**The Open University of Sri Lanka**

**Faculty of Engineering Technology**

**Bachelor of Software Engineering Honors**

**Department of Electrical and Computer Engineering**

**EEX5362 – Performance Modelling**

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**Deliverable 1**

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**Smart Traffic Light Control System**

**1. High-Level Problem Description**

Urban traffic congestion has become a major issue in modern cities due to increasing vehicle density and inefficient traffic signal management. Traditional traffic light systems operate using fixed timers, regardless of the actual traffic flow at intersections. This leads to unnecessary waiting times, wasted fuel, and increased air pollution.

To address these inefficiencies, a Smart Traffic Light Control System is proposed. The system leverages sensors, IoT devices, and intelligent control algorithms to dynamically adjust traffic signal timings based on real-time traffic conditions.

**System Overview**

The Smart Traffic Light Control System continuously monitors vehicle flow and adjusts light durations to optimize traffic movement. It collects real-time data from multiple intersections, processes it using decision-making algorithms, and updates the light cycles accordingly.

**Key Components:**

* Sensors: Installed at intersections to detect the number of vehicles, their speed, and queue length.
* Controller: Processes sensor data and makes dynamic signal timing decisions.
* Network Communication: Connects all traffic controllers for coordinated multi-intersection management.
* Dashboard Interface: Displays system metrics and real-time traffic status for monitoring by administrators.

**Key Benefits:**

* Reduces average waiting time for vehicles.
* Improves overall traffic flow and throughput.
* Decreases fuel consumption and vehicular emissions.
* Enhances scalability for growing urban areas.

**2. Performance Objectives**

The performance of the Smart Traffic Light Control System will be evaluated based on measurable characteristics that define system efficiency and responsiveness.

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| --- | --- | --- |
| Performance Objective | Performance Metric | Description |
| Minimize Average Waiting Time | Average waiting time per vehicle (seconds) | Reduce the queue time by adapting signal durations dynamically. |
| Maximize Throughput | Number of vehicles passed per minute | Ensure more vehicles move through intersections efficiently. |
| Optimize Resource Utilization | CPU and network usage | Maintain real-time performance with minimal system resource load. |
| Reduce Fuel Consumption | Estimated fuel usage per vehicle | Lower idle times to save fuel and reduce emissions. |
| Enhance Scalability | Response time under increased intersections | Ensure the system continues to perform efficiently as the number of intersections grows. |

**3. Dataset Description**

Acknowledging the importance of using realistic data, this project will adopt publicly available real-world traffic datasets to model the performance of the Smart Traffic Light Control System. The datasets will be adapted to generate the required metrics for the performance objectives (waiting time, throughput, resource utilization, etc.).

**Selected Datasets:**

* Dataset A: Traffic Intersection Volumes (Adelaide City Council, Australia) — This dataset provides hourly traffic volumes from various intersections, including site identifiers, date, time, and hourly traffic counts.
* Dataset B: Traffic Flow Dataset for Traffic Signal Timing Optimization — This dataset contains traffic volume data across multiple road network configurations, including both synthetic and real-world scenarios, suitable for signal timing optimization research.

**Attributes / Fields Used:**

* Intersection ID or Site ID (unique identifier)
* Timestamp (date + hour or finer interval)
* Vehicle count or hourly traffic volume
* Lane or approach identifier (if available)
* Signal state (Red, Yellow, Green)
* Waiting time or queue length

**Data Usage:**

The chosen datasets will be cleaned and pre-processed to handle missing or incomplete records. Certain fields (like waiting time or signal state) may be estimated or derived based on available information and reasonable assumptions. The datasets are publicly available through government and research data portals. The final dataset will then be used to evaluate performance objectives such as average waiting time, throughput, and scalability of the Smart Traffic Light Control System.

**4. Expected Outcomes**

Using real-world traffic data grounds the performance evaluation in practical and realistic conditions. The Smart Traffic Light Control System is expected to demonstrate:

* A measurable reduction in average vehicle waiting time compared to fixed-time traffic control under varying traffic volumes.
* Throughput improvements during both peak and off-peak hours.
* Improved system scalability and responsiveness across multiple intersections.
* Potential reduction in fuel consumption and emission levels due to decreased idle time.

**5. Summary**

This project focuses on the development and evaluation of a Smart Traffic Light Control System aimed at optimizing real-time urban traffic management. By applying data-driven decision-making and real-world datasets, the system can reduce delays, improve vehicle flow, and enhance overall traffic efficiency.

The performance evaluation will be based on key measurable objectives, including waiting time reduction, throughput improvement, and scalability under increasing traffic demand**.**