REQUIREMENTS ANALYSIS

Shape, background pattern

Description automatically generated

CAPSTONE

PROJECT

Mentor

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AUTHOR

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DATE PREPARED

01/08/2024

Version

0.0.1

# VERSION HISTORY

| VERSION | APPROVED BY | REVISION DATE | DESCRIPTION OF CHANGE | AUTHOR |
| --- | --- | --- | --- | --- |
| 0.0.1 |  | 06/08/2024 | Initial Issue of Document | Tathagata |
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# INTRODUCTION

## Purpose

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| The aim is to improve vehicular and pedestrian traffic through the use of Cloud and Edge Computing technologies, assisted by High Performance Computing. This system enables traffic to be controlled smoothly and allow for safe passage of emergency vehicles causing minimal delay, all the while minimizing the impact on traffic. |

## Reference Documents

Include any external documentation that may add value for stakeholders.

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| --- | --- | --- |
| **NAME** | **DESCRIPTION** | **LOCATION/LINK** |
| Capstone SDLC - Agile Gantt Chart | To keep track of project timeline and deadlines | "Capstone Project\Capstone SDLC - Agile Gantt Chart.xlsx" |
| Requirements Feasibility Analysis | Analyzing the data points required and how to approach | "Capstone Project\Requirements\Requirements Feasibility Analysis.docx" |
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## Abbreviations and Acronyms

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| **TERM** | **FULL NAME** | **DESCRIPTION** |
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# DESCRIPTION

## Product Context

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| The product is meant for Urban and Suburban Smart cities, that enables the City Traffic Management Authorities to have smooth flowing traffic, as well as having the ability to monitor and route traffic if necessary. |

## User Classes and Characteristics

Include a description of all system users and their usage characteristics.

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| **USER CLASS** | **CHARACTERISTICS** |
| Traffic Mgmt. Authorities | Monitoring traffic conditions, controlling traffic signals, planning and implementing traffic management strategies, ensuring public safety. |
| Municipal Govt. Officials | Overseeing urban development, allocating budgets for infrastructure projects, setting traffic regulations. |
| Commuters | Reaching destinations efficiently and safely. |
| Public Transport Operators | Managing public transport schedules and routes, ensuring timely and efficient public transport services. |
| Emergency Services | Responding to emergencies quickly and efficiently, ensuring public safety. |

## Operating Environment

If you are seeking a SaaS or an on-premises solution, please include the relevant details below (such as any necessary technical requirements for an on-premises implementation).

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# BUSINESS DRIVERS

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# STAKEHOLDERS

Include all stakeholders and the roles they play in the project.

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| **STAKEHOLDER** | **ROLE** |
| City Traffic Mgmt. Authority | Responsible for managing and controlling traffic flow. |
| Commuters | Daily users of roads and pedestrian pathways. |
| Emergency Services | Fire, police, and ambulance services that need efficient routes. |
| Public Transport Operators | Managing buses, trams, and other public transport vehicles. |

# REQUIREMENTS

Include all of the requirements collected from stakeholders.

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| **Vehicle and Pedestrian Detection:**   * Detect vehicles and pedestrians in real-time using YOLOv8. * Classify and differentiate between vehicles and pedestrians with high accuracy.   **Tracking:**   * Track detected objects across multiple frames using ByteTrack. * Assign unique IDs to each object to maintain continuity of tracking.   **Counting and Analysis:**   * Count the number of vehicles and pedestrians passing through predefined zones. * Plot time-distribution curves to analyse traffic patterns.   **Integration with Traffic and V2X Infrastructure:**   * Interface with traffic signals to optimize timing based on real-time data. * Support V2X communication protocols for enhanced traffic management.   **Cloud and Edge Computing:**   * Process data locally on edge devices to minimize latency. * Aggregate and analyse data in the cloud for large-scale deployments.   **Data Storage and Management:**   * Store detection, tracking, and analysis data in a secure, centralized database. * Ensure data integrity and consistency across all devices and locations.   **Visualization and Reporting:**   * Provide real-time dashboards for traffic monitoring. * Generate and export detailed performance and optimization reports. |

## Performance Requirements

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| **Real-Time Processing:**   * Process video feeds at 30 frames per second on edge devices. * Ensure detection latency does not exceed 200 milliseconds.   **Scalability:**   * Support up to 5,000 edge devices in an urban environment. * Handle data from over 200,000 vehicles per day.   **Data Throughput:**   * Ensure continuous data transmission with a bandwidth of 5 Mbps per device. * Support cloud infrastructure capable of processing and storing 50 TB of data daily.   **Accuracy:**   * Achieve at least 95% detection and classification accuracy for vehicles and pedestrians. * Maintain tracking accuracy with less than 2% ID-switch rate in crowded environments. |

## Security Requirements

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| **Data Encryption:**   * Encrypt data during transmission (using TLS/SSL) and at rest (using AES-256). * Secure communication between edge devices, cloud servers, and traffic infrastructure.   **Access Control:**   * Implement role-based access control (RBAC) for system users. * Ensure authentication and authorization mechanisms are in place for all components.   **Data Integrity:**   * Implement measures to prevent data tampering or unauthorized access. * Ensure data redundancy and backups to prevent data loss.   **Compliance:**   * Ensure the system complies with relevant data protection regulations, such as GDPR. * Regularly audit and update security protocols to address emerging threats. |

## Usability Requirements

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| **User Interface:**   * Provide an intuitive and user-friendly dashboard for monitoring and reporting. * Ensure that non-technical users can easily navigate and use the system.   **Responsiveness:**   * The system should respond to user inputs within 1 second. * Real-time data updates should be reflected on the dashboard with minimal delay.   **Customization:**   * Allow users to customize views, reports, and alerts based on specific needs. * Provide configurable thresholds for traffic density alerts.   **Training and Documentation:**   * Offer comprehensive documentation and training materials for users and administrators. * Provide tutorials, FAQs, and support for troubleshooting. |

## Other Requirements

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# Appendix A: Analysis Models

List any attached/referenced documentation, such as data flow diagrams, class diagrams, state-transition diagrams, entity-relationship diagrams, etc.

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# Appendix B: Issues List

List and describe any unresolved issues.

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| **ISSUE ID** | **DESCRIPTION** | **STATUS** |
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