Software Requirements Specification (SRS) Document

1. Introduction

1.1 Purpose

The purpose of this project is to develop a real-time, IoT-based pollution monitoring system that can detect and measure pollution levels in air, water, and soil using integrated sensors, Automatically collect and process data using a Raspberry Pi and display it on the Blynk IoT platform.

1.2 Scope

Real-time environmental pollution monitoring system that tracks air, water, and soil pollution using IoT technology.

- **Air quality** (smoke, CO, methane),**water quality** (turbidity),**soil condition**(moisture and temperature)
- Uses Raspberry Pi 3 as the central controller
- Collects data from multiple sensors via MCP3008 ADC
- Displays real-time values on the Blynk IoT app
- Voice alerts using Bluetooth speaker
- Visual data representation on Blynk app
- Audio alerts for immediate attention

1.3 Definitions, Acronyms, and Abbreviations

- **IoT –** Internet of Things
- **API –** Application Programming Interface
- **ADC –** Analog to Digital Converter
- **SMS –** Short Message Service
- **CO –** Carbon Monoxide

1.4 References

- Research papers on **Real time pollution monitoring system.**
- [1]Gupta, R., & Kumar, S. (2021). Smart Environmental Monitoring System Using IoT. International Journal of Computer Applications.

- [2] Kumar, S., & Jasuja, A. (2023). Air Quality Monitoring System Based on IoT using Raspberry Pi. International Journal of Environmental Science and Technology.
- [3] Zhang, Y., & Wang, L. (2022). A Review of IoT-Based Environmental Monitoring Systems Sensors.
- Documentation on **Blynk app,Bluetooth speaker,and Speech Recognition APIs**

2. Overall Description

2.1 Product Perspective

The Real-Time Pollution Monitoring System is designed as a standalone IoT-based product that integrates multiple environmental sensors to monitor air, water, and soil pollution levels.

2.2 Product Features

- **Multi-Environmental Monitoring**
- **Real-Time Data Processing**
- **IoT Integration**
- **Automated Alerts System**
- **Visual Dashboard Interface**
- **Integrated Sensor Network**

2.3 User Characteristics

- **General Users** – Access data via the Blynk IoT app for awareness or educational purposes.
- **Technical Users (System Admins/Developers)** – Configure and maintain hardware (Raspberry Pi, sensors, speaker, etc.) Manage backend software (Python code, APIs like Twilio, eSpeak, Blynk).

2.4 Constraints

- Accuracy of pollution readings can vary depending on sensor quality and environmental conditions.
- Limited processing power of Raspberry Pi 3 may restrict scalability if additional sensors or modules are added.
- Sensors may need frequent calibration to maintain data reliability.

2.5 Assumptions and Dependencies

- **Raspberry Pi** and **sensors** will have a stable and uninterrupted power supply for real-time monitoring.
- Users can monitor data remotely via the **Blynk mobile app** or dashboard.

3. Specific Requirements

3.1 Functional Requirements

1. **Air Pollution Monitoring**

Uses MQ2 and MQ3 sensors to detect gases (methane, smoke, alcohol).

Converts analog sensor data to digital using MCP3008 ADC.

Displays real-time AQI on the Blynk IoT platform with categorized health impact levels.

Uses multiple sensors for source triangulation and hotspot alerts.

2. **Soil Condition Monitoring**

Measures moisture, temperature, pH, and salinity to assess soil health.

Detects heavy metals (lead, arsenic, mercury) for contamination analysis.

Provides nutrient (NPK) analysis and fertilizer recommendations.

3. **Real-Time Alerts**

Uses Twilio API for instant SMS notifications.

Integrates eSpeak for real-time voice alerts.

Sends alerts to farmers, authorities, and environmental agencies.

4. **IoT Platform Integration (Blynk)**

Remote monitoring via mobile/web interface.

Real-time data visualization with customizable dashboards.

Cloud storage for long-term trend analysis.

5. **Threshold & Emergency Alerts**

Predefined safety levels trigger alerts for hazardous conditions.

Emergency alerts if multiple gases exceed critical levels.

Users can customize sensitivity settings based on location.

6. **Automated & Multi-User System**

Operates autonomously, minimizing manual intervention.

Supports multiple users, ensuring broad stakeholder engagement.

3.2 Non-Functional Requirements

Performance – The system should respond to sensor input and send alerts within 2 seconds of detecting critical levels.

Usability –Provide an intuitive user interface on the Blynk platform for non-technical users.

Scalability – The system should accommodate additional sensors or functionalities for broader environmental monitoring.

Reliability – Ensure accurate data collection and transmission by calibrating sensors and using robust hardware.

Portability - Use lightweight components like Raspberry Pi to ensure the system can be deployed in diverse locations.

3.3 External Interface Requirements

User Interfaces – GUI using Tkinter or PyQt6 for real-time data visualization and control.

Hardware Interfaces – Requires MQ2 & MQ3 gas sensors, turbidity sensor, soil moisture & temperature sensors, Raspberry Pi, MCP3008 ADC, Wi-Fi/Ethernet module, microphone, and speakers for sensor data collection and alerts.

Software Interfaces – Uses Python for programming, Blynk for IoT visualization, Twilio API for SMS notifications, and eSpeak for voice alerts.

4. System Features

4.1 Air Pollution Monitoring Module

- **MQ2 & MQ3 Sensors** – Detects harmful gases such as smoke, methane, and carbon monoxide.
- **Data Processing** – Sensor readings are converted using MCP3008 ADC and processed by Raspberry Pi.
- **Monitoring & Alerts** – Data is uploaded to Blynk IoT for real-time monitoring, triggering alerts when pollution exceeds safe levels.

4.2 Water Pollution Monitoring Module

- **Turbidity Sensor** – Measures water clarity and detects contamination levels.
- **Data Processing** – Sensor data is digitized using MCP3008 ADC and sent to Raspberry Pi.
- **Monitoring & Alerts** – Real-time updates are displayed on Blynk IoT, with alerts triggered for poor water quality.

4.3 Soil Pollution Monitoring Module

- **Soil Moisture & Temperature Sensors** – Tracks soil conditions for agricultural and environmental monitoring.
- **Data Processing** – Sensor data is processed through MCP3008 ADC before being sent to Blynk IoT.
- **Monitoring & Alerts** – Farmers receive instant alerts when soil conditions require attention.

4.4 IoT & Alerts Module

- **Raspberry Pi** – Manages sensor data and system operations.
- **Blynk IoT** – Provides a real-time dashboard for environmental data visualization.
- **Twilio API** – Sends SMS alerts when pollution levels exceed predefined thresholds.
- **eSpeak** – Generates voice alerts to notify users of critical pollution levels.

5. Other Requirements

5.1 Software Requirements

- **Blynk Application**: Displays sensor data and sends notifications.
- **Python**: Codebase for sensor data processing, IoT communication, and threshold checks.
- **Voice Alert System**: Uses a text-to-speech library for real-time audio alerts.

5.2 Hardware Requirements

- **Raspberry Pi** – Central processing & IoT hub
- **Air Sensors:** MQ2 (smoke, methane), MQ3 (CO, alcohol)
- **Water Sensor:** Turbidity sensor (water clarity)
- **Soil Sensors:** Moisture & temperature sensors
- **MCP3008 ADC:** Converts analog to digital signals
- **Speaker & Bluetooth Module:** Provides audio alerts when thresholds are breached

Conclusion

This **SRS document** outlines the features, and requirements providing a comprehensive guide for the development and implementation of the Real-Time Pollution Monitoring System, ensuring that it meets stakeholder expectations and operates effectively in diverse environments.

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