Software Requirements Specifications

for

Smart Cloud Based Soil Advisor

Version 1.0 approved

Prepared by BSSE-25-28

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GROUP COMPOSITION

Table 1: Showing the group composition

NAME	REGISTRATION NUMBER
MUGOYA MOSES	21/U/10447/PS
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List of Tables

Table Of content

Revision History

Table 2: showing revision history

Name	Date	Reason For Changes	Version
BSSE-24-28	17TH OCTOBER,2024	Initial Version	**Version 1.0**

1 Introduction

The purpose of this document is to specify the software requirements for the **"Smart Cloud-Based Soil Advisor" (CBSA)** system, version 1.0. This SRS defines the functionality, constraints, and external interfaces of the system. The Smart Cloud-Based Soil Advisor enables agricultural organisations and farmers to make data-driven decisions based on real-time data on soil health metrics, including moisture, temperature, and nutrient levels, and automated recommendations for sustainable farming for optimising agricultural practices.

1.1 Purpose

The purpose of the CBSA system is to provide a cloud-based platform that monitors soil health parameters such as moisture, temperature, and nutrient levels (NPK) using IoT sensors and offers actionable insights and recommendations for crop selection, irrigation, and nutrient management.

1.2 Document Conventions

To make this SRS more readable and effective, it is written using

Font style: Times New Roman, 12pt for paragraphs, 14pt for Heading 2, 18pt for Heading 1.

Formatting: Italicized text for technical terms, bold headings, and 1.5-line spacing for readability.

1.3 Intended Audience and Reading Suggestion

This document is intended for the following audiences:

- **Developers**: Responsible for implementing system functionalities based on the requirements described in this document.
- **Project Managers:** Oversee the project's progress, ensuring alignment with the system requirements and timelines.

- **Testers:** Validate the system against the defined functional and performance requirements, ensuring the software meets the desired standards.
- **Agricultural Organisations**: The primary users of the system, including agricultural cooperatives, extension services, and research institutions. They will use the system to monitor soil health across multiple farms and provide advisory services to farmers as they can access the system to understand high-level recommendations and soil health data, but the main users will be agricultural experts within organisations who analyse and manage the data.

1.4 Product Scope

The Smart Cloud-Based Soil Advisor system aims to monitor real-time soil health conditions (moisture, temperature, nutrients) using IoT sensors. The system will provide actionable insights, such as recommendations for optimal crop selection, improving farm productivity and resource use.

1.4.1 Goal

The goal of the system is to empower agricultural organisations to make data-driven decisions, improve resource efficiency, and promote sustainable farming practices by providing real-time monitoring of soil conditions.

1.4.2 Objectives

- To provide real-time soil monitoring by continuously tracking soil health parameters like moisture, temperature, and nutrients using IoT sensors.
- To offer actionable insights that include automated crop recommendations, irrigation schedules, and nutrient management advice based on real-time data.
- To support decision-making for agricultural organisations with data analytics tools to assess soil health trends, forecast future needs, and enhance farm productivity.
- To promote sustainability by reducing the environmental impact of farming, optimising water usage, reducing fertiliser waste, and encouraging crop rotations that maintain soil health.

1.4.3 Benefits

- **Improved Yield:** By making timely, data-driven decisions, farmers and organisations can improve crop yields and optimise resource allocation.
- **Cost Efficiency:** Optimised use of water, fertilisers and soil testing, offering a more sustainable approach.
- **Scalability:** The cloud-based architecture allows for easy scaling from small farms to large agricultural organisations, without needing expensive local infrastructure.
- **Data-Driven Farming:** Historical data analysis and trends provide long-term insights, improving the overall planning and execution of farming practices.

1.5 References

- Soil Testing in India, "Soil Testing in India, Department of Agriculture & Cooperation Ministry of Agriculture Government of India," 2011. [Online]. Available: https://agriculture.uk.gov.in/files/Soil_Testing_Method_by_Govt_of_India.pdf

- Operational Guidelines, "National Mission for Sustainable Agriculture, Department of Agriculture & Cooperation Ministry of Agriculture Government of India," 2014. [Online].
  Available: https://nmsa.dac.gov.in/pdfdoc/NMSA_Guidelines_English .pdf

- Nattapol Kaewmard, and Saiyan Saiyod, "Sensor Data Collection and Irrigation Control on Vegetable Crop Using Smart Phone and Wireless Sensor Networks for Smart Farm," in Proc. IEEE Conference on Wireless Sensors (ICWiSE), Jul. 2014, pp. 106–112, doi: 10.1109/ICWISE.2014.7042670.

2 Overall Description

2.1 Product Perspective

This product will be a standalone system aimed at farmers and agricultural organisations. It integrates IoT sensor data with a cloud-based platform to deliver real-time insights. The product functions as a part of broader smart agriculture solutions, connected via APIs to external weather services and advisory platforms.

2.2 Product Functions

- **Monitoring Soil Health**: Continuous tracking of soil moisture, temperature, and nutrient levels.
- **Automated Recommendations**: Intelligent recommendations on crop choice, irrigation, and fertilisation based on real-time data.
- **User Interfaces**: Web and mobile apps provide accessible, real-time updates and notifications.
- **Alerts**: Sends critical alerts when soil conditions deviate from optimal ranges.

2.3 User Classes and Characteristics

- **Cooperative Farmers**: Primary users interested in soil health and crop recommendations.
- **Agricultural Experts**: Secondary users analysing soil health data for research.
- **System Administrators**: For managing and troubleshooting system operations in organisations that will be using the system.

2.4 Operating Environment

- **Hardware**: The system shall use sensors for moisture, temperature, and NPK.
- **Software**: The system shall use a cloud-based platform with web and mobile interfaces.
- **Network**: Wireless communication via Wi-Fi or cellular network.

2.5 Design and Implementation Constraint

Server Requirements:

The CBSA system's backend shall be hosted on an online server that shall require a storage of about 100Gb of size to handle data for analytics and user accounts.

Access Requirements:

The system shall be accessed via web browsers and maybe mobile applications.

Language Requirements:

English shall be used as the language in the applications.

Communication Protocols:

HTTPs protocol shall be used as the communication protocol to receive and send requests via the applications.

Security Considerations:

The user such their soil data analytics and profile shall be safeguarded from unauthorised access to other parties as it is sensitive.

User Documentation:

A user manual shall be available. This shall include the online user manual that shall be available on the applications blog and also downloadable for hard copy.

2.6 Assumptions and Dependencies

- The system assumes stable internet connectivity for real-time data transmission to the cloud, especially during peak usage times.
- The sensors and other hardware will have a reliable power source, whether from solar, battery, or direct electrical power, whichever the client may want to use.
- Soil characteristics within a monitored area are assumed to be relatively uniform; otherwise, multiple sensors may be required for accurate monitoring.
- The system assumes stable internet connectivity for real-time data transmission to the cloud, especially during peak usage times.

3 External Interface Requirements

3.1 User Interfaces

- The system shall provide web applications that provide real-time access to data with user-friendly navigation and graphical representations of soil health metrics.

3.2 Hardware Interfaces:

- The system shall use IoT sensors like temperature and moisture sensor, and the NPK sensor for collecting soil moisture, temperature, and nutrient levels and will interface with the platform through an IoT gateway.

3.3 Software Interfaces

- The system will integrate with external APIs for weather data, ensuring that recommendations align with current and forecasted environmental conditions.

3.4 Communication Interfaces:

- Secure data communication between the IoT devices and the cloud server will be conducted over HTTPS or MQTT to ensure data integrity.
- We shall use RS485 module provides a serial communication protocol between the Board and the sensor,

4 System Features

4.1 Device Configuration / Registration

4.1.1 Description and Priority

- **Description:** The device registration feature allows each sensor to register itself with the system by sending a unique device ID, type, and other relevant information to the application. This is to ensures that the system can track and manage multiple devices, differentiating data streams from each sensor based on its unique identifier.
- **Priority**: **High** – Device registration is a critical function that must be completed before any data can be collected, transmitted, or analysed. Without successful registration, the system cannot reliably identify or process data from each device.

4.1.2 Stimulus/Response Sequence

Table 3 showing CBSA use case narrative for device configuration

Use Case ID	CBSA-01
Use Case name	Register Device
Description	This use case allows a sensor device to register itself with the system by sending its unique device ID and other information to the application.
Actors	Device, System Administrator
Preconditions	Device is powered on and connected to the network. The system is operational.
Trigger	The device initiates registration when first set up or after a reset.
Basic Flow	1. Device sends a registration request to the system, including its unique device ID and type. 2. System receives the registration request and stores the device information in the database. 3. System sends a confirmation response to the device indicating successful registration.
Exception	If the device ID already exists, the system rejects the registration request with an error message.
Post Condition	Device is registered in the system and can begin data transmission.

4.1.3 Functional Requirements

- **REQ-1**: Each device must have a unique identifier (e.g., serial number or UUID) for differentiation.
- **REQ-2**: The device should be connected to the network (Wi-Fi, LoRa, or cellular) to communicate with the system.
- **REQ**-3 The backend should store device information (ID, type, location) in a database upon successful registration.

4.2 Soil Data Collection

4.2.1 Description and Priority

- **Description**: Enables soil sensors to measure soil conditions, including moisture, temperature, and nutrient (NPK) levels. This data is collected at regular intervals and transmitted to the cloud for further processing.
- **Priority**: **High** – Core feature of the system that facilitates real-time soil monitoring, without which the system cannot provide valuable insights or recommendations.

4.2.2 Stimulus/Response Sequences

1. The sensor captures soil data.
2. Data is sent to the cloud for storage and processing.

Table 4 showing CBSA use case narrative for soil data collection

Use Case ID	CBSA-02
Use Case Name	Provide Crop Recommendations
Description	This use case allows the system to suggest suitable crops based on the analysed soil data and the predefined crop requirements.

Primary Actors	Farmers
Secondary Actors	System
Preconditions	1. Soil data has been analysed, and the system has access to crop requirements.
Trigger	When a system generates recommendations after data analysis or on user request.
Basic Flow	1. Devices measure soil moisture, temperature and nutrient levels. 2. Device send data, tagged with its unique ID, to the system 3. System receives and stores the data in the database associated with the specific device ID 4. System processes the data to identify any significant soil trends.
Exception	If data transmission fails, the device retries or stores data locally until the connection is restored.
Postcondition	Data is stored and available for analysis and display in the user interface selection and soil management

4.2.3 Functional Requirements

- **REQ-4**: The system shall collect soil data depending on the configured time for collection.
- **REQ-5**: The system shall support multiple sensors for distributed data collection.

4.3 Crop Recommendation

4.3.1 Description and Priority

- **Description**: Based on analyzed soil data, the system cross-references nutrient levels, moisture, and temperature with known crop requirements, offering suitable crop recommendations tailored to the current soil conditions.
- **Priority**: **Medium** – Important for advising farmers on crop selection, which enhances soil management and productivity. While valuable, this feature depends on accurate data analysis to be effective.

4.3.2 Stimulus/Response Sequence

Table 5 showing CBSA use case narrative for crop recommendation

Use Case ID	CBSA-03
Use Case Name	Provide Crop Recommendations
Description	This use case allows the system to suggest suitable crops based on the analysed soil data and the predefined crop requirements.
Primary Actors	Farmers
Secondary Actors	System
Preconditions	2. Soil data has been analysed, and the system has access to crop requirements.
Trigger	When a system generates recommendations after data analysis or on

	user request.
Basic Flow	System reviews soil data analysis results to assess current soil conditions. 2. System cross-references soil data with crop requirements to identify suitable crops. 3. System displays recommendations on the users dashboard highlighting suitable options
Exception	If soil conditions do not match any crop requirements, the system displays an advisory suggesting soil treatment.
Postcondition	Farmer can view crop recommendations based on current soil health. The crop selection and soil management

4.3.3 Functional Requirements

- **REQ-6**: The system shall recommend crops based on soil moisture, temperature, and nutrient levels.

4.4 View Data and Recommendations in Dashboard

4.4.1 Description and Priority

- **Description:** Provides a user interface where farmers can view real-time and historical soil data, trends, and system-generated crop recommendations, allowing informed decision-making.
- **Priority: Medium** – Essential for usability and user interaction with the system, but the core system can still function without this feature being fully developed.

4.4.2 Stimulus/Response Sequences

Table 6 showing CBSA use case narrative for User Interface view

Use Case ID	CBSA-04
Use Case Name	View Data and Recommendations
Description	This use case shall enable the farmers to access and view real-time soil data and crop recommendations through the dashboard
Primary Actors	Farmers
Secondary Actors	System
Preconditions	1.Farmer is authenticated and Logged in. 2. Data and the recommendations are available
Trigger	Farmer navigates to the dashboard to check current soil data and analytics
Basic Flow	Farmer logs into the system and access the dashboard. 2. Dashboard displays recent

	soil data readings (moisture, temperature NPK levels) for each sensor. Dashboard shows soil analytics There is a button for crop recommendation according to the current soil status
Exception	If data is delayed or unavailable the system notifies the farmer that it no longer receiving new data
Postcondition	Farmer is able to make informed Decisions on the crop selection and soil management

4.4.3 Functional Requirements

- **REQ-6**: Users shall be able to view data graphs and crop recommendations.
- **REQ-8**: Generates alerts for specific conditions, such as low moisture or nutrient levels, allowing timely interventions.

5 Nonfunctional Requirements

5.1 Performance Requirements

- The system must process sensor data in real-time, ensuring updated soil health metrics within a maximum latency of 5 seconds.
- The system shall support up to 500 concurrent users without performance degradation, maintaining responsiveness in the UI within 3 seconds for each action.

5.2 Safety Requirements

- Data privacy is critical, especially regarding farm-specific soil health data. Access to sensitive data should be controlled and limited to authorised personnel only.
- The system should provide user activity logs to track access and modifications to sensitive data.

5.3 Security Requirements

- **Data Encryption:** All data transmitted between IoT devices and the cloud should be encrypted using HTTPS/TLS or MQTT protocols.
- **User Authentication**: Multi-factor authentication (MFA) will be implemented for all administrative accounts to prevent unauthorised access.
- **Access Control:** Role-based access control (RBAC) will be enforced to restrict access based on user roles.

5.4 Software Requirements

- **Backend:** The system shall use a cloud-based infrastructure such as AWS or Azure to ensure scalability and resilience.
- **Database:** A NoSQL database like MongoDB will be used to store sensor data due to its flexibility and scalability.
- **Frontend:** Developed using ReactJS for web and mobile applications to offer responsive and interactive user experiences.

5.5 Software Quality Attributes

- **Reliability:** The system must have 99.9% uptime, as soil monitoring is critical for effective farming operations.

- **Usability:** User interfaces should be simple and intuitive, enabling users to access essential data and insights with minimal training.
- **Maintainability:** The system's modular architecture allows for easy updates and troubleshooting without impacting overall performance.
- **Scalability:** The cloud-based design ensures scalability for handling a growing number of users and data inputs from additional IoT sensors.

5.6 Business Rules

- Data Retention: User data should be retained for a minimum of five years to enable longitudinal soil health analysis and historical trend insights.
- User's login detail must match

6 Appendices

6.1 Appendix A: Glossary

Table 7 showing CBSA use case narrative for Acronyms and Abbreviation

Acronyms and Abbreviations	Meaning Of Acronym
CBSA	Cloud Based Soil Advisor
API	Application Programming Interface
HTTPS	Hyper Text Transfer Protocol
MQTT	Message Queuing Telemetry Transport
GB	Giga Byte