Software Requirements Specification

for

Pothole Detection System

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Revision History

Name	Date	Reason For Changes	Version

1. Introduction

1.1 Purpose

This Software Requirements Specification (SRS) document pertains to the development of the Pothole Detection Software, utilizing IoT, Cloud Computing, and AI/ML technologies. It outlines the requirements for the software system, detailing its functionalities and features. The scope of this SRS encompasses the entire Pothole Detection Software system, including all subsystems and modules.

1.2 Document Conventions

This document adheres to the following conventions:

- Requirement priorities are denoted using a standardized priority scheme (e.g., High, Medium, Low).
- Each requirement statement is assigned its own priority level.

1.3 Intended Audience and Reading Suggestions

This document is intended for various stakeholders involved in the development, deployment, and maintenance of the Pothole Detection Software, including developers, project managers, testers, documentation writers, and other relevant personnel.

The SRS is organized as follows:

- Section 1 provides an introduction to the document, including its purpose and scope.
- Section 2 describes the overall product scope and its objectives.
- Section 3 details specific requirements, including functional and non-functional requirements.
- Section 4 includes any external references or documents mentioned within this SRS.

1.4 Product Scope

The Pothole Detection Software is a solution aimed at detecting potholes on road surfaces using IoT sensors, Cloud Computing infrastructure, and AI/ML algorithms. It serves to enhance road safety and infrastructure maintenance by providing real-time detection and notification of potholes to relevant authorities. By leveraging IoT, Cloud Computing, and AI/ML technologies, the software aims to automate the process of pothole detection and reporting, thereby improving the efficiency of road maintenance operations.

1.5 References

1. **IoT Sensor Documentation Title:**
- Author: XYZ Sensors Inc.
- Version Number: 2.0
- Date: January 15, 2023
- Source/Location: https://www.xyzsensors.com/docs/iot-sensor-docs

2. **Cloud Computing Infrastructure Specifications Title:**
- Author: CloudTech Solutions
- Version Number: 1.5
- Date: February 1, 2023
- Source/Location: https://www.cloudtechsolutions.com/specs/cloud-infrastructure-specs

3. **AI/ML Algorithms Documentation Title:**
- Author: AI Innovations Research Lab
- Version Number: 3.2
- Date: March 10, 2023
- Source/Location: https://www.aiinno.com/docs/ai-ml-algorithms-docs

4. **Road Safety Standards and Regulations:**
- Author: Department of Transportation
- Date: December 20, 2022
- Source/Location: https://www.dot.gov/road-safety-standards

2. Overall Description

2.1 Product Perspective

The Pothole Detection Software is a new, self-contained product designed to address the need for efficient and automated detection of potholes on road surfaces. It integrates IoT sensors, Cloud Computing infrastructure, and AI/ML algorithms to provide real-time detection and reporting of potholes. While it may interface with existing transportation management systems or databases for data exchange and reporting, it primarily operates as an independent solution for pothole detection.

2.2 Product Functions

- Collect data from IoT sensors deployed on various devices.
- Process sensor data using AI/ML algorithms to identify potential potholes.
- Generate alerts or notifications for identified potholes.
- Store and manage pothole data in a centralized database.
- Provide reporting and visualization of pothole data for analysis and decision-making.

2.3 User Classes and Characteristics

- **City Officials:** Responsible for road maintenance and infrastructure management. They have access to all features of the software and require detailed reporting and analysis capabilities.
- **Maintenance Crews:** Field personnel tasked with repairing identified potholes. They may have limited access to the software for viewing pothole locations and details.
- **System Administrators:** IT personnel responsible for managing the software's deployment, configuration, and maintenance.

2.4 Operating Environment

- **Hardware Platform:** Compatible with IoT sensor devices and standard computing hardware for Cloud Computing.
- **Operating System:** Compatible with major operating systems such as Windows, Linux, and MacOS.
- **Software Components:** Requires compatible web browsers for user interface access and communication protocols for IoT sensor data transmission.

2.5 Design and Implementation Constraints

- **Regulatory Compliance:** Must comply with relevant data privacy and road safety regulations.
- **Hardware Limitations:** IoT sensors may have constraints on power consumption and data transmission bandwidth.
- **Technological Compatibility:** Requires compatibility with selected Cloud Computing platforms and AI/ML frameworks.

2.6 User Documentation

User documentation components include:

- User Manuals
- Future integration with external systems

2.7 Assumptions and Dependencies

- **Assumptions:** The software assumes the availability and reliability of IoT sensor data for pothole detection. It also assumes access to Cloud Computing infrastructure for data processing and storage.
- **Dependencies:** The project depends on the availability of IoT sensor hardware, Cloud Computing services, and AI/ML libraries for implementation.

3. External Interface Requirements

3.1 User Interfaces

- **Dashboard:** Provides an overview of detected potholes, including a map view with pothole locations marked.
- **Pothole Details:** Allows users to view detailed information about individual potholes, such as location coordinates, severity, and timestamp.
- **Alerts and Notifications:** Displays alerts and notifications for new pothole detections.
- **Settings:** Enables users to configure notification preferences and customize dashboard views.

3.2 Hardware Interfaces

The software will integrate with IoT sensors deployed on vehicles or roadways to collect data.

- **Supported Devices:** Various IoT sensor devices capable of detecting road conditions.
- **Data Interaction:** Sensors transmit data to the software for processing via wireless communication protocols such as Bluetooth or Wi-Fi.

3.3 Software Interfaces

- **Cloud Computing Infrastructure:** Utilizes cloud-based servers for data processing and storage.
- **AI/ML Algorithms:** Integrates AI/ML models for pothole detection and analysis.
- **Database System:** Stores pothole data in a database for retrieval and management.

3.4 Communications Interfaces

- **Data Transfer:** Utilizes HTTPS protocol for secure data transfer between IoT sensors and the cloud server.
- **Alert Notifications:** Sends email or SMS notifications to relevant stakeholders upon detecting new potholes.
- **API Communication:** Uses RESTful API endpoints for communication between the software and external systems.
- **Data Synchronization:** Implements real-time synchronization mechanisms to ensure consistency of pothole data across distributed systems.

4. System Features

4.1 System Feature 1

4.1.1 Description and Priority

The Pothole Detection feature enables the software to detect and report potholes on road surfaces in real-time. It is of High priority as it forms the core functionality of the software, contributing to road safety and infrastructure maintenance.

4.1.2 Stimulus/Response Sequences

- **Stimulus:** User initiates the pothole detection process.
- **Response:** The system collects data from IoT sensors, processes it using AI/ML algorithms, identifies potholes, and generates alerts or notifications.

4.1.3 Functional Requirements

- **REQ-1:** The system shall collect data from IoT sensors deployed on various devices.
- **REQ-2:** The system shall process sensor data using AI/ML algorithms to identify potential potholes.
- **REQ-3:** The system shall generate alerts or notifications for identified potholes.
- **REQ-4:** The system shall store and manage pothole data in a centralized database.
- **REQ-5:** The system shall provide reporting and visualization of pothole data for analysis and decision-making.

4.2 System Feature 2

4.2.1 Description and Priority

The Notification feature allows the software to send alerts and notifications to relevant stakeholders upon detecting new potholes. It is of medium priority as it enhances the effectiveness of pothole detection by notifying responsible authorities promptly.

4.2.2 Stimulus/Response Sequences

- **Stimulus:** System detects a new pothole.
- **Response:** The system sends email or SMS notifications to relevant stakeholders, including city officials and maintenance crews.

4.2.3 Functional Requirements

- **REQ-6:** The system shall allow users to configure notification preferences.
- **REQ-7:** The system shall send email notifications to designated email addresses.

5. Other Nonfunctional Requirements

5.1 Performance Requirements

- **Real-time Processing:** The software shall process incoming data from IoT sensors and perform pothole detection within milliseconds to ensure timely alert generation.
- **Scalability:** The system shall be able to handle a high volume of data from IoT sensors and scale horizontally to accommodate increased sensor deployments without compromising performance.
- **Response Time:** The software shall respond to user queries and generate reports within seconds, even under peak load conditions.

5.2 Safety Requirements

- **Data Privacy:** The software shall adhere to data privacy regulations such as GDPR to ensure the confidentiality of personal information collected by IoT sensors.
- **Reliability:** The system shall accurately detect potholes to prevent accidents and ensure road safety for drivers and pedestrians.
- **Fault Tolerance:** The software shall be designed with redundancy and failover mechanisms to ensure continuous operation in the event of hardware or software failures.

5.3 Security Requirements

- **Data Encryption:** All communication between IoT sensors, cloud servers, and user interfaces shall be encrypted using industry-standard encryption algorithms to prevent unauthorized access.
- **Access Control:** The software shall implement role-based access control (RBAC) to restrict access to sensitive functionality and data based on user roles and permissions.
- **Audit Trails:** The system shall maintain audit trails of user activities and system events to facilitate forensic analysis in case of security incidents.

5.4 Software Quality Attributes

- **Maintainability:** The software shall be modular and well-documented to facilitate future enhancements and maintenance tasks.
- **Usability:** The user interface shall be intuitive and user-friendly, with clear navigation and informative error messages to assist users in operating the software effectively.
- **Reliability:** The system shall have a high level of reliability, with minimal downtime and accurate pothole detection to instill confidence in users.

5.5 Business Rules

- **Authorized Users:** Only authorized personnel, such as city officials and maintenance crews, shall have access to the software for pothole detection and management tasks.
- **Data Ownership:** The data collected by IoT sensors and stored in the system shall be owned by the respective municipalities or organizations deploying the sensors, with the software provider having limited rights for analysis and reporting purposes.

6. Other Requirements

6.1 Database Requirements

- The software shall utilize a relational database management system (RDBMS) to store pothole data.
- Database schema shall be designed to efficiently store and retrieve pothole information, including location coordinates, severity, and timestamp.
- The system shall implement database backup and recovery mechanisms to ensure data integrity and availability.

6.2 Internationalization Requirements

- The user interface shall support multiple languages to accommodate users from different linguistic backgrounds.
- Date and time formats shall be localized based on user preferences and geographical location.

6.3 Legal Requirements

- The software shall comply with relevant data privacy regulations, such as GDPR, regarding the collection and processing of personal data.
- The system shall adhere to transportation safety regulations and standards to ensure the accuracy and reliability of pothole detection.

6.4 Reuse Objectives

- The software shall be designed with modularity and reusability in mind to facilitate the integration of future enhancements and additional functionalities.
- Code components implementing AI/ML algorithms for pothole detection shall be designed for reuse in other related applications or projects.

Appendix A: Glossary

- **IoT:** Internet of Things
- **AI/ML:** Artificial Intelligence/Machine Learning
- **API:** Application programming interface
- **HTTPS:** Hyper Text Transfer Protocol Secure
- **RDBMS:** Relational Database Management System
- **GDPR:** General Data Protection Regulation

Appendix B: Analysis Models

- **Data Flow Diagram:** Illustrates the flow of data between IoT sensors, cloud computing infrastructure, AI/ML algorithms, and user interfaces.

- **Class Diagram:** Represents the structure of software components, including classes for pothole detection, user management, and data storage.

Appendix C: To Be Determined List

- **TBD 1:** Specify hardware specifications for IoT sensors.

- **TBD 2:** Define the backup frequency and retention policy for the database.