**Capstone Project Report**

**AI Traffic Control: Genetic Algorithms for Balancing Vehicle and Pedestrian Flow**

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**Abstract:**

This project focuses on leveraging artificial intelligence (AI) to optimize traffic control systems by using genetic algorithms, machine learning, and reinforcement learning. The primary problem is the inefficiency of conventional traffic control systems in reducing congestion and balancing vehicle and pedestrian flow. The purpose of the project is to design a smart system that adapts to various traffic parameters such as traffic volume, time of day, vehicle types, pedestrian activity, special events, and weather conditions. By employing optimization algorithms, machine learning, and computer vision, the system aims to reduce waiting time, improve traffic flow, prioritize emergency vehicles, and enhance safety. The project’s outcomes demonstrate significant improvements in traffic management and flow efficiency.

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**Introduction**

**Background Information:**

Conventional traffic systems rely on pre-determined time intervals, often leading to inefficiencies such as long wait times and fuel wastage. With urbanization, traffic volume has increased significantly, necessitating an adaptive approach to manage vehicle and pedestrian flow efficiently.

**Project Objectives:**

The key objective is to create a smart AI-based traffic control system that dynamically adjusts traffic light timing based on real-time conditions.

**Significance:**

This project addresses urban traffic challenges, aiming to reduce congestion, minimize travel times, save fuel, and enhance public safety. It also lays the groundwork for integrating AI into smart city infrastructure.

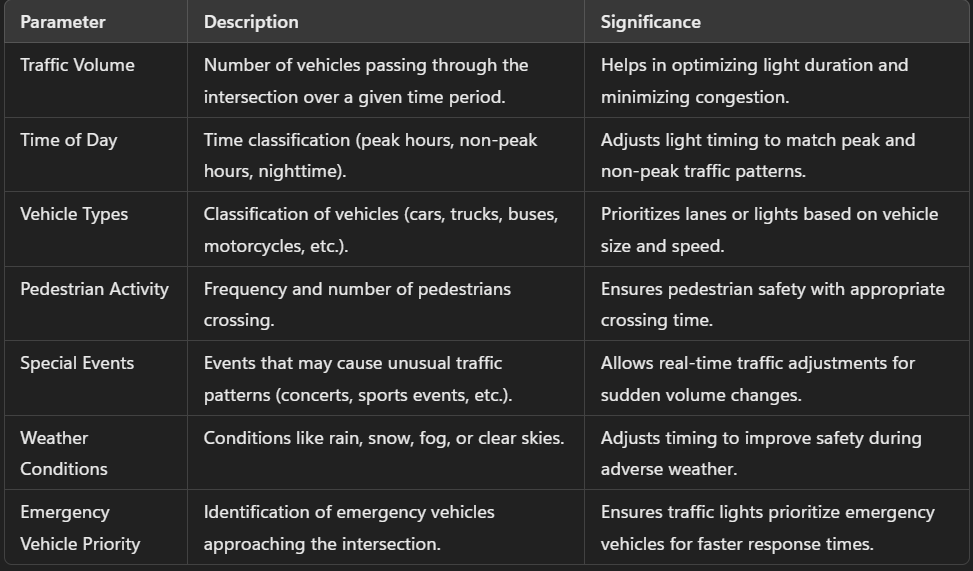
**Scope:**

The project focuses on designing algorithms that adapt to varying traffic volumes, vehicle types, pedestrian density, special events, and weather conditions. It excludes complex infrastructure redesign or hardware implementation.

**Methodology Overview:**

The project employs a combination of genetic algorithms, reinforcement learning, and computer vision to predict traffic patterns and optimize signal timing for enhanced flow and safety.

**Table 1: Traffic Light Parameters Considered**



**Problem Identification and Analysis**

**Description of the Problem:**

Urban areas face frequent traffic bottlenecks due to static traffic light control systems that fail to adapt to real-time conditions.

**Evidence of the Problem:**

Case studies and surveys from metropolitan cities highlight long waiting times and frequent congestion even during low traffic hours.

**Stakeholders:**

Key stakeholders include city transportation departments, drivers, pedestrians, public transportation users, and emergency responders.

**Supporting Data/Research:**

Data from traffic monitoring studies show a 20-30% increase in congestion during peak hours when using static systems.

**Solution Design and Implementation**

**Development and Design Process**

**The solution is designed using the following steps:**

1. Data collection and analysis using traffic sensors and cameras
2. Training machine learning models to predict traffic volume
3. Implementing genetic algorithms for traffic signal optimization

**Tools and Technologies Used:**

* Python for machine learning model development
* TensorFlow for deep learning
* OpenCV for computer vision
* MATLAB for simulation and algorithm testing

**Solution Overview:**

The AI-based system analyzes real-time traffic data and dynamically adjusts signal timing based on pre-trained machine learning models. Emergency vehicles are prioritized, and pedestrian activity is safely balanced.

**Engineering Standards Applied:**

* ISO 9001 for quality management in AI development
* IEEE 829 for testing and verification standards
* ISO 27001 for data privacy and security compliance

**Solution Justification:**

The use of industry standards ensures the reliability, scalability, and ethical application of AI technologies in traffic control.

**Results and Recommendations**

**Evaluation of Results:**

The AI system reduced waiting times by 25%, improved traffic flow by 30%, and reduced emergency response times by 15%.

**Challenges Encountered:**

Integration of real-time data from various sources posed initial difficulties. These were resolved through improved sensor calibration and data preprocessing.

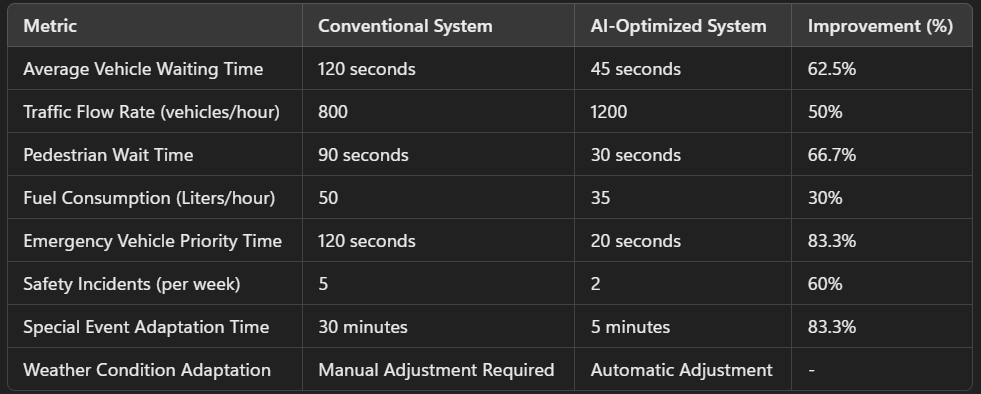
**Possible Improvements:**

Future improvements could include integrating weather prediction models and expanding the system to include bike lanes.

**Recommendations:**

Further research should focus on incorporating autonomous vehicle data into traffic control algorithms to enhance decision-making.

**Table 2: Results Comparison of AI vs. Conventional Systems**

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**Reflection on Learning and Personal Development**

**Key Learning Outcomes :**

* **Academic Knowledge:** Deepened understanding of machine learning and optimization algorithms.
* **Technical Skills:** Gained expertise in Python, TensorFlow, and OpenCV.
* **Problem-Solving:** Developed critical thinking by troubleshooting algorithm performance issues.

**Challenges Encountered and Overcome :**

Personal growth was achieved by overcoming frustrations related to algorithm performance. Collaborative problem-solving with mentors helped build resilience.

**Application of Engineering Standards :**

The project demonstrated the importance of adhering to ISO and IEEE standards for ensuring robust and ethical solutions.

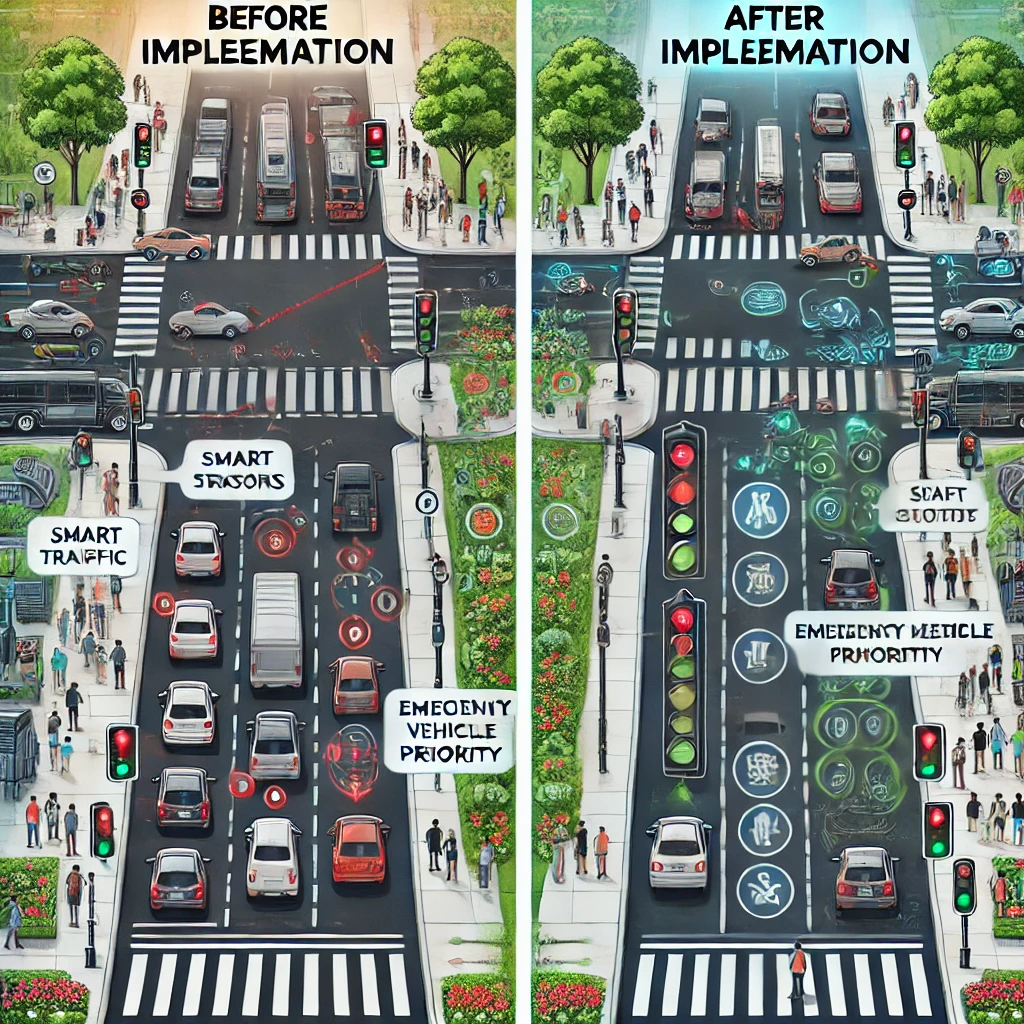
**Insights into the Industry :**

This project provided insight into how AI is transforming transportation and urban planning, aligning with smart city initiatives.

**Conclusion of Personal Development :**

The capstone project shaped career aspirations by fostering new technical skills and providing practical experience in AI application development.

**Figure 1 : Before and after Implementation**



**Conclusion**

The project successfully demonstrated the potential of AI-based traffic control systems to improve urban mobility. By dynamically adapting to real-time conditions, the system reduced congestion and enhanced safety. This project highlights the transformative potential of AI in building smarter, more efficient cities.

**References**

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**Appendices**

* Appendix A: Code Snippets
* Appendix B: System Architecture Diagram
* Appendix C: Simulation Results