Software Requirements Specification

for

Traffic Detection in Hairpin Turns

Version 1.0  
  
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# Introduction

## Purpose

India is a country with diverse terrain, some of them are covered with mountains having roads full of hair pin turns. These roads have mountain wall on one side and deep trenches on the other making it very dangerous and prone to accidents. The sharp turns make the situation worse as there is no space left for two vehicles to cross in these turns and can lead to head-on collision.  
 To address this issue we are providing sensor-based traffic signals that will warn the driver on each side of turn regarding any approaching vehicles from the other side and save the day.

## Intended Audience and Reading Suggestions

**Development Team**: This includes software developers, hardware engineers, and any other technical personnel involved in building the sensor-based traffic signal system. They need detailed technical information to implement the system correctly.

**Project Managers**: Project managers will need a clear understanding of the system's requirements to plan resources, set timelines, and manage the development process effectively.

**Stakeholders**: These may include city or government officials, transportation agencies, and citizens affected by the traffic signal system. They need a high-level understanding of the system's goals and functionalities.

**Quality Assurance and Testing Team**: The testing team will use the SRS as a reference to create test cases and ensure that the final system meets the specified requirements.

**Maintenance and Support Teams**: Those responsible for maintaining and supporting the system after deployment need to understand the system's requirements to provide efficient support and updates.

**Regulatory Bodies**: If there are specific regulations or standards that the traffic signal system must adhere to, representatives from regulatory bodies may need to review the SRS.

## Product Scope

## Our product aims to address the safety concerns on mountainous roads with hairpin turns by introducing a sensor-based traffic signal system. The scope of this product includes the following key features and functionalities:

## Sensor Deployment: The system will utilize a network of sensors strategically placed at critical points along the mountain roads, particularly at hairpin turns.

## Vehicle Detection: The sensors will be equipped with technology capable of detecting approaching vehicles from both sides of the hairpin turn.

## Data Processing: The collected sensor data will be processed in real-time to determine the presence, speed, and proximity of vehicles on either side of the turn.

## Warning Signals: When an approaching vehicle is detected from the opposite direction, the system will activate warning signals, alerting drivers on both sides of the turn.

## Warning Types: The warning signals will include visual indicators such as flashing lights and possibly digital message boards, audible alerts, and potentially automated communication with onboard vehicle systems (if applicable).

## User Interface: The system may include a user interface for monitoring and configuring the sensors, as well as reporting and logging incidents.

## Power Supply: The product will have provisions for power supply, which may include solar panels or other sustainable energy sources, ensuring uninterrupted operation.

## Weather Resistance: The system will be designed to withstand various weather conditions prevalent in mountainous regions, including rain, snow, and extreme temperatures.

## Remote Monitoring: Depending on requirements, the product may offer remote monitoring capabilities, allowing authorities to track system performance and respond to incidents.

# Overall Description

## Product Perspective

## The sensor-based traffic signal system for mountainous roads is designed to operate within a broader context of road safety and transportation infrastructure. Understanding its product perspective is crucial for stakeholders, developers, and users to appreciate how it fits into the larger ecosystem and how it interacts with various elements. Here's the product perspective:

## Integration with Existing Road Infrastructure: The product is intended to seamlessly integrate with existing mountainous road infrastructure without requiring significant modifications to the roads themselves. It complements the current road design by enhancing safety at hairpin turns.

## Complementary Technology: It works in synergy with existing traffic management and safety measures, such as road signs, speed limits, and lane markings. The sensor-based system augments these measures by providing real-time warnings specific to the challenging conditions of mountainous roads.

## Interactions with Drivers: The product directly interacts with drivers on the road by issuing visual warnings when detecting approaching vehicles on the opposite side of a hairpin turn. It serves as an additional safety layer and aids drivers in making informed decisions.

## Safety Enhancement: The primary objective of the system is to enhance safety on mountainous roads by reducing the risk of head-on collisions during hairpin turns. It complements other safety initiatives and traffic management strategies to create a safer driving environment.

## Data Communication: Depending on the implementation, the system may have the capability to transmit data to a central monitoring station, allowing authorities to monitor its performance, receive incident reports, and make data-driven decisions.

## Environmental Considerations: To reduce its environmental impact, the product may incorporate sustainable features such as solar panels for power generation. This aligns with broader environmental goals and regulations.

## Scalability and Customization: The product's design should consider scalability for deployment on various mountainous roads with different traffic conditions and requirements. It may also allow for customization based on specific road layouts and needs.

## Maintenance and Support: It requires a maintenance and support framework to ensure uninterrupted operation. Regular inspections, software updates, and hardware maintenance are essential aspects of the product's perspective.

## Regulatory Compliance: The product perspective includes adherence to local and national regulations related to road safety and traffic management. It must meet any standards or certifications necessary for deployment.

## User Experience: For drivers and operators, the product should provide a user-friendly experience with clear and understandable warning signals and, if applicable, an intuitive user interface for monitoring and management.

## Long-term Sustainability: The perspective encompasses the product's long-term sustainability, including its ability to adapt to changing technology, traffic patterns, and safety requirements.

## Collaboration with Authorities: The product may require collaboration with relevant transportation authorities, local governments, and law enforcement agencies to ensure effective deployment, operation, and enforcement of safety measures.

## Product Functions

This product Reads the data from the sensors placed in the roads and analyses it to get information about upcoming vehicles invisible to the drivers of the other side of the turn and regulates the traffic using traffic and hazard lights.

## User Classes and Characteristics

## User classes represent different categories of users or stakeholders who interact with a system. Each user class has distinct characteristics, needs, and roles within the system. In the context of the sensor-based traffic signal system for mountainous roads, here are some potential user classes and their characteristics:

## Drivers:

## Characteristics:

## General public, including commuters and tourists.

## Have varying levels of driving experience.

## May not be familiar with the specific mountainous road conditions.

## Needs:

## Receive timely warnings about approaching vehicles on hairpin turns.

## Understand and respond to warning signals effectively.

## Ensure safe navigation through challenging road segments.

## Traffic Signal Operators:

## Characteristics:

## Trained personnel responsible for monitoring and managing the traffic signal system.

## Have knowledge of the system's operation and maintenance.

## Needs:

## Access to a user interface for monitoring the status of sensors and the system.

## Ability to configure system settings and respond to system alerts.

## Generate reports on system performance and incidents.

## Maintenance Personnel:

## Characteristics:

## Technicians and engineers responsible for maintaining and repairing the system.

## Familiar with the system's hardware and software components.

## Needs:

## Perform routine inspections and maintenance to ensure the system's functionality.

## Identify and resolve hardware or software issues promptly.

## Keep the system operating reliably.

## Local Authorities and Government Agencies:

## Characteristics:

## Representatives from local government and transportation agencies.

## Responsible for road safety and traffic management policies.

## Needs:

## Ensure that the sensor-based traffic signal system aligns with regional safety objectives.

## Collaborate on the deployment and regulatory compliance of the system.

## Access data and reports for traffic analysis and policy decisions.

## Operating Environment

## Geographic Location:

## The system will be deployed on mountainous roads in various regions of India.These roads may vary in altitude, terrain, and climate, so the system should be adaptable to different geographical conditions.

## Weather Conditions:

## Mountainous regions can experience extreme weather conditions, including heavy rainfall, snowfall, fog, and high winds. The system should be designed to withstand and operate in such adverse weather, ensuring sensors and components remain functional.

## Temperature Extremes:

## Temperatures in mountainous regions can fluctuate significantly between day and night, and across seasons. The system should be able to operate reliably in a wide temperature range, including sub-zero temperatures during winter.

## Power Supply:

## Mountainous areas may have limited access to electrical infrastructure. The system may incorporate solar panels or other sustainable energy sources to ensure continuous operation, especially in remote locations.

## Road Conditions:

## Mountain roads can be narrow, winding, and unevenly paved.Sensors and infrastructure must be designed to withstand road vibrations, shocks, and potential damage from landslides or falling rocks.

## Remote Locations:

## Some mountainous roads may be located in remote areas with limited access to maintenance and support. The system should be designed for ease of maintenance and, if possible, offer remote monitoring and diagnostics.

## Traffic Density:

## Traffic density on mountainous roads can vary, with occasional congestion during peak travel times. The system should be capable of handling varying traffic loads and providing timely warnings even during high traffic volumes.

## Design and Implementation Constraints

The Design is based on the basic Traffic Lights used in the streets of the country but we will be using advanced Sensors to detect vehicle and warn the driver on the other side. There will be some implementation constraints due to this product being implemented in hilly terrain.

## Assumptions and Dependencies

Assumptions:  
  
  
Sensor Accuracy: Assuming the sensors deployed for vehicle detection are highly accurate and reliable in detecting approaching vehicles, considering various weather conditions and vehicle types.  
  
Data Transmission Reliability: Assuming a reliable communication infrastructure for transmitting sensor data to the processing unit, considering potential connectivity issues in remote mountainous areas.  
  
Power Supply: Assuming consistent power availability for the operation of sensors, data processing units, control units, and traffic lights, or implementing adequate backup power sources for uninterrupted functioning.  
  
Regulatory Compliance: Assuming the software design adheres to traffic safety standards and regulations governing traffic light control and hazard signaling in the region of deployment.  
  
User Response: Assuming drivers will promptly and appropriately respond to warnings provided by the system, enhancing road safety

**Dependencies:**

1. **Hardware Procurement:** Depending on timely procurement and installation of advanced sensors, microcontrollers, and other hardware components crucial for the system's operation.
2. **Network Connectivity:** Dependency on reliable network connectivity for data transmission between sensor nodes, data processing units, control units, and monitoring interfaces.
3. **Weather Conditions:** Dependency on moderate weather conditions during installation and ongoing operation to ensure optimal sensor performance and system reliability.
4. **Regulatory Approval:** Dependency on obtaining necessary approvals and compliance with local authorities for deploying the system on public roads.

# External Interface Requirements

## User Interfaces

**Driver Interface**:

* **Description:** The primary interface for drivers to receive warnings about approaching vehicles.
* **Components:**
  + Visual Interface: Flashing lights or digital message boards near the hairpin turn.
  + Audible Interface: Alarms or auditory warnings.
  + In-car Notifications: Integration with vehicle systems (if applicable) to alert drivers inside vehicles.

**Traffic Signal Operator Interface:**

* **Description:** Web-based or dashboard interface for traffic signal operators to monitor and configure the system.
* **Components:**
  + Real-time Dashboard: Displaying sensor data, warnings, and system status.
  + Configuration Tools: Interface for adjusting system settings, thresholds, and alerts.

## Hardware Interfaces

**Sensor Interface:**

* **Description:** Interface for sensor integration with the system.
* **Components:**
  + Sensor Connectivity: Compatibility with various sensor types (radar, LiDAR, cameras) for vehicle detection.
  + Data Transmission: Mechanism for transferring sensor data to the processing unit.

**Control Unit Interface:**

* **Description:** Interface for communication between the control unit and traffic lights.
* **Components:**
  + Control Signals: Communication protocol between the control unit and traffic lights to regulate signal changes.
  + Hardware Integration: Compatibility with microcontrollers or hardware controlling the traffic lights.

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## Software Interfaces

**Data Processing Interface:**

* **Description:** Software interface for processing incoming sensor data.
* **Components:**
  + Data Ingestion: Mechanism for receiving, filtering, and analyzing sensor data.
  + Algorithms: Integration with algorithms for vehicle detection and hazard identification.

**Control Software Interface:**

* **Description:** Interface between the control software and the hardware components (traffic lights).
* **Components:**
  + Signal Control: APIs or communication protocols for sending commands to adjust traffic light signals.
  + Status Feedback: Mechanism to receive status updates from traffic lights regarding changes and operation.