Software Requirements Specification

for

RESCUE ROUTE

Version 1.0 approved

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1. Introduction

1.1 Purpose

The purpose of this document is to build a model to control traffic on road and provide ambulances an emergency passage to save life of people.

1.2 Document Conventions

DB	Database
DS	Data Set
ER	Entity Relationship

1.3 Intended Audience and Reading Suggestions

This project is a prototype for Traffic control and providing passage to ambulances to save life of people and it is restricted on single lane of road. This has been implemented under the guidance of college professors. This project is useful for all the people of our country.

1.4 Project Scope

The scope of the smart traffic management system project includes developing a system to automate traffic control using technologies like RCNN, webcams, NodeMCU controllers, and OpenCV. The system will detect and count vehicles, adjust traffic signals based on traffic density, and prioritize emergency vehicles. It aims to improve traffic flow, reduce congestion, and enhance emergency vehicle response times.

1.5 References

1. [1] Varsha Srinivasan et al 2018 IOP Conf. Ser.: Mater. Sci. Eng. 402 012015

2. [2] Papageorgiou M., Diakaki C., Dinopoulou V., Kotsialos, A.,"Review of road traffic control strategies", Proceedings of IEEE, Vol. 91, Issue 12, pp. 2043-2067, November 2004.

3. [3] Georgios Vigos, Markos Papageorgioua, Yibing Wangb, "Real-time estimation of vehicle-count within signalized links", Journal of Transportation Research Part C: Emerging Technologies, Volume 16, Issue 1, pp.18–35, February 2008.

2. Overall Description

2.1 Product Perspective

The Smart Traffic Management System is a standalone software system that integrates with existing traffic infrastructure to automate traffic control and improve efficiency. It is designed to work alongside traditional traffic management systems, enhancing their capabilities through advanced technologies such as computer vision and machine learning.The system interfaces with hardware components such as webcams, NodeMCU controllers, and LEDs to detect vehicles, adjust traffic signals, and prioritize emergency vehicles. It also includes a user interface for monitoring traffic conditions and controlling the system manually if needed. From a broader perspective, the system can be seen as part of a larger trend towards smart cities and intelligent transportation systems. It aligns with efforts to use technology to improve urban mobility, reduce congestion, and enhance safety on roads.In summary, the Smart Traffic Management System is a software solution that complements existing traffic management infrastructure, offering advanced capabilities to improve traffic flow and emergency vehicle response times.


START
Camera capturing real time images of vehicles
sending these images to MCU
is ambulance detected?
If red signal
Change to Green light
If yellow signal
Change to green light
If green signal
Keep it green
Resume back to flow
Count number of vehicles captured
Number of vehicles >0?
Per vehicle time = time+2
Regular Timings
END

2.2 Product Features

- Vehicle Detection: Uses RCNN and OpenCV to detect and count vehicles in real-time.

- Traffic Signal Control: Adjusts traffic signal timings based on traffic density to optimize traffic flow.
- Emergency Vehicle Prioritization: Provides priority passage for emergency vehicles by turning traffic lights green.
- User Interface: Allows users to monitor traffic conditions and control the system manually if needed.
- Hardware Integration: Interfaces with webcams, NodeMCU controllers, and LEDs to control traffic signals.
- Scalability: Can scale to handle increased traffic volume and additional lanes or intersections.
- Reliability: Provides reliable operation under varying traffic conditions.
- Usability: Offers a user-friendly interface for easy monitoring and control.
- Security: Ensures secure communication and operation to prevent unauthorized access.
- Performance: Provides real-time response to changes in traffic conditions.

2.3 Operating Environment

The Smart Traffic Management System operates within a complex and dynamic environment that demands compatibility with a variety of hardware and software components. It must seamlessly integrate with standard hardware such as webcams, NodeMCU controllers, and LEDs, while also being compatible with prevalent software frameworks like OpenCV, TensorFlow, and PyTorch for image processing and machine learning. The system relies on a stable network connection, typically via Wi-Fi, to facilitate communication between its components and external servers. It is designed to function effectively in diverse environmental conditions, including varying light levels, weather conditions, and temperatures. A reliable power supply is essential to ensure uninterrupted operation. Security is paramount, requiring robust measures to protect against unauthorized access and data breaches. The system also needs to comply with relevant regulations and standards related to traffic management and data privacy. Additionally, it should be

designed for ease of maintenance and updates to ensure long-term performance and compatibility with emerging technologies.

2.4 User Documentation

Components that will be delivered along with the software:

1. *Software Requirement Specification*
2. *Specification Manual*
3. *Working Manuals*
4. *Tutorial Manuals*

2.5 Assumptions and Dependencies

Assumptions:Availability of stable power supply and network connection.Deployment in urban environment with standard traffic infrastructure.Hardware compatibility and user training.

Dependencies:Reliability of hardware components.Accuracy and efficiency of RCNN and OpenCV algorithms.Timely detection of emergency vehicles.Design of user interface and user training

3. System Features

3.1.1 Description and Priority

The Smart Traffic Management System incorporates several key features to automate traffic control and enhance road safety. At the core of the system is its ability to detect and count vehicles in real-time using RCNN and OpenCV, enabling it to adjust traffic signal timings based on traffic density and optimize traffic flow. Additionally, the system prioritizes emergency vehicles by providing them with priority passage through the manipulation of traffic lights. The system's user interface allows for easy monitoring of traffic conditions and provides manual control options if needed. Hardware integration with webcams, NodeMCU controllers, and LEDs ensures seamless operation. The system is designed for scalability, reliability, usability, and security, making it a comprehensive solution for efficient traffic management.

3.1.2 Functional Requirements

- Description: The system shall detect and count vehicles, adjust traffic signals based on traffic density, and prioritize emergency vehicles.
- Use Case Scenarios:
- User observes traffic flow on the user interface
- System detects an emergency vehicle and prioritizes its passage

- User Interaction and Interfaces: The system will have a user interface for monitoring traffic conditions and controlling traffic signals.
- Input and Output Requirements: Input will be from webcams and user interface. Output will be traffic signal control commands.
- Error Handling and Recovery: The system shall handle errors such as lost connection to webcams and recover gracefully.

4.NONFUNCTIONAL REQUIREMENTS

4.1 PERFORMANCE REQUIREMENTS

The steps involved to perform the implementation of airline database are as listed below.

A) E-R DIAGRAM The E-R Diagram constitutes a technique for representing the logical structure of a database in a pictorial manner. This analysis is then used to organize data as a relation, normalizing relation and finally obtaining a relation database.

- **ENTITIES:** Which specify distinct real-world items in an application.
- **PROPERTIES/ATTRIBUTES:** Which specify properties of an entity and relationships.
- **RELATIONSHIPS:** Which connect entities and represent meaningful dependencies.

B) NORMALIZATION:

The basic objective of normalization is to reduce redundancy which means that information is to be stored only once. Storing information several times leads to wastage of storage space and increase in the total size of the data stored.

If a database is not properly designed it can give rise to modification anomalies. Modification anomalies arise when data is added to, changed or deleted from a database table. Similarly, in traditional databases as well as improperly designed relational databases, data redundancy can be a problem. These can be eliminated by normalizing a database.

Normalization is the process of breaking down a table into smaller tables. So that each table deals with a single theme. There are three different kinds of modifications of anomalies and formulated the first, second and third normal forms (3NF) is considered sufficient for most practical purposes. It should be considered only after a thorough analysis and complete understanding of its implications.

4.2 SAFETY REQUIREMENTS

If there is extensive damage to a wide portion of the database due to catastrophic failure, such as a disk crash, the recovery method restores a past copy of the database that was backed up to archival storage (typically tape) and reconstructs a more current state by reapplying or redoing the operations of committed transactions from the backed up log, up to the time of failure.

4.3 SECURITY REQUIREMENTS

Security systems need database storage just like many other applications. However, the special requirements of the security market mean that vendors must choose their database partner carefully.

4.4 SOFTWARE QUALITY ATTRIBUTES

- **AVAILABILITY:** The website should be available on the specified date and specified time as many customers are using the platform simultaneously.
- **CORRECTNESS:** The website should reach the target audience and produce the most effective outcome of the specified problems.
- **MAINTAINABILITY:** Maintenance of the website is one of the most important aspect of the development process bonce the project is deployed.
- **USABILITY:** The outcome must reach the needs ofpeiple and people must be satisfied with the presented resaut.

Models	Accuracy
Decision Tree	82.79
SVC	69.05
Random Forest	89.42
Logistic Regression	83.32
K Nearest Neighbors	74.34
XGBRF	85.89
CatBoost Classifier	92.64

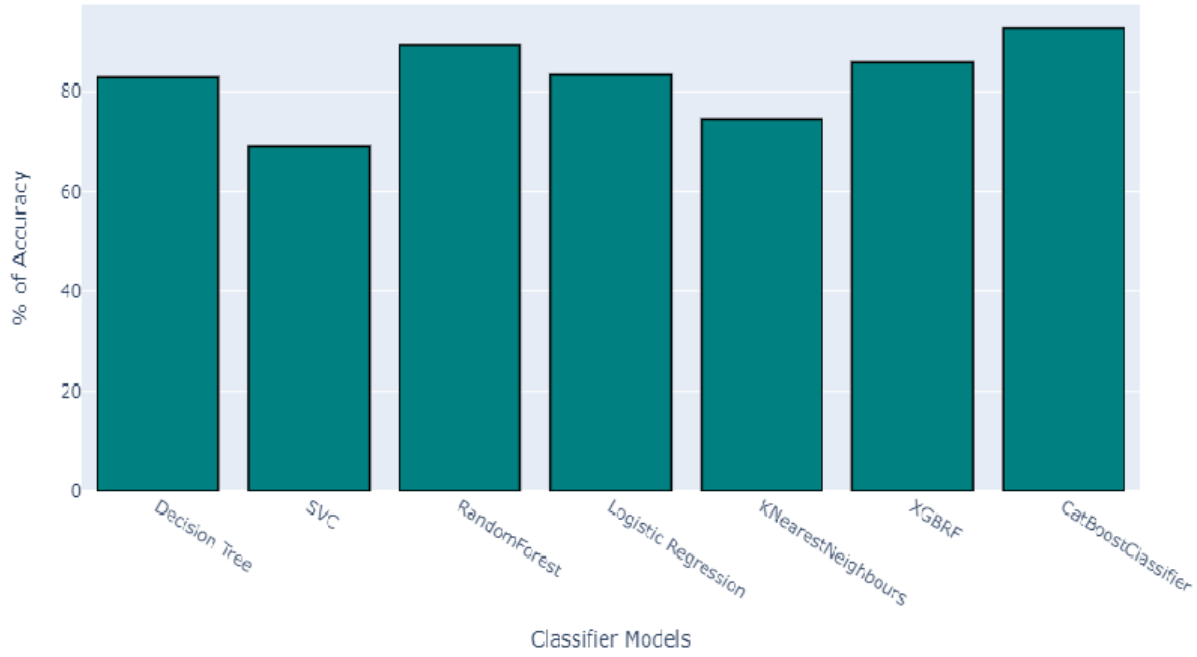

Table 3. K Fold Cross Validation Scores

	Fold 1	Fold 2	Fold 3	Fold 4	Fold 5	Mean Accuracy
Random Forest Classifier	0.895349	0.930233	0.872093	0.918605	0.929412	0.909138
Logistic Regression	0.918605	0.918605	0.872093	0.872093	0.917647	0.899808
Linear SVM	0.895349	0.883721	0.872093	0.848837	0.905882	0.881176
Radial SVM	0.941860	0.883721	0.813953	0.883721	0.882353	0.881122
KNeighbors Classifier	0.883721	0.883721	0.837209	0.883721	0.894118	0.876498
Gaussian Naive Bayes	0.895349	0.906977	0.779070	0.848837	0.917647	0.869576

Table 4. Classification Report

	Precision (Class 1, Class 2)	Recall (Class 1, Class 2)	Fscore (Class 1, Class 2)
Linear SVM	(0.911, 0.850)	(0.911, 0.850)	(0.911, 0.850)
Radial SVM	(0.855, 0.906)	(0.955, 0.725)	(0.902, 0.805)
Logistic Regression	(0.888, 0.888)	(0.941, 0.800)	(0.914, 0.842)
Random Forest Classifier	(0.891, 0.941)	(0.970, 0.800)	(0.929, 0.864)
KNeighbors Classifier	(0.820, 0.866)	(0.941, 0.650)	(0.876, 0.742)
Gaussian Naive Bayes	(0.923, 0.813)	(0.882, 0.875)	(0.902, 0.843)

5.Other Non- Functional Requirements

5.1 Safety Requirements

The Smart Traffic Management System is designed with several safety requirements to ensure the safety of road users and the efficient flow of traffic. One of the primary safety features is the system's ability to provide immediate priority passage for emergency vehicles by turning traffic lights green when detected. This ensures that emergency vehicles can navigate through traffic quickly and safely. Additionally, the system must prioritize pedestrian safety by coordinating traffic signals to allow safe crossing. It must also maintain the integrity of traffic signals to prevent confusion and accidents. Adherence to local traffic laws and regulations is crucial to ensure safe and legal traffic management. The system should also adapt to weather conditions to ensure safe traffic management during adverse weather. Avoidance of traffic congestion is another important safety requirement to prevent unsafe conditions on the road. Coordination with emergency response services is essential to ensure safe and efficient passage for emergency vehicles. The system must be fault-tolerant to ensure continued safe operation in the event of hardware or software failures. Users of the system must undergo safety training to ensure they understand how to operate the system safely. Finally, the system must have security measures in place to prevent unauthorized access and ensure the safety of traffic data.

5.2 Security Requirements

The Smart Traffic Management System incorporates several security measures to protect against unauthorized access and ensure the safety of traffic data. Access control is enforced through strict measures to prevent unauthorized access to sensitive data and system functionalities. All data transmitted and stored by the system is encrypted to protect it from unauthorized access. Secure communication protocols are used to ensure that data exchanged between system components is not intercepted or tampered with. Users and system components are authenticated and authorized before accessing sensitive data or performing critical operations. Data stored by the system is stored securely to prevent unauthorized access or data breaches. The system maintains logs of all user and system activities for auditing and monitoring purposes. Backup and recovery mechanisms are in place to protect data in case of system failures or disasters. The system receives regular security updates to protect against new vulnerabilities and threats. Users of the system receive training on security best practices to prevent security breaches. Physical access to system

components is restricted to prevent unauthorized access. These security measures ensure the integrity and confidentiality of traffic data and the overall security of the system.