coordination, and dynamic adaptability remain critical challenges.
- **Recommendation:**
    - Combining the decentralized approach of SURTRAC with advanced AI models and robust data acquisition (as explored in Paper 3) could address current limitations.

Citation

1. https://onlinelibrary.wiley.com/doi/full/10.1155/2018/1096123

2. https://www.mdpi.com/2079-9292/13/19/3875

3. https://ojs.aaai.org/index.php/ICAPS/article/view/13594