Software Requirements Specification

for

Weather Prediction System for Smart Farm

Version 1.45 approved

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Revision History

Name	Date	Reason For Changes	Version
FarmCast	26-10-24	Initial version	1.0
FarmCast	18-11-24	Updating Functional-req	1.1
FarmCast	11-12-24	Updating Nonfunctional-req	1.45

1. Introduction

1.1 Purpose

The purpose of this Software Requirements Specification is to outline the system's functional and non-functional requirements for the Weather Prediction System for Smart Farm. It serves as a guide for all the project stakeholders to establish a well understood foundation for what the project is and what it is supposed to do.

1.2 Document Conventions

This SRS document follows IEEE standards and implements the MLA format.

1.3 Intended Audience and Reading Suggestions

The intended readers of this SRS document are the development team, testers, documenters, DB administrators and other stakeholders. To navigate this document efficiently, start with the introduction to get an idea about the project's purpose and scope. Next, read the description of the project and the functionalities and features.

1.4 Product Scope

The product is an application made to help farmers easily optimize their farming methods. It offers real-time sensor data, crop-specific insights, precise weather forecasts, and irrigation scheduling. To satisfy the increasing demand for smart farming solutions in the agricultural technology sector, it also enables users to monitor soil health, personalize warnings, and interact with agronomists.

1.5 References

IEEE Standard for Software Requirements Specifications

Title: IEEE Recommended Practice for Software Requirements Specifications (IEEE 830-1998)
Author: IEEE Computer Society
Version: 1998
Source: IEEE Xplore Digital Library

User Interface Design Guidelines

Title: Usability Guidelines for Web and Mobile Applications
Author: World Wide Web Consortium (W3C)
Version: 2023
Source: https://www.w3.org/WAI/
Agriculture Weather Forecast API Documentation

Title: API Documentation for Agriculture-focused Weather Prediction
Author: OpenWeather
Version: 2.5
Source: https://openweathermap.org/agriculture
Agricultural Meteorology Overview

Title: Basics of Agricultural Meteorology
Author: Food and Agriculture Organization (FAO)
Version: 2021
Source: https://www.fao.org/agriculture
Vision and Scope Document for Smart Farming Weather Prediction System

Title: Vision and Scope Document for the CMSE321 Project: Weather Prediction System for Smart Farming
Author: CMSE321 Course Team
Version: Fall 2024/2025
Source: CMSE321 Course Repository (accessible by enrolled students)

2. Overall Description

2.1 Product Perspective

FarmCast is a weather application tailored for farmers; it is designed to show weather developments beneficial to farmers, holding the idea of a normal weather forecast and adding unique features that cater specifically to farmers' needs. The app targets commercial and smallholder farmers but can be used by anyone. This app will allow crop type-based weather customization, which can filter the time in which certain crops conditions have been met; The application is made for independent use but can be linked with larger farm management systems for more detailed reports, in addition to all this, a user-friendly interface is used.

2.2 Product Functions

- Login
- Create account
- Access Crops
- Dashboard
- Settings
- Automated crop recommendations
- Extreme weather alerts
- Irrigation scheduling
- Crop based weather analysis
- Dashboard graphs and visualizations

2.3 User Classes and Characteristics

Farmers

- **Frequency Of Use:** Daily
- **Product Functions Used**: Daily access to warnings, weather predictions, and configuration changes
- **Tech Expertise**: Basic.
- **Security/Privilege Levels:** Standard user privileges
- **Educational Level: R**anges from primary education to advanced
- **Experience:** Farming experience practically but limited experience technically
- **Importance:** High; Primary users, they require a simple UI for easy navigation and actionable recommendations for increased farm productivity.

Agronomists

- **Frequency Of Use:** Weekly
- **Product Functions Used:** Analyse soil and crop data and form many recommendations for farmers based on that.

- **Tech Expertise:** Moderate to advanced
- **Security/Privilege Levels:** Advanced privileges to access detailed data
- **Educational Level:** Professional level education in related fields
- **Experience:** Professional in soil, crop and agricultural management in general
- **Importance:** High; serves as a part of expert advice to farmers on crop health and management.

System Administrator

- **Frequency Of Use:** Whenever needed for troubleshooting
- **Product functions used:** Managing accounts, deleting/creating accounts as well as updating the system.
- **Tech Expertise:** Advanced
- **Security/Privilege Levels:** Full access
- **Educational Level:** IT background or related fields
- **Experience:** Expert in managing technological issues and managing software systems.
- **Importance:** Moderate; for maintaining the systems smoothness

Irrigation Engineers

- **Frequency Of Use:** Every 2 days during farming season
- **Product functions used:** Reviewing soil moisture, creating irrigation schedules, generating reports of water usage.
- **Tech Expertise:** Moderate to Advanced
- **Security/Privilege Levels:** Advanced Privileges for accessing Iot sensor data

- **Educational Level:** Professional/Expert in water/irrigation management
- **Experience:** Specialized in management of irrigation systems
- **Importance:** High; they ensure the success of the farm through high crop yield and prevention of water wastage

Scholars and Data Scientists

- **Frequency Of Use:** 1-3 times per month
- **Product functions used:** Access of historical crop data in addition to the testing and development of new prediction algorithms
- **Tech Expertise:** High
- **Security/Privilege Levels:** Advanced Privileges to access raw data
- **Educational Level:** Advanced degrees in data science and/or related fields
- **Experience:** Expert in data analysis and development of algorithms
- **Importance:** Medium; their work causes the system to predict more accurately causes better recommendations and higher user satisfaction.

2.4 Operating Environment

The system requires the following hardware and software platforms: -

- Operating system: IOS 11 and above, Android 7.0 and above, macOS versions 10 and above Windows 7 and above.
- Web browsers Microsoft Edge, Opera, Safari, Mozilla Firefox. Brave Browser, and Google Chrome.

2.5 Design and Implementation Constraints

Hardware limitations:

Processor: Equivalent to Intel i3 or higher
RAM: 2 GB minimum
HDD/SDD: minimum of 5GB storage is required
Other limitations: The app should be created using java and JS Integtated in HTML, to be available through IntelliJ IDE then eventually displayed to the public through a server.

2.6 User Documentation

User Manual: A thorough manual that provides step-by-step usage instructions for every system function, feature descriptions, and setup instructions. This guide will be accessible through the web application's help area and be available as a downloadable PDF.

Online Help: Integrated online assistance available within the application and provides brief responses and clarifications for often requested questions. For functions and tasks, users can obtain context-sensitive support, along with links to more thorough documentation when necessary.

Tutorials: Interactive lessons that walk users through important tasks like creating farm profiles, configuring alarms, and comprehending weather forecast screens. To make onboarding simple, these tutorials will be accessible as brief video snippets and in-app walkthroughs.

Quick Start Guide: A concise manual to help new users create accounts, use key features, and navigate the system. For convenience, the Quick Start Guide will be displayed on the first user login screen and made available as a downloadable PDF.

Release Notes: A document that lists each version's problem corrections, new features, and system updates. This will be connected within the application and accessible online.

2.7 Assumptions and Dependencies

Assumptions:

- It is expected that the user has access to the internet at least occasionally.
- The user's system is compatible with the hardware.

Dependency:

- Web browser compatibility for the device and website.
- Compatibility of the app and device with application stores (ex. Google Play and App Store).

3. External Interface Requirements

3.1 User Interfaces

- Homepage prompts the user to either create an account or login
- Informs the user of any incorrect credential's entry
- Bottom navigation bar leads to all 3 sections of the application
- Home button redirects to main dashboard
- Settings section allows users to customize and manage their account
- Current weather is displayed on the home screen
- User notifications customizable in settings
- Help and support access through the navigation bar on the top right of the screen.

3.2 Hardware Interfaces

The device should be connected to the internet by LAN, WLAN, WAN, or other network types to provide constant connectivity for syncing with cloud services and real-time data updates. To guarantee compatibility with the newest software features detailed in section 2.4 and the seamless operation of the smart farming application, the hardware must satisfy the minimal system requirements listed in section 2.5. The gear should also be able to track location in order to monitor meteorological data, map farm regions accurately, and enhance the precision of localized recommendations. For efficient collection and processing of real-time environmental data, integration with IoT sensors is necessary.

3.3 Software Interfaces

The Weather Prediction System is going to be compatible with the most widely used mobile operating systems, Windows, Mac Android and IOS. It will be made to utilize RDBMS (Relational Database Management Systems) to control and update data into the database easily, which will then be seamlessly integrated into the Weather Prediction System.

3.4 Communications Interfaces

HTTPS is utilized to guarantee effective data transit between the client application and weather prediction servers. Because HTTPS is more secure than HTTP, it is utilized instead. FTPS is used for encryption and other effective file transfers. While IMAP is used to receive communications, SMTP is used to send effective emails, verification codes, and other messages. As was already said, HTTPS and FTPS are used to include SSL.

4. System Features

4.1 User Registration and Profiles

4.1.1 Description and Priority

Users can establish an account, log in, and manage their profiles with this feature. Users can change their personal data, customize weather alert settings, and activate two-factor authentication for added protection. By saving user-specific information like farm location and crop preferences, the function guarantees a customized experience.

4.1.2 Stimulus/Response Sequences

Stimulus: A new user submits their registration details (e.g., name, email, password).
Response: The system validates the input, checks for duplicates, creates the account, and sends a confirmation email.
Stimulus: A user logs in with their credentials.
Response: The system verifies the credentials and redirects the user to their personalized dashboard.
Stimulus: A user updates their profile information (e.g., location, crop preferences, or contact details).

Response: The system validates the updated data, saves the changes, and confirms the update.

4.1.3 Functional Requirements

- **REQ-1:** New users shall be able to register a new account
- **REQ**-2: Users shall be able to update their profile details
- **REQ**-3: Users shall be able to customize weather alert preferences
- **REQ**-4: Users shall be able to enable two-factor authentication
- **REQ**-5: Users shall be able to change the language of the application
- **REQ**-6: User should be able to update their contact information

4.2 Weather Forecasting

4.2.1 Description and Priority

The user may efficiently organize farming activities based on precise weather forecasts thanks to this function, which gives them access to real-time weather forecasts. With an emphasis on variables like temperature, wind speed, and precipitation, it incorporates external weather APIs to provide real-time updates.

Priority: High

Benefit: 9 (critical to optimize farming activities and reduce risks)
Penalty: 8 (significant if not implemented, as users rely heavily on this feature)
Cost: 6 (moderate, requires integration with reliable weather APIs)
Risk: 5 (moderate, due to potential API downtimes or inaccuracies).

4.2.2 Stimulus/Response Sequences

Stimulus: A user customizes weather metrics to view specific details (e.g., rainfall, temperature, wind speed).
Response: The system filters and displays the selected metrics as per user preferences.
Stimulus: A user accesses historical weather data for analysis.
Response: The system retrieves past weather records from the database and displays them in a visual format, such as graphs or charts.

4.2.3 Functional Requirements

- **REQ**-1: User shall receive daily, weekly, and monthly forecasts for selected farms
- **REQ**-2: System shall display weather conditions for selected farm
- **REQ**-3: User shall be able to select specific metrics to customize forecast display
- **REQ**-4: Users shall be able to access historical weather data
- **REQ**-5: Users shall be able to select to select different forecasts for comparison
- **REQ**-6: System shall display visual representation of forecasts in the form of charts, graphs, or maps

4.3 Crop Management

4.3.1 Description and Priority

This feature serves to help farmers monitor optimize and manage their crops health, by giving the farmer recommendations regarding crops based on crop type, weather and soil health. Farmers can view their crop progress from here as well as receive alerts for pest infestations and disease risks.
Priority High
Benefit: 9 (High, minimizes risk while maximizing productivity)
Penalty: 9 (High, yield loss as a result of poor crop management)
Cost: 7 (Moderate due to use of external data)
Risk: 6 (Moderate, due to usage of third-party data)

4.3.2 Stimulus/Response Sequences

Stimulus: The user monitors a crop
Response: The system retrieves the crop's data and sends it to the user
Stimulus: The user reports a pest outbreak
Response: The system uses patterns in weather soil health and other crop data to find the cause and gives recommendations to the user.

4.3.3 Functional Requirements

- **REQ**-1: System shall allow users to enter their crop types to receive specialized advice
- **REQ**-2: System shall allow users to log and monitor crop-related tasks such as planting, fertilizing, watering, etc.
- **REQ**-3: System shall display customized advice on resource distribution specific to the type of crop being used

- **REQ**-4: System shall suggest fertilization schedules based on soil nutrients and crop growth stages
- **REQ**-5: System shall offer recommendations on the use of pesticides and herbicides
- **REQ**-6: System shall notify users of unexpected growth patterns of crops
- **REQ**-7: System shall advise users on efficient use of resources

4.4 Irrigation Scheduling

4.4.1 Description and Priority

Irrigation scheduling is included as a system feature to assist irrigation engineers with tools that help clarify all the farm's irrigation needs. This is done using IoT sensors to record real time soil moisture information, in conjunction with weather forecasting data and crop needs.

Priority: Medium
Benefit: 9 (Critical, Efficient water-usage and improved crop health)
Penalty: 8 (High, Neglect could lead to water wastage and crop damage)
Cost: 7 (Moderate/High, Integration with IoT sensors is required)
Risk: 6 (Moderate, Due to reliance on external data and advanced irrigation techniques)

4.4.2 Stimulus/Response Sequences

Stimulus: The Irrigation engineer requests data in order to assist creating the irrigation schedule
Response: The system provides weather, soil moisture and crop requirements data as well as other data to the irrigation engineer.
Stimulus: Irrigation engineer receives an alert for concerning soil moisture levels
Response: The Irrigation engineer alters the Irrigation schedule's details to address the issues

4.4.3 Functional Requirements

REQ-1: System shall integrate IoT sensors to monitor soil moisture levels in real-time and adjust accordingly
REQ-2: System shall provide recommendations based on the weather forecasts and collected soil moisture data
REQ-3: System shall alert users when moisture levels are not in the desirable range
REQ-4: System shall take predicted rainfall into consideration to avoid overwatering
REQ-5: System shall generate reports detailing all irrigation activities in a specified period

4.5 Agronomic Analysis

4.5.1 Description and Priority

The purpose of the agronomic analysis function is to give agronomists the resources they need to track and evaluate data pertaining to crops and the environment, make suggestions, and help farmers communicate with one another. In order to enhance farming operations decision-making and resource management, this feature combines data visualization, reporting, and communication capabilities.

Priority: High

Benefit: 9 Offers vital information for maximizing agricultural productivity and resource use.
Penalty: 8 Significant crop loss or decreased yield might be the consequence of errors or delays.
Cost: 6 Development necessitates integration with external data sources.
Risk: 5 Moderate risk because of user uptake and reliance on external environmental data.

4.5.2 Stimulus/Response Sequences

Stimulus: Access to environmental data is requested by an agronomic.
Response: On the dashboard, the system obtains and shows pertinent data, including crop growth phases, soil conditions, and predictions.
Stimulus: Agronomists provide fresh suggestions for farmers.
Response: The system alerts the appropriate farmers of the updated suggestions, verifies the input, and updates the database.
Stimulus: A report that summarizes crop performance and weather influence is prepared by an agronomic.
Response: The system creates the report, gathers the required data, and offers download and sharing options.

4.5.3 Functional Requirements

- **REQ**-1: System shall allow agronomists to access environmental data such as forecasts, soil conditions crop growth phases etc.
- **REQ**-2: System shall allow agronomists to input and update recommendations for farmers
- **REQ**-3: System shall provide agronomists with a dashboard featuring graphs, heatmaps and trends for field condition analysis
- **REQ**-4: System shall provide a platform that allows the agronomists to communicate directly with the farmers
- **REQ**-5: System shall generate reports summarizing crop performance, weather impact and resource utilization

4.6 Notification Management

4.6.1 Description and Priority

Users may alter how and when they get system updates and alerts by using the notification management tool. This minimizes needless disruptions while guaranteeing that users are notified of important events. Setting preferences, choosing delivery alternatives, and establishing quiet hours are all possible with this function.
Priority: medium

Benefit: 7 By customizing alerts to each user's schedule and preferences, it improves the user experience.
Penalty: 6 Ineffective notification handling may cause users to become dissatisfied or miss important information.
Cost: 5 User interface modifications and integration with various communication platforms are necessary for development.
Risk: 4 Low to moderate risk because to user behavior unpredictability and technological complexity.

Stimulus/Response Sequences
Stimulus: The notification preference of a user is updated.
Response: The notification settings are modified in accordance with the saved preferences.
Stimulus: a crucial system alert sent to the user.
Response: Using the user's preferred delivery mode (such as SMS, email, or in-app), the system sends the notification.

Stimulus: Notifications are enabled during quiet hours by the user.
Response: Non-essential alerts are ignored by the system during the designated hours, and then regular messages are restored.

4.6.3 Functional Requirements

- **REQ**-1: Users shall be able to set notification preferences
- **REQ**-2: Users can select notification delivery methods like in-app SMS, email, etc.
- **REQ**-3: Users shall be able to disable notifications during off-hours

5. Other Nonfunctional Requirements

5.1 Performance Requirements

- **Response Times**: The system must respond to user requests (e.g., retrieving vehicle availability) within **3 seconds** under typical network conditions.
- **Concurrent Users**: Ensure stable performance with up to **100,000 concurrent users**, maintaining response times under **5 seconds**.
- **Caching**: Use caching techniques to reduce server load and improve query times, ensuring repeat queries are served in under **1 second**.
- **Application Launch**: The application must launch on modern devices in less than **2 seconds** from the user tapping the icon.
- **Real-Time Alerts**: Real-time notifications (e.g., booking confirmations) must have a latency of less than **1 second**.

5.2 Safety Requirements

- **System Uptime**: Achieve **99.9% system uptime annually**, limiting downtime to no more than **8.76 hours per year**.
- **Failure Recovery**: Implement error-handling mechanisms to recover from partial failures within **10 seconds**, ensuring no disruption to user sessions.
- **Data Backup**: Perform data backups every **15 minutes** to minimize data loss in case of system failure.
- **Failover Systems**: For critical services, ensure redundancy with failover systems that restore operations within **1 minute** in case of hardware failure.

5.3 Security Requirements

- **Data Encryption**: Encrypt all sensitive data using **bcrypt** with a work factor of at least **12**.
- **Testing and Assessments**: Conduct penetration tests and vulnerability assessments quarterly, addressing high-risk issues within **48 hours (about 4 days)**.
- **Authentication**: Implement multi-factor authentication (MFA) for all accounts, requiring a second factor for **100% of logins**.
- **Compliance**: Adhere to applicable data protection laws (e.g., GDPR, CCPA) and conduct compliance audits annually.
- **Fix Timelines**: Resolve identified security flaws within **24–48 hours and** ensure all data transmissions use end-to-end encryption.

5.4 Software Quality Attributes

- **Scalability**: Design the system to handle a **10% annual increase** in both user base and data volume without architectural changes.
- **Availability**: Ensure **redundancy and failover systems** to guarantee availability during peak demand periods.
- **Maintainability**: Use modular architecture, allowing individual components to be replaced or upgraded in under **2 hours**.
- **Usability**: Provide interactive tutorials for complex features, with completion times of less than **10 minutes**.
- **Accessibility**: Adhere to WCAG 2.1 Level AA standards, including features like voice commands, screen reader support, and high-contrast themes.
- **Portability**: Ensure compatibility with iOS (iOS 12+), Android (API level 21+), and **95% of modern web browsers**.

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5.5 Business Rules

- **Access Control**: Define role-based access, ensuring only authorized users can perform specific actions such as booking management or payment processing.
- **Regional Customization**: Support region-specific pricing and tax calculations to comply with local regulations.
- **User Data Transparency**: Display source and timestamp of all provided data to ensure transparency.
- **Service Expansion**: Add support for at least **2 new vehicle types or regional locations annually** to maintain growth.
- **Audit Logs**: Maintain logs for all critical operations, ensuring traceability and accountability in case of disputes.

6. Other Requirements

Database requirement

- The system shall record user information, crop recommendations, soil analysis results, and weather data using a Relational Database Management System (RDBMS).
- The database must be scalable enough to accommodate up to 100,000 users at once.
- To guarantee data recovery in the event of a system failure, data backups must be performed every day.

Internationalization Requirements

- English, Spanish, and French are among the languages that the system will handle; additional languages may be added in later updates.
- The user's regional choices will determine the format of the date, time, and measurement (metric vs. imperial, for example).

Legal and Regulatory Requirements

- The system has to operate by data protection laws, such as the California Consumer Privacy Act (CCPA) and the General Data Protection Regulation (GDPR).
- To collect and store location-based and personal data, user consent must be sought.

Reuse Objectives

- To reuse components for upcoming agricultural applications, the software will be modular.
- It will be simple to include common algorithms (such weather analysis and irrigation recommendations) into new applications.

Accessibility

- To guarantee usability for people with disabilities, the system must adhere to WCAG (Web Content Accessibility Guidelines).
- For better accessibility, features like voice navigation and high contrast themes must be provided.

Scalability and Extensibility

- New features or integrations must be supported by the system architecture without requiring a major redesign.
- The system will grow to handle more users during the busiest farming seasons.

Integration with IoT Devices

- IoT sensors will be integrated into the system to gather ambient, temperature, and soil moisture data in real time.
- The database will store and process data from IoT devices to produce insights that can be put to use.

Environmental Impact

- By using less water and wasting fewer resources, the system will encourage sustainable farming methods.

- Sustainability measures will be included in system-generated reports so users may monitor their environmental impact.

Appendix A: Glossary

- **IoT**: Internet of Things
- **DB**: Database
- **HTML**: Hypertext Markup Language
- **API**: Application Programming Interface
- **RDBMS**: Relational Database Management System
- **LAN**: Local Area Network
- **WLAN**: Wireless Local Area Network
- **WAN**: Wide Area Network
- **SMTP**: Simple Mail Transfer Protocol
- **IMAP**: Internet Message Access Protocol
- **HTTP**: Hypertext Transfer Protocol
- **HTTPS**: Hypertext Transfer Protocol Secure
- **FTPS**: File Transfer Protocol Secure
- **SSL**: Secure Sockets Layer
- **WCAG**: Web Content Accessibility Guidelines
- **CCPA**: California Consumer Privacy Act
- **GDPR**: General Data Protection Regulation
- **MFA**: Multi-Factor Authentication

Appendix B: Analysis Models

Figure 1.1 System Architecture Diagram

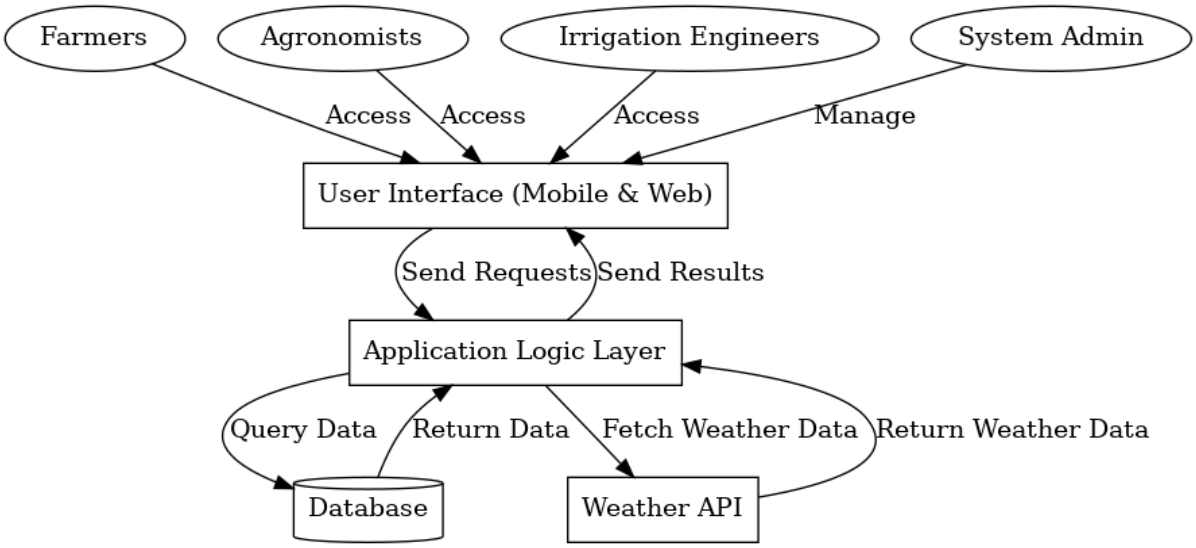


Figure 1.2: Organizational Diagram

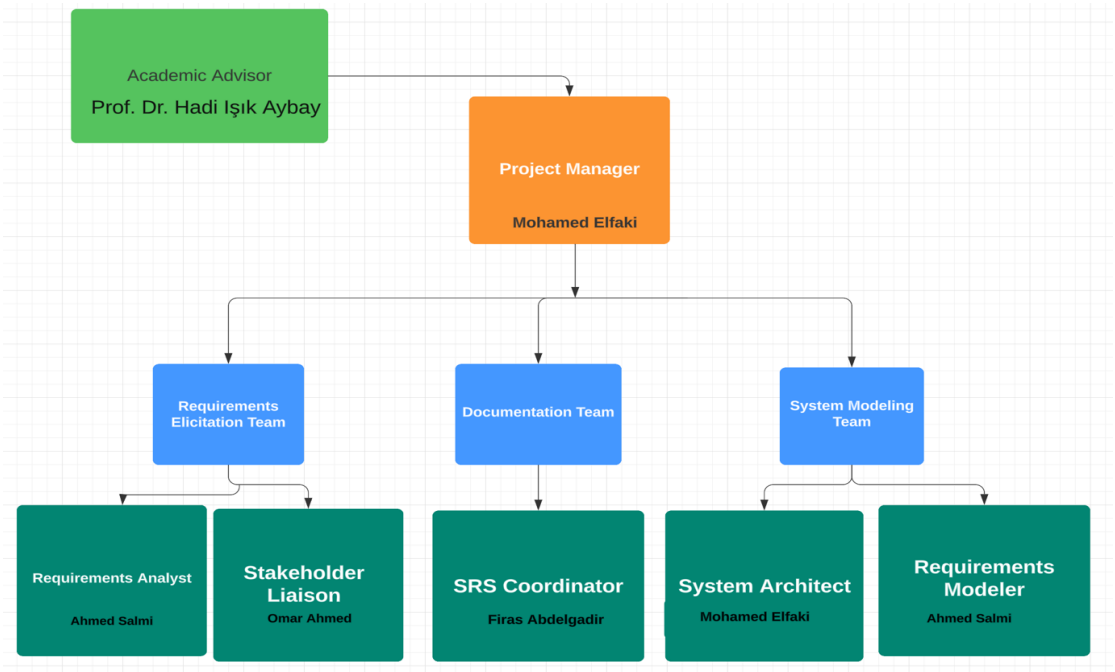


Figure 1.3 Use Case Diagram

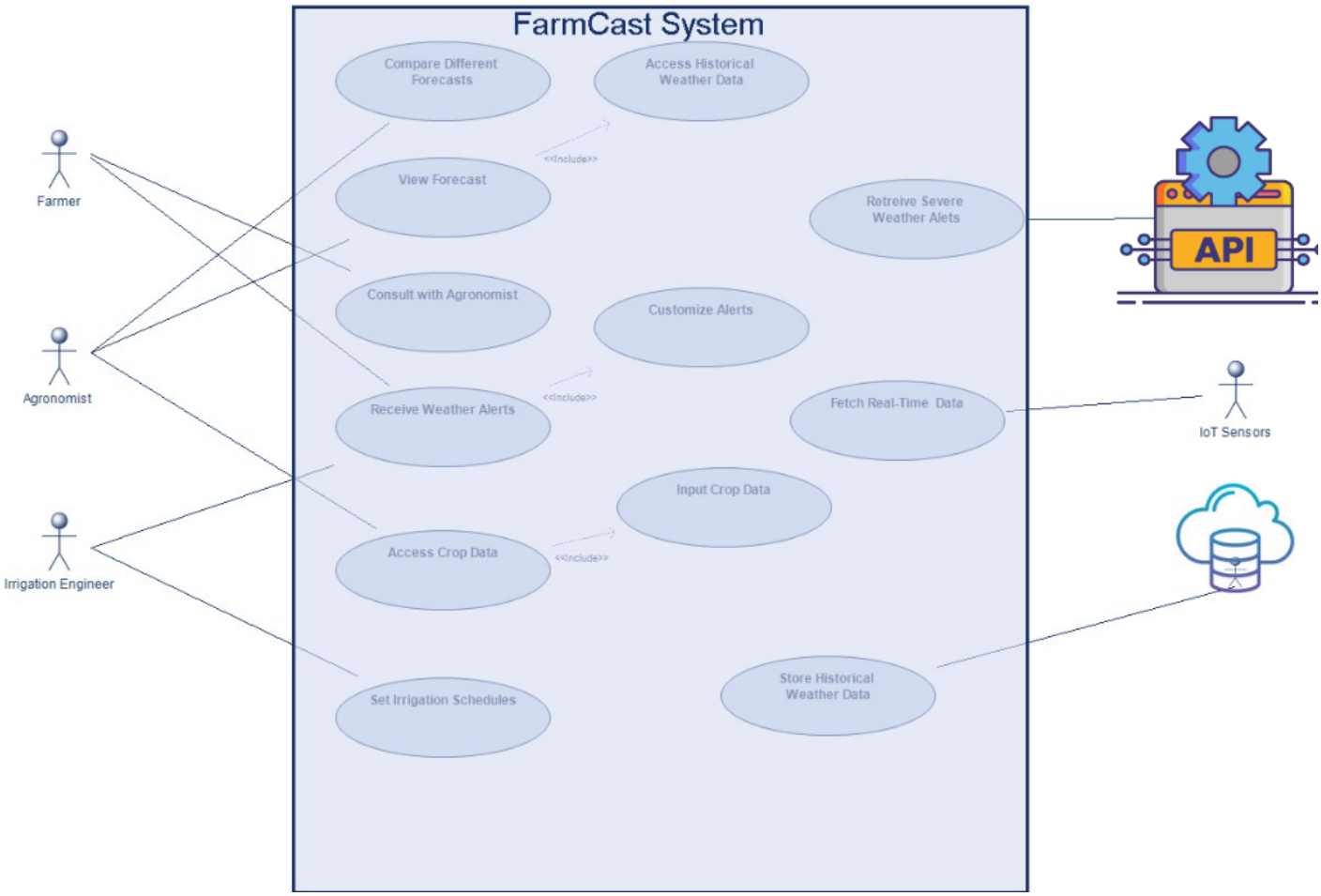


Figure 1.4 State Machine Diagram:

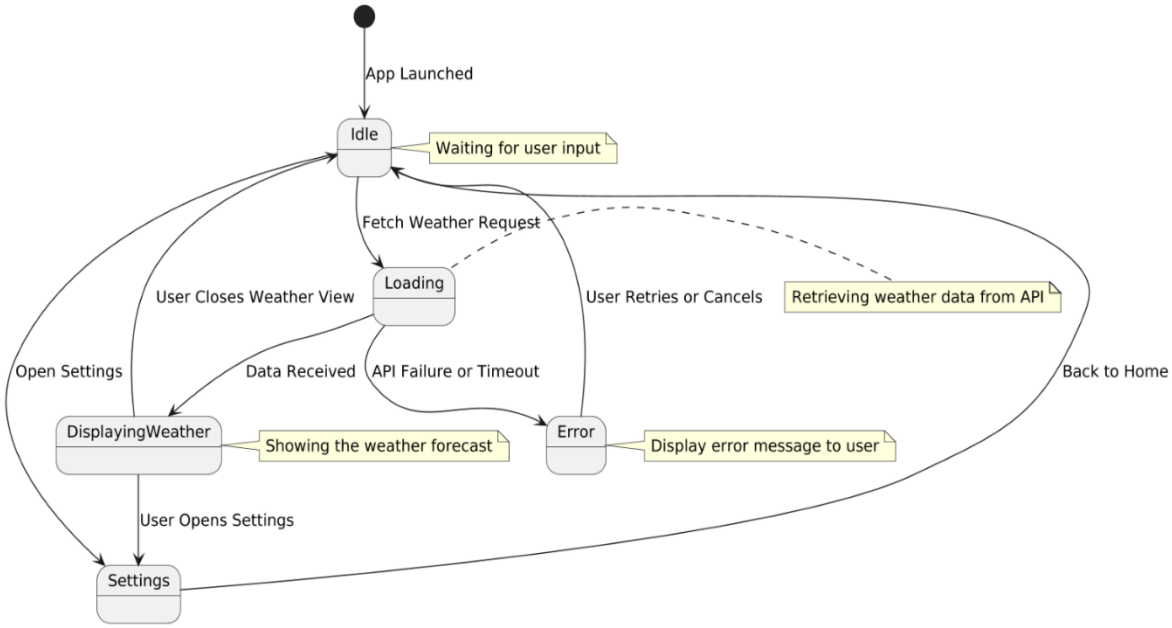


Figure 1.5 Class Diagram:

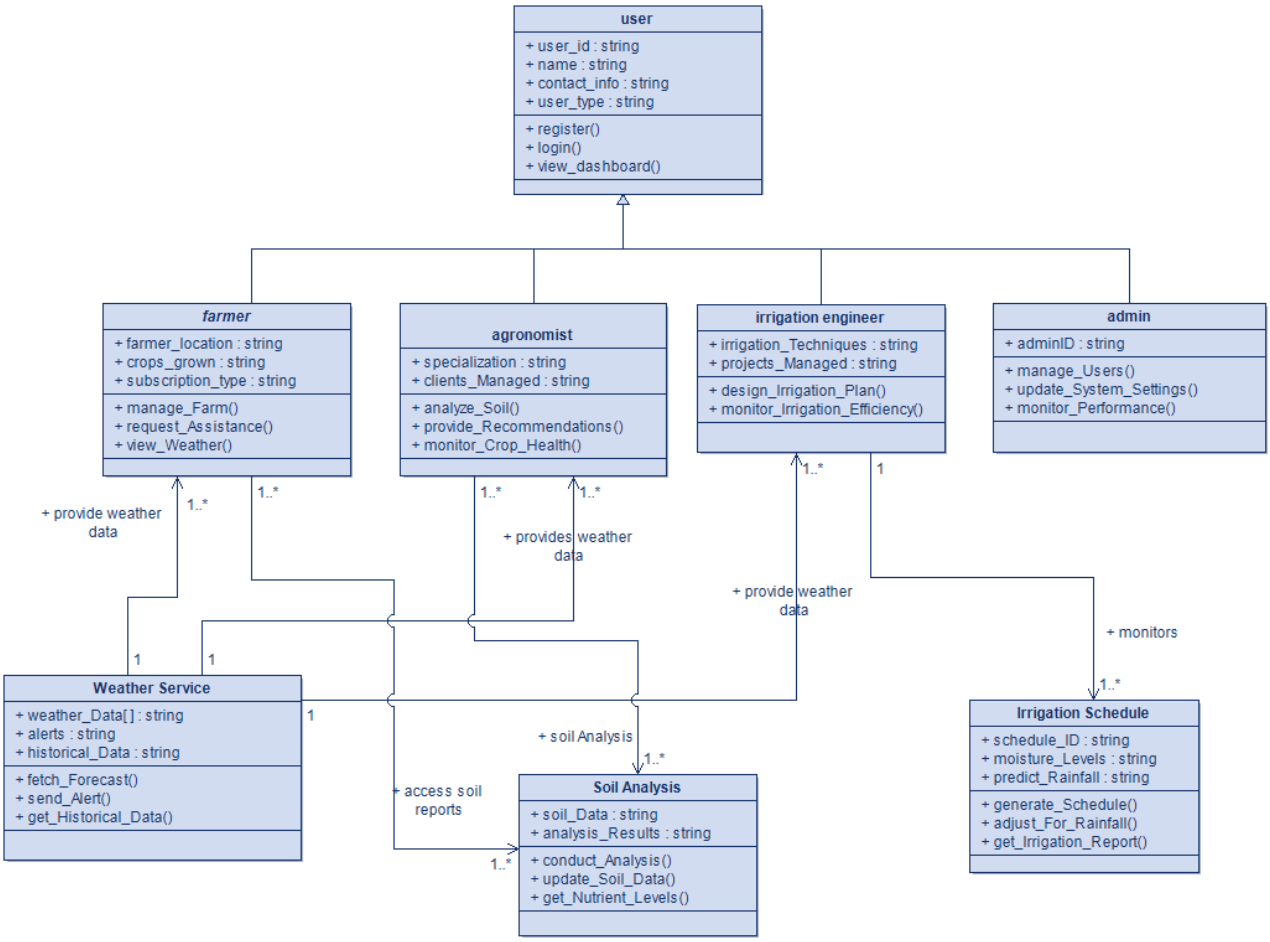


Figure 1.6 Sequence Diagram:

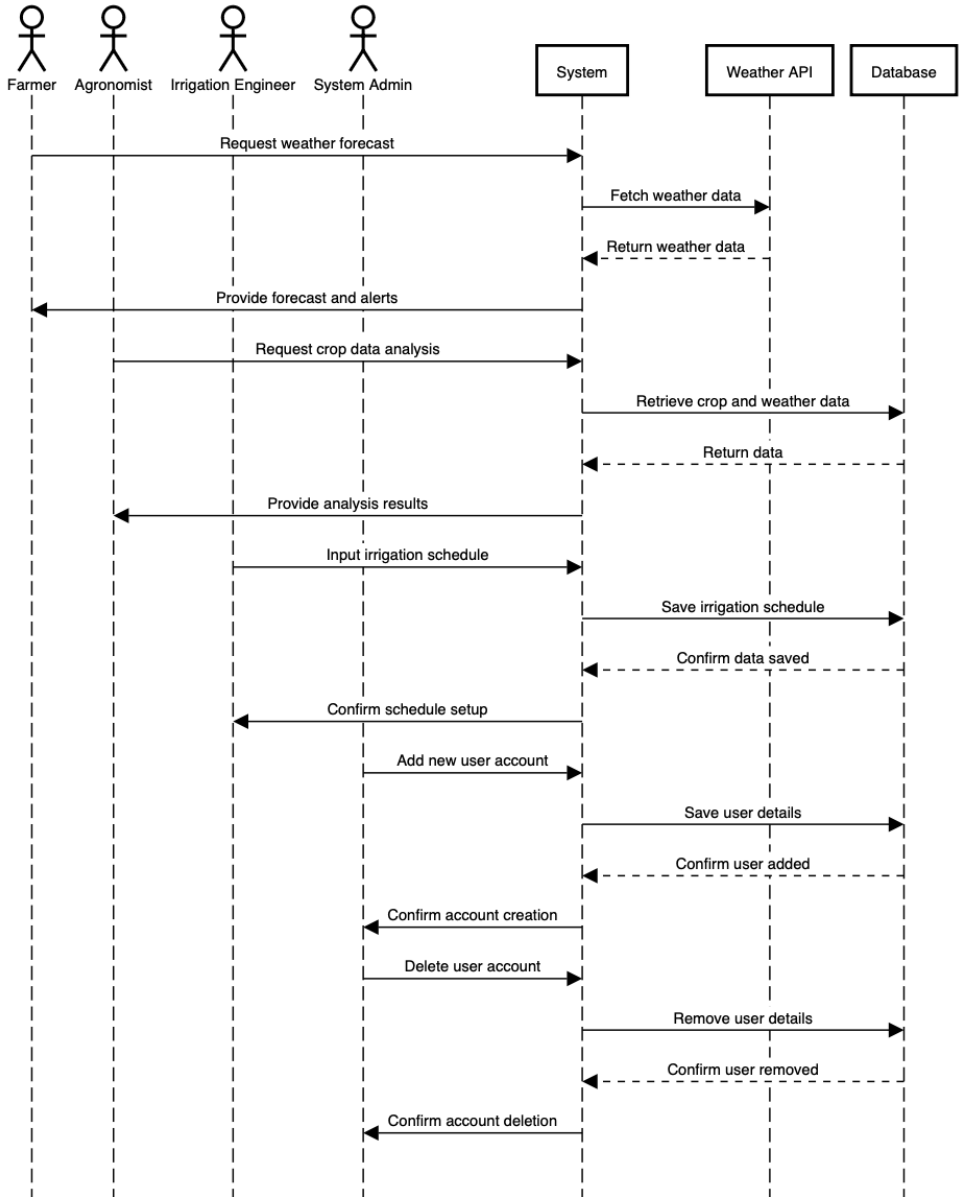
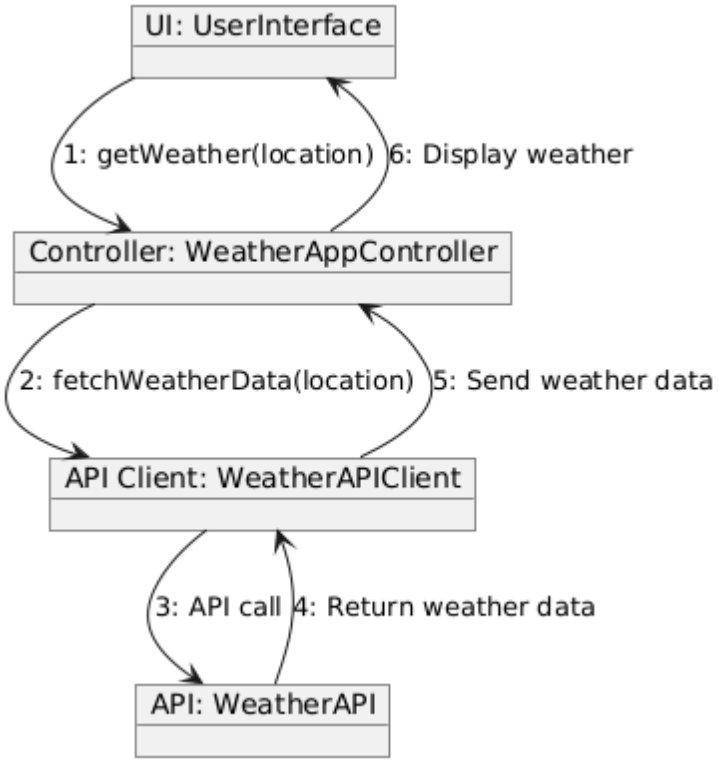


Figure 1.7 Collaboration Diagram:



Appendix C: To Be Determined List

- The payment gateway is to be determined.
- The application's technological infrastructure is to be determined.
- How much server and database space the application needs are to be determined.
- The amount of money needed to finish the implementation is to be determined.
- The languages the program will support are to be determined.
- The application's design and user interface are to be determined.
- The application's test scenarios and test are to be determined.
- which platforms will publish the application are to be determined.
- The application's traffic capacity and user count are to be determined.
- The application's update schedule is to be determined.

As the project progresses, this list could be updated even more.

Page on the use of GEN AI TOOLS

1. Introduction

- **Tool Used**: ChatGPT
- **Purpose**: Helped construct a rough report and introduction framework and brainstormed important concepts.
- **Percentage of Use**: 20%

2. Related Work

- **Tool Used**: ChatGPT
- **Purpose**: Compiled current material and produced concepts for contrasting with study results.
- **Percentage of Use**: 30%

3. Methodology

- **Tool Used**: None

4.Planned Activities and Contributions

- **Tool Used**: None

5. Conclusion

- **Tool Used**: None

6. References

- **Tool Used**: None

7. Grammar and Spelling Checks

- **Tool Used: Grammarly**

- **Purpose:** The tool was employed to find and correct grammatical errors, spelling mistakes, and improve sentence clarity throughout the report.
- **Percentage of Use: 10%**