Software Requirements Specification

for

Weather Forecasting System for Farmers

Version 1.1 approved

Group 14

EMU

29 December 2024

Table of Contents

Revision History

Name	Date	Reason For Changes	Version
Group 14	15/12/2024	Initial version	1.0
Group 14	29/12/2024	Error correction	1.1

1. Introduction

1.1 Purpose

This document specifies software requirements for farmers which provides weather predictions for wide time intervals to be able to take prevention for unexpected weather conditions, and also gives helpful advice for specific crops based on weather conditions to increase efficiency. This document is planned includes the design, development, and deployment of the Weather Advisor System that uses machine learning technology for improved forecast correctness. The core functionality of the system, weather forecasting, and product-specific recommendations are covered in this SRS. It excludes hardware integration or external tools that are not related to the forecast engine or advisory features. This document focuses only on the software subsystem responsible for data collection, processing, forecasting, advisory outputs and a notification feature to alert farmers of critical weather updates and crop advisories.

1.2 Document Conventions

This document adheres to the IEEE standard for Software Requirements Specification. The MLA format has been applied in its structure. Section and subsection headings are emphasized using bold font and indentation. The rest of the document is written in the standard Times New Roman font.

1.3 Intended Audience and Reading Suggestions

This document is for the project manager, development team, testers, documenters, and customers. Each group will use the Software Requirements Specification (SRS) to effectively fulfill their roles: The document is organized by priority, with the most important requirements first. Everyone should have a good understanding of this SRS to avoid errors and ensure the smooth running of the project.

1.4 Product Scope

This document describes the Weather Advisor System, a software designed to help farmers take precautions against unexpected weather conditions and provide crop-specific recommendations based on weather forecasts to increase productivity. The application aims to provide weather forecasts to the user using machine learning technologies. The benefits of the system include the ability to get good results on weather-related risks, optimized resource usage and predict adverse weather conditions. The system also has a notification mechanism to alert farmers in real time about critical weather updates, severe conditions and crop-specific alerts. The Weather Advisor System aims to help farmers adapt to changing weather conditions and contribute to long-term agricultural success. This scope focuses only on the software components responsible for data collection, processing, forecasting and providing advisory outputs. It excludes hardware integration or external tools not directly related to the forecast engine or advisory features.

1.5 References

- IEEE Standard 830-1998: Recommended Practice for Software Requirements Specification from, https://ieeexplore.ieee.org/document/720574
- Modern Language Association (MLA) Style Guide: Formatting and Style Rules from, owl.purdue.edu
- Sommerville, I. (2016). Software Engineering (10th Edition). Pearson Education.
- Pressman, R. S., & Maxim, B. R. (2020). Software Engineering: A Practitioner's Approach (9th Edition). McGraw-Hill.

2. Overall Description

2.1 Product Perspective

The weather prediction and notification system is a new product designed to help farmers deal with weather problems. The system uses weather data from weather APIs to check weather conditions. This system is designed for farmers, especially those in remote areas where internet access is not always available. That’s why, the system sends notifications via SMS to farmers to get important updates and warnings about the weather if they don’t have an internet connection. This product does not replace any existing system but provides a solution to specific problems farmers face.

2.2 Product Functions

The weather prediction and notification system performs the following functions:

- Weather Data Collection: The system collects weather data from other APIs.
- Weather analysis: The system can find out about storms, frost, heavy rainfall, or extreme heat from weather data analysis.
- Personal Notifications: Based on the availability of farm material or the crop types one generally deals with, the system will send personalized notifications.
- SMS Alerts: It sends SMS alerts to those farmers who cannot access an internet connection regarding updates in weather conditions that are thought to be crucial for them.
- User Profile Management: It permits farmers to set/update their profile and add details about their crops and tools.
- Risk Alerts: The system sends notifications for weather risks that could affect the farmer's crops or tools, advising on how to prepare against risks or avoid them.
- Weather Summaries: The system sends regular weather summaries daily or weekly to keep farmers informed.

2.3 User Classes and Characteristics

The weather prediction and notification system is designed for the following user classes:

1. Farmers (Main Users)

· Frequency of Use: Daily and regular use.

· Abilities: Weather monitoring-based early warnings, alerts, and notifications.

· Technical ability: Basic to intermediate

Key Characteristics:

· The target users will be farmers who use the system to protect their crops and farm materials against heavy weather conditions.

· Notifications will be delivered either by way of SMS or application depending on what the user has utilized regarding their internet connection.

2. System Administrators:

· Frequency of Use: Rare; for administering the system and maintenance

· Straightforward Functions: Administering the system user account, updating the system, and error-handling technical issues.

· Technical Proficiency: Advanced, full understanding of operations of the system.

Key Characteristics:

· Handling user account management, conducting system updates, and resolving technical issues.

2.4 Operating Environment

The following configuration will be used by the weather forecasting and alarm system:

Hardware:

· The cloud’s servers will be used by the system to process and store data.

· Smartphones running IOS and Android will be able to use the program.

System of operation:

· IOS devices having certain version or above and Android smartphones with specific version will both be supported by the mobile app.

Program:

· Weather APIs: To acquire real-time meteorological data, the system will use third-party weather APIs.

· SMS Service: Users without internet connection will be able to get notifications via text messages due to an SMS gateway.

· Database: An external SQL database will contain user data and meteorological knowledge.

2.5 Design and Implementation Constraints

The limitations that follow will guide the advancement of the weather predicting and notification system:

Hardware Limitations:

· The system must function well on cloud servers and smartphones, even older devices with inferior hardware capabilities.

Technology Constraints:

· The system's capabilities will be dependent on external weather data APIs and SMS providers to deliver notifications, which will restrict its possibilities.

Security Limitations:

· User data must be protected and processed following relevant privacy rules.

Integration with External Applications

· To operate effectively, the system must ensure smooth interaction having third-party weather APIs and SMS services.

2.6 User Documentation

The following user documentation will be provided with the weather prediction and notification system:

Online Help: In application, a help section that explains common tasks and using methods for users.

Tutorials: A step by step tutorial for explain how to use the system appears on the first place of opening application or first time of registration on the website.

Online help and tutorials will be accessible in the mobile app and website.

2.7 Assumptions and Dependencies

The system assumes that weather data will be available from weather APIs. If the service has any problem, the system might not provide accurate weather analyses.

It is assumed that users know how to use smartphones.

The system uses third party SMS services to send messages. If services have problems, it might affect notifications.

The system depends on the cloud hosting services will be stable.

The mobile app is expected to work on Android 5.0 and iOS 10 and above. Older devices are not supported.

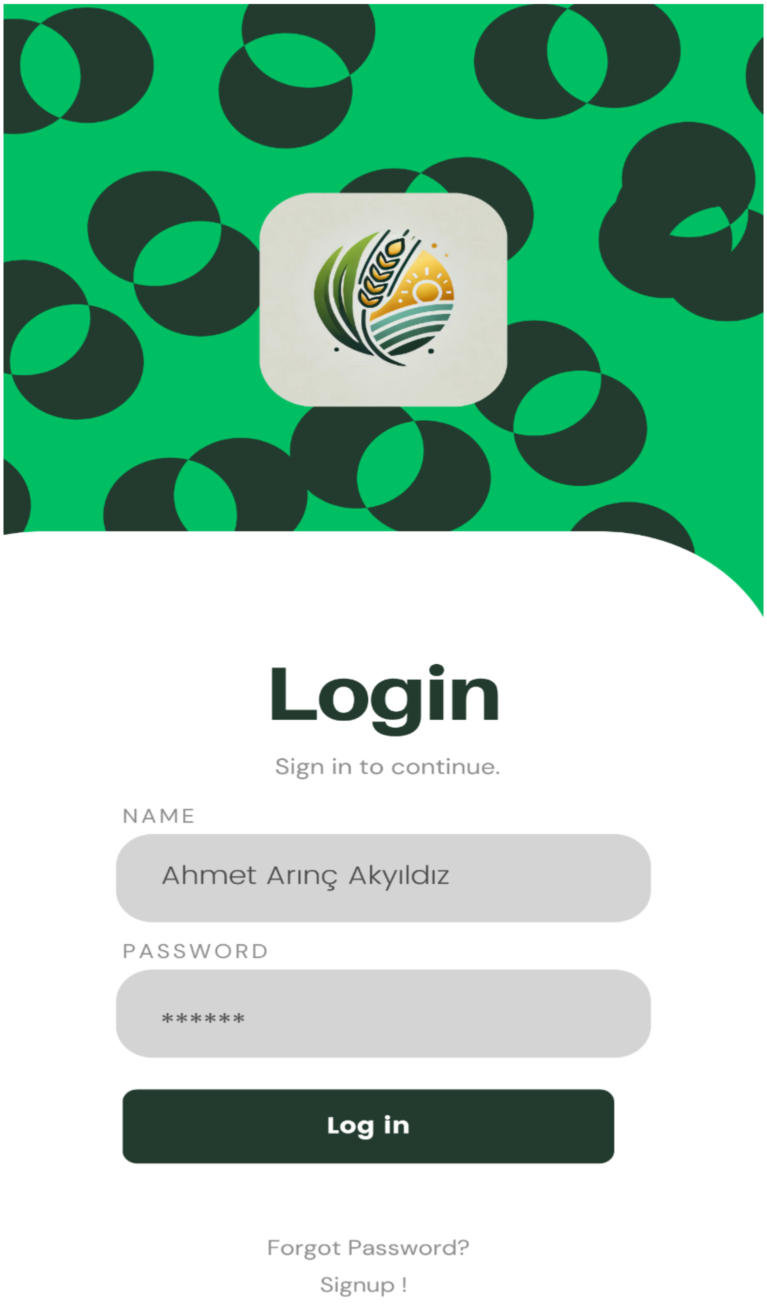
3. External Interface Requirements

3.1 User Interfaces

The user interface is designed to be easily understood and to be usable for all users without any technical information. Some user interface descriptions are in the following:

- Sign up and login interface are standard as any other applications that users are familiar with.
- Homepage is also designed to increase simplicity and understanding. Almost all functionality of the application can be reached from the homepage. High priority notifications and warnings are displayed here.
- Profile management page is straightforward providing textboxes, comboboxes and checkboxes to the user to input required personal data.
- Settings screen provides an interface for preference specification such as notification preferences.
- Community panel is where the other users share some ideas or advices with other users.

Figure 1: Login



Login

Sign in to continue.

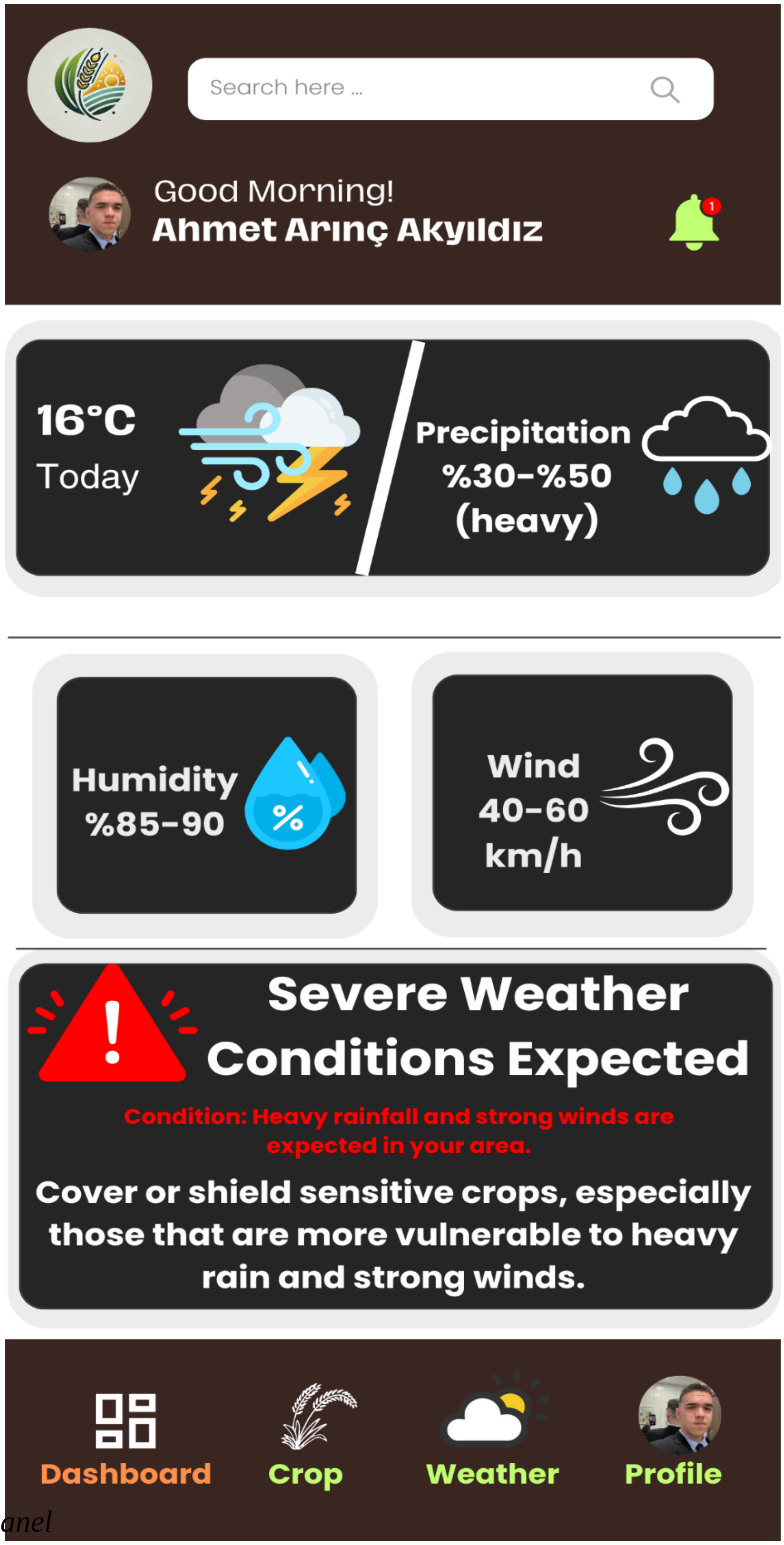
NAME

Ahmet Arınç Akyıldız

PASSWORD

******

Figure 2: Dashboard Panel



Good Morning!
Ahmet Arınç Akyıldız

16°C
Today

Precipitation
%30-%50
(heavy)

Humidity
%85-90

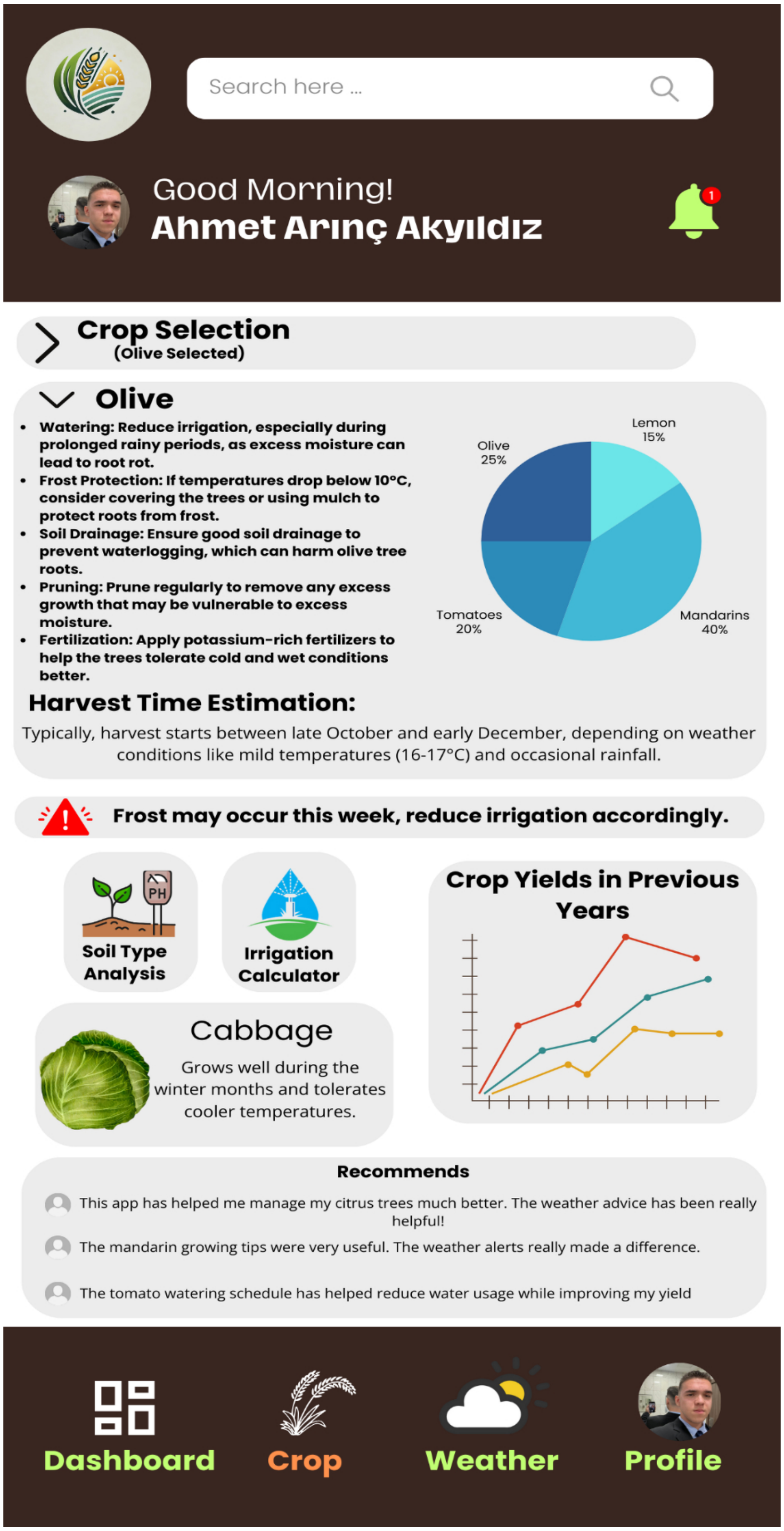
Wind
40-60
km/h

Severe Weather Conditions Expected

Condition: Heavy rainfall and strong winds are expected in your area.

Cover or shield sensitive crops, especially those that are more vulnerable to heavy rain and strong winds.

Figure 3: Crop Panel



Search here ...

Good Morning!

Ahmet Arınç Akyıldız

Crop Selection
(Olive Selected)

Olive

- **Watering: Reduce irrigation, especially during prolonged rainy periods, as excess moisture can lead to root rot.**
- **Frost Protection: If temperatures drop below 10°C, consider covering the trees or using mulch to protect roots from frost.**
- **Soil Drainage: Ensure good soil drainage to prevent waterlogging, which can harm olive tree roots.**
- **Pruning: Prune regularly to remove any excess growth that may be vulnerable to excess moisture.**
- **Fertilization: Apply potassium-rich fertilizers to help the trees tolerate cold and wet conditions better.**

Harvest Time Estimation:

Typically, harvest starts between late October and early December, depending on weather conditions like mild temperatures (16-17°C) and occasional rainfall.

Frost may occur this week, reduce irrigation accordingly.

Cabbage

Grows well during the winter months and tolerates cooler temperatures.

Crop Yields in Previous Years

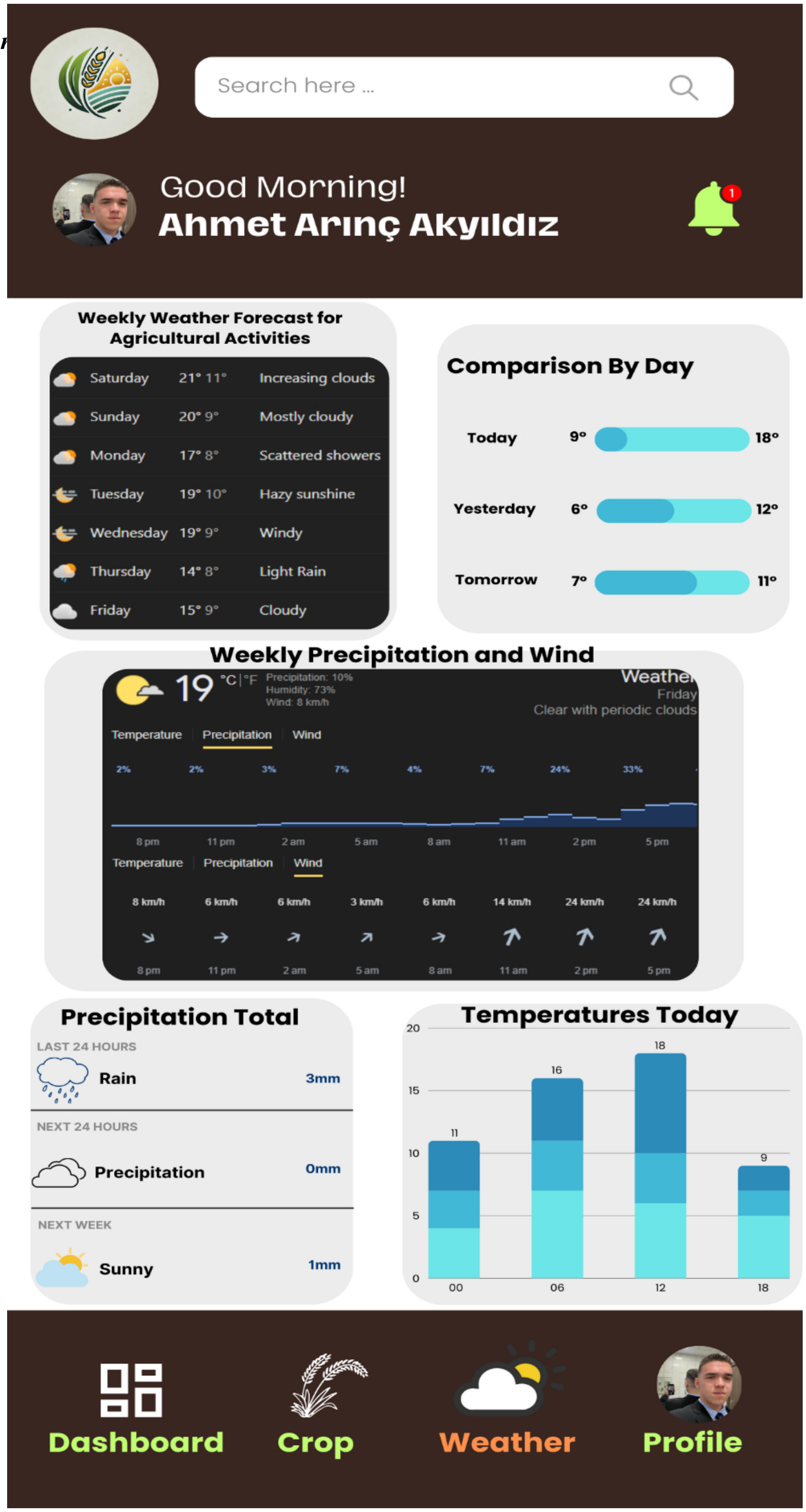
Recommends

This app has helped me manage my citrus trees much better. The weather advice has been really helpful!

The mandarin growing tips were very useful. The weather alerts really made a difference.

The tomato watering schedule has helped reduce water usage while improving my yield

Figure 4: Weather Panel



Search here ...

Good Morning!
Ahmet Arınç Akyıldız

Weekly Weather Forecast for Agricultural Activities

Saturday	21° 11°	Increasing clouds
Sunday	20° 9°	Mostly cloudy
Monday	17° 8°	Scattered showers
Tuesday	19° 10°	Hazy sunshine
Wednesday	19° 9°	Windy
Thursday	14° 8°	Light Rain
Friday	15° 9°	Cloudy

Comparison By Day

Today	9°	18°
Yesterday	6°	12°
Tomorrow	7°	11°

Weekly Precipitation and Wind

19 °C | °F
Precipitation: 10%
Humidity: 73%
Wind: 8 km/h

Weathe
Friday
Clear with periodic clouds

Precipitation Total

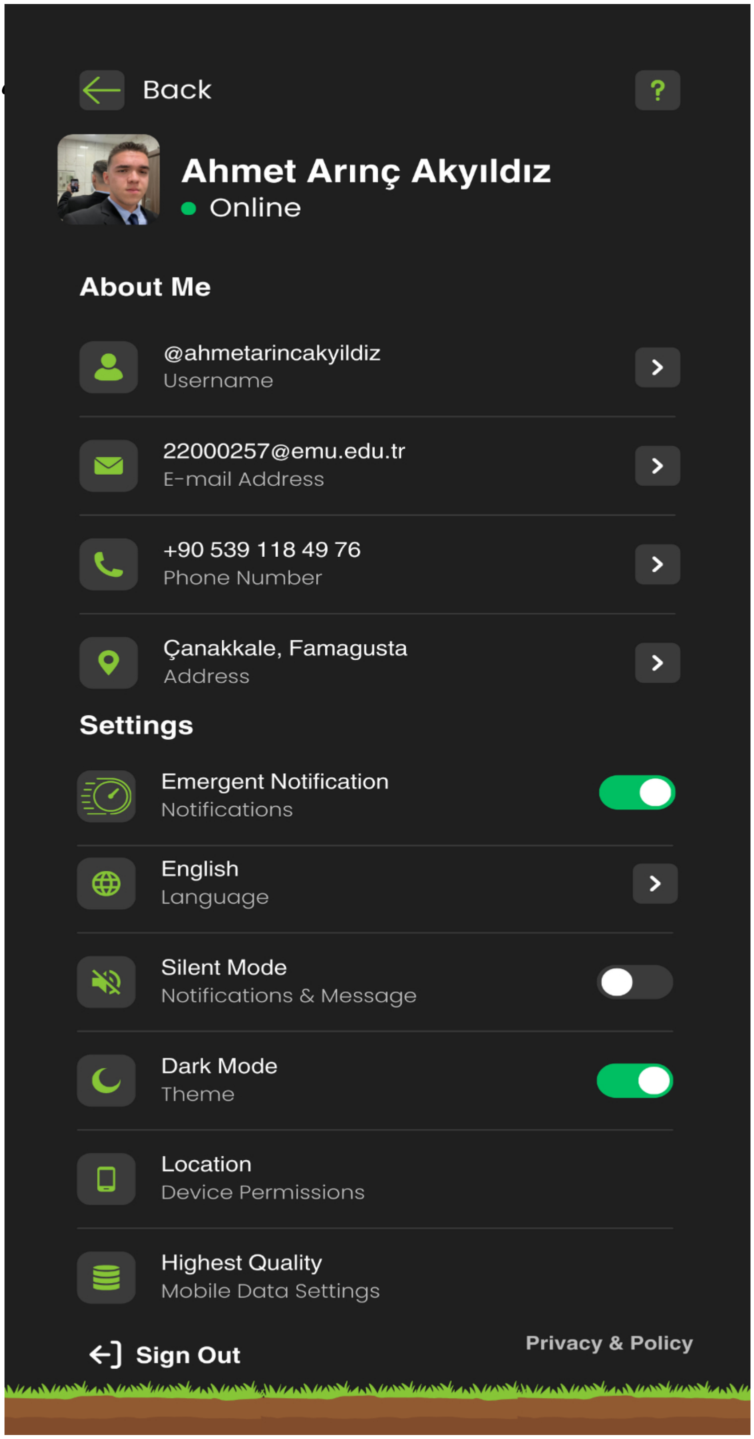
LAST 24 HOURS
Rain 3mm

NEXT 24 HOURS
Precipitation 0mm

NEXT WEEK
Sunny 1mm

Temperatures Today

Figure 5: Profile Panel



Back

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Ahmet Arınç Akyıldız
● Online

About Me

@ahmetarincakyildiz
Username

22000257@emu.edu.tr
E-mail Address

+90 539 118 49 76
Phone Number

Çanakkale, Famagusta
Address

Settings

Emergent Notification
Notifications

English
Language

Silent Mode
Notifications & Message

Dark Mode
Theme

Location
Device Permissions

Highest Quality
Mobile Data Settings

Sign Out

Privacy & Policy

3.2 Hardware Interfaces

The client application of our weather forecasting system executes on mobile devices since these devices are the most common. So, the system is being developed to be able to work on appropriate versions of both iOS and android. As the processes on the client side are light, 1GB disk space, 1GB of memory and a medium level ARM based processor are enough for the system to execute properly. Wi-Fi and cellular data are required to establish communication with the server. When it comes to server side, as we use machine learning, powerful hardware are must. AMD Threadripper series processors, ECC(error correcting code) memories, high performance PCIe SSDs in raid mode and graphics processors for parallel computations are needed. IoT sensors are deployer for collecting external.

3.3 Software Interfaces

The system fetches past weather records and future predictions from an external API named OpenWeather. All the data obtained from this API and IoT sensors are first routed to the data processing unit of the system and are preprocessed using numerical methods that are implemented in Pandas and Numpy libraries of Python. Rearranged data is then processed by LSTM machine learning algorithm which is implemented Scikitlearn, Pytorch and Tensorflow libraris which are also supplied by Python. The data so called are stored in MySQL database management system in which, we can store data in a well-organized form. In the client side, Entity Framwork which is a object relational mapping technology, was preferred in order to establish communication with database. User interfaces are going to be integrated with react. OneSignal, Twilo APIs are in the notification side of the system including app notifications and SMS messages.

3.4 Communications Interfaces

Messages are conducted via SMS protocol. The application and server are going to communicate TCP/IP protocol. To carry out data transfer from sensors to servers is handled by DHT proprietary protocol. Data security is conformed with AES-128 encryption standard.

4. System Features

4.1 Account Management

4.1.1 Description and Priority

This feature is essential for the system as customers must be able to manage their personal information, location etc. Also, preferences such as notifications or message are defined in this feature. So, it holds the medium priority.

4.1.2 Stimulus/Response Sequences

Use Case – 1.1	Register
Actor	User
Goal	To create an account
Preconditions	The system displays the register page
Stimulus	The user wishes to create a new account
Scenario	1) The user selects ‘Register’ from the homepage menu 2) The system prompts the user for information (Name, Email, Password, Confirm Password) 3)The user fills in the data fields 4) The system analyzes the user’s data for validity 5) A security confirmation link is sent to the user’s email 6) The user confirms their identity by clicking on the link
Exceptions	Invalid information is inputted by the user

Use Case – 1.2	Login
Actor	User
Goal	Log in the system
Preconditions	The system displays the login page
Stimulus	The user wishes to log in
Scenario	1) User opens the applications 2) Login page is directly displayed 3) The user fills in the data fields (email, password) 4) User clicks the login button 5) The system analyzes the user’s data for validity 6) Main menu is displayed
Exceptions	Invalid information is inputted by the user

Use Case – 1.3	Logout
Actor	User
Goal	To finish the user’s access to the system
Preconditions	User must already be logged in
Stimulus	The user does not require access the system anymore
Scenario	1) The user clicks on the logout button on the main menu 2) System disables the access of the user
Exceptions	-

Use Case – 1.4	Change preferences
Actor	User
Goal	To change notification or language preferences
Preconditions	User must already be logged in
Stimulus	The user needs to change preferences
Scenario	1) The user clicks on the settings button on the main menu 2) The user clicks on the preferences button 3) User selects preferences from related menu 4) User clicks on save button
Exceptions	-

Use Case – 1.5	Forgot password
Actor	User
Goal	To let users to reset their password if they forgot it
Preconditions	Login page is loaded
Stimulus	User click on forgot password button
Scenario	1) Related form is loaded to fill email, name and surname 2) User fills in the form 3) Provided information is checked and if it is valid, password reset link is sent by email 4) User clicks on the link and enters the new password 5) if approved login page is loaded back
Exceptions	Misinformation is entered Incorrect password format

4.1.3 Functional Requirements

REQ-1: Users shall be able to register to the system.

REQ-2: Users shall be able to log in.

REQ-3: Users who logged in shall be able to log out.

REQ-4: Users shall be able to manage their profile.

REQ-5: Users shall be able to change their password.

REQ-6: Users shall be able to specify their preferences.

REQ-7: System shall send verification email.

REQ-8: Users should be able to reset password if they forgot it.

4.2 Data Collection

4.2.1 Description and Priority

The system must collect external weather data through OpenWeather API and current hyperlocal data from the sensor located near that area. As the system's functionality depends on these data, this future has the very high priority on the development phase.

4.2.2 Stimulus/Response Sequences

Use Case – 2.1	Retrieve weather data
Actor	System, OpenWeather API
Goal	Retrieving weather data from the OpenWeather API
Preconditions	API is configured correctly
Stimulus	System periodically triggers retrieving data

Scenario	1) The system requests data from the API 2) OpenWeather API returns the data 3) System checks the validity of the data 4) Data is saved to database 5) The data is routed to preprocessing unit
Exceptions	API connection failure

Use Case – 2.2	Collecting sensor data
Actor	System, Sensors
Goal	To collect sensor data including hyperlocal weather data
Preconditions	Sensors are available
Stimulus	System periodically triggers retrieving data from sensors
Scenario	1) The system requests data from sensors 2) Sensors return current readings 3) Data is validated 4) Sensor data is merged with API data
Exceptions	Sensor connection errors

4.2.3 Functional Requirements

REQ-1: System shall fetch weather data from the API.

REQ-2: System shall current read data from the sensors.

REQ-3: System shall handle missing or corrupted data.

REQ-4: System shall merge and organize the data to be processed by machine learning algorithms

REQ-5: System shall store the obtained data in an organized manner.

4.3 Alarm Triggering and Notification

4.3.1 Description and Priority

This feature mainly checks the generated data from the system itself to trigger the alarms located in the agricultural area and sends notifications and SMS messages according to the user’s preferences. As some serious situations that farmer intervention plays vital role, may occur, high priority is assigned to this feature.

4.3.2 Stimulus/Response Sequences

Use Case – 3.1	Alarm triggering
Actor	System
Goal	To warn user about upcoming critical weather conditions
Preconditions	System detects critical weather conditions
Stimulus	Conditions that alarms must be triggered, are detected
Scenario	1) System forecasted data periodically 2) Dangerous situations are detected 3) System triggers alarms
Exceptions	Alarm hardware malfunctions Connection issues

Use Case – 3.2	Send notifications
Actor	System, User
Goal	Inform users via communication channel preferences
Preconditions	User preferences are existing in database
Stimulus	Notifications are generated
Scenario	1) The system generates notification messages 2) Message is formatted and sent via preferred communication channel (app notifications or SMS)
Exceptions	Connection error

4.3.3 Functional Requirements

REQ-1: The system shall frequently check the forecasts generated by the system itself and the sensors.

REQ-2: System shall analyze both current and forecasted data.

REQ-3: System shall decide whether to trigger the alarms and send notifications considering the analysis.

REQ-4: System shall trigger alarms when needed.

REQ-5: System shall send notification and SMS conforming to the user’s preferences.

4.4 Community Features

4.4.1 Description and Priority

This feature aims to create an environment for users to share their predictions on the upcoming weather conditions, advice and information for specific crop types. In other words, our goal is to increase interaction among farmers. So, this feature is not vital, it is prioritized as low.

4.4.2 Stimulus/Response Sequences

Use Case – 4.1	Post content
Actor	User, System
Goal	To share advice or predictions
Preconditions	User is logged in to the system
Stimulus	User wishes to share post
Scenario	1) User clicks on the community button located at the bottom of the main menu 2) User clicks on new post button 3) User inputs the content into the textbox 4) User clicks on post button 5) System checks for misinformation or inappropriate language 6) If the content is approved, it is posted to the community panel
Exceptions	Post contains inappropriate content

Use Case – 4.2	Interaction with post
Actor	User, System
Goal	To interact with posts (like or comment)
Preconditions	User is logged in to the system
Stimulus	User selects a post
Scenario	1) User clicks on like or comment buttons 2) System checks if the comment is inappropriate 3) If approved, post metrics and comments are updated 4) Update post is displayed to users
Exceptions	Post contains inappropriate content

4.4.3 Functional Requirements

REQ-1: Users shall be able to display the community panel.

REQ-2: Users shall be able to post contents.

REQ-3: Users shall be able to interact with the posts; like, comment etc.

REQ-4: System shall check if the posts are appropriate for the platform.

REQ-5: Inappropriate and misleading posts must be removed by the system.

REQ-6: System shall give priority to posts which are shared from near locations.

5. Other Nonfunctional Requirements

5.1 Performance Requirements

The application will receive weather data from APIs while also using real-time sensor inputs to keep critical notification times below 3 seconds. It will optimize database query performance and manage intensive user transactions

5.2 Safety Requirements

The app must absolutely protect the confidentiality of user information. Access to user information should be limited to ensure that only authorized users have access. The system must have a strong infrastructure that can protect itself against hacking and malware.

5.3 Security Requirements

The user authentication system should be strengthened by taking strong measures such as strong passwords and double-factor authentication. The system must take precautions to prevent security vulnerabilities with continuous security scans, etc.

5.4 Software Quality Attributes

Adaptability: The application will be modular to include APIs or features.
Reliability: Error rates will remain below a very low figure with testing and verification.
Usability: Interfaces are designed to be simple to provide ease of use for farmers who are not good at using technology

5.5 Business Rules

Administrators should only manage user profiles by accessing the most important user data at a minimum level, so there will be no security issues for users.

6. Other Requirements

Internationalization Requirements

Application will be regionally localized to cater to diverse users across regions and will allow farmers to access the application in their own language.

Legal Requirements

Application is required to comply with regional data protection regulations such as EU laws to ensure privacy of its users.

System Integration Requirements

Platform will seamlessly integrate with external APIs such as OpenWeather and Twilio while maintaining compatibility with future services.

Scalability Requirements

Designed to handle data sources as the number of users increases without degrading performance, application will use load balancing and distributed architecture.

Testing and Validation Requirements

Application weather forecasting It will be put through a lot of testing using large data sets to verify its accuracy and ensure reliability against real-world conditions.

Appendix A: Glossary

AES:	Advanced Encryption Standard
API:	Application Programming Interface
ECC:	Error Correcting Code
IoT:	Internet of Things
LSTM:	Long Short Term Memory
PCIe:	Peripheral Component Interconnect Express
SMS:	Short Messaging Service
SRS:	Software Requirement Specification
SSD:	Solid State Drive
TCP/IP:	Transmission Control Protocol/Internet Protocol
Wi-Fi:	Wireless Fidelity

Appendix B: Analysis Models

Figure 6: BPMN Diagram

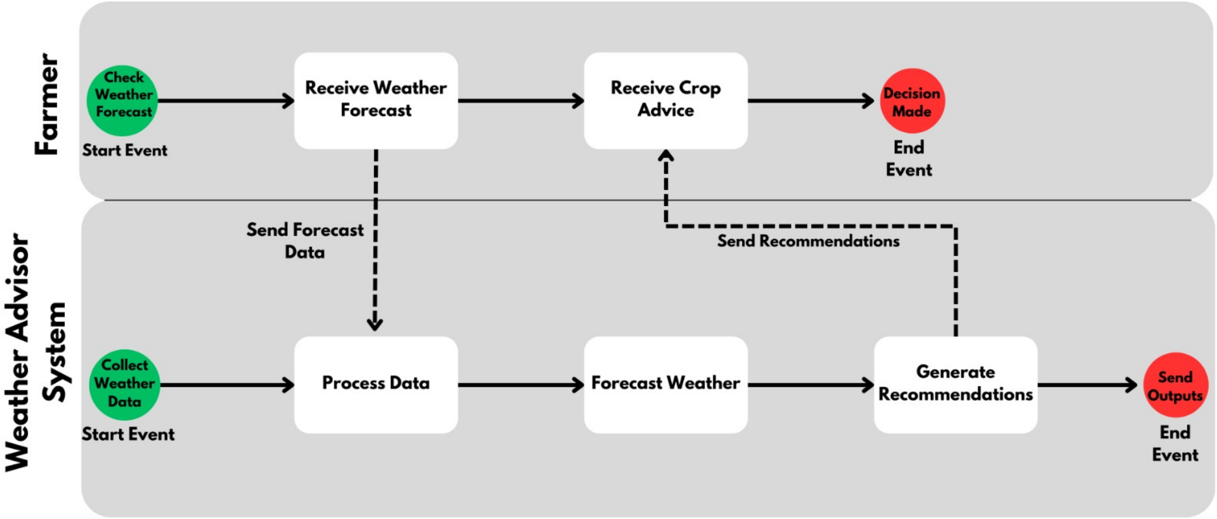


Figure 7: Context Diagram

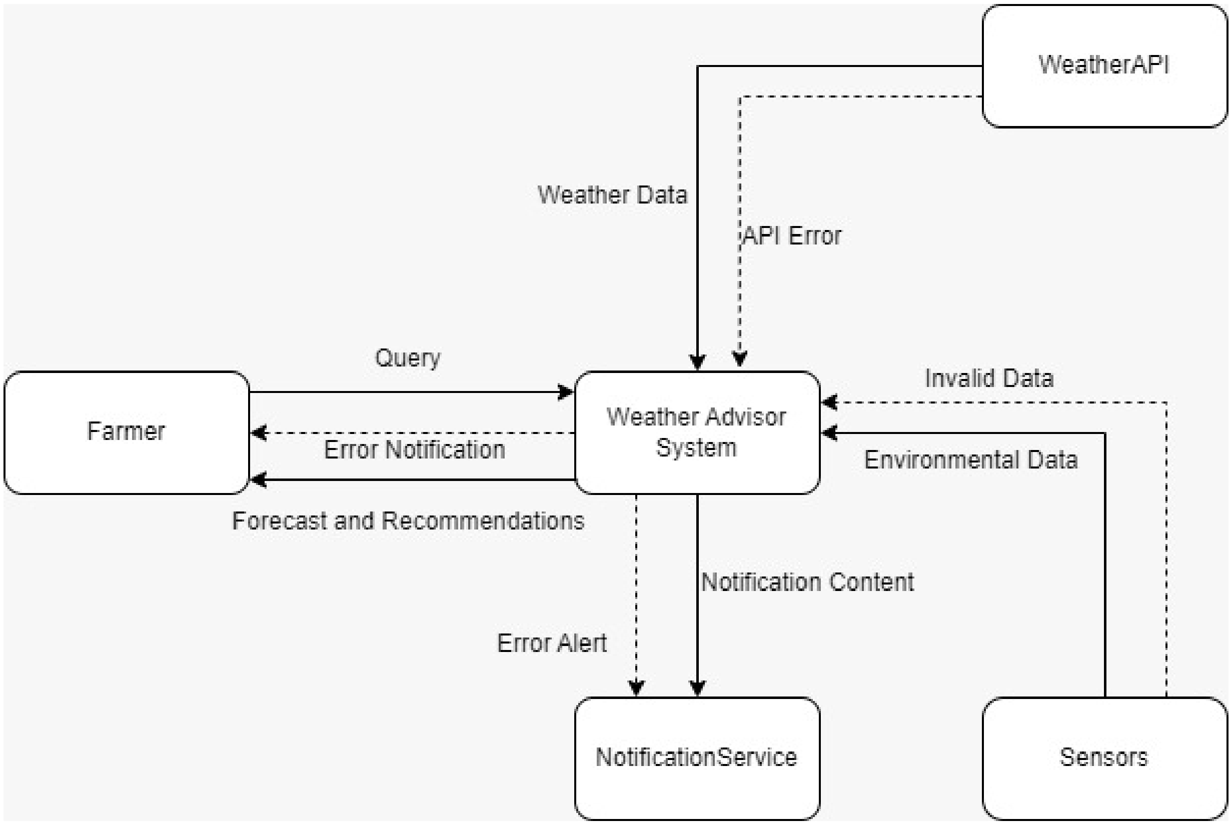


Figure 8: State Machine Diagram

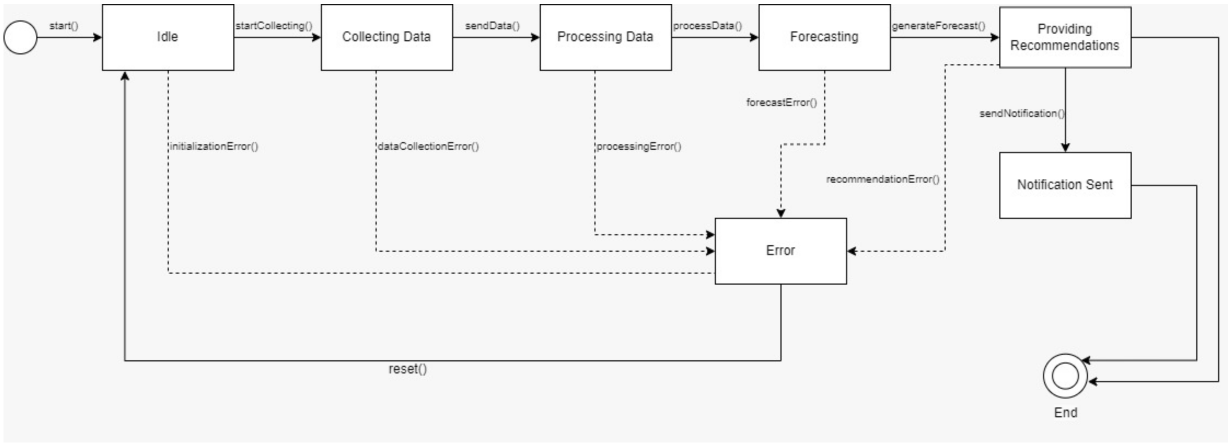


Figure 9: Use Case Diagram

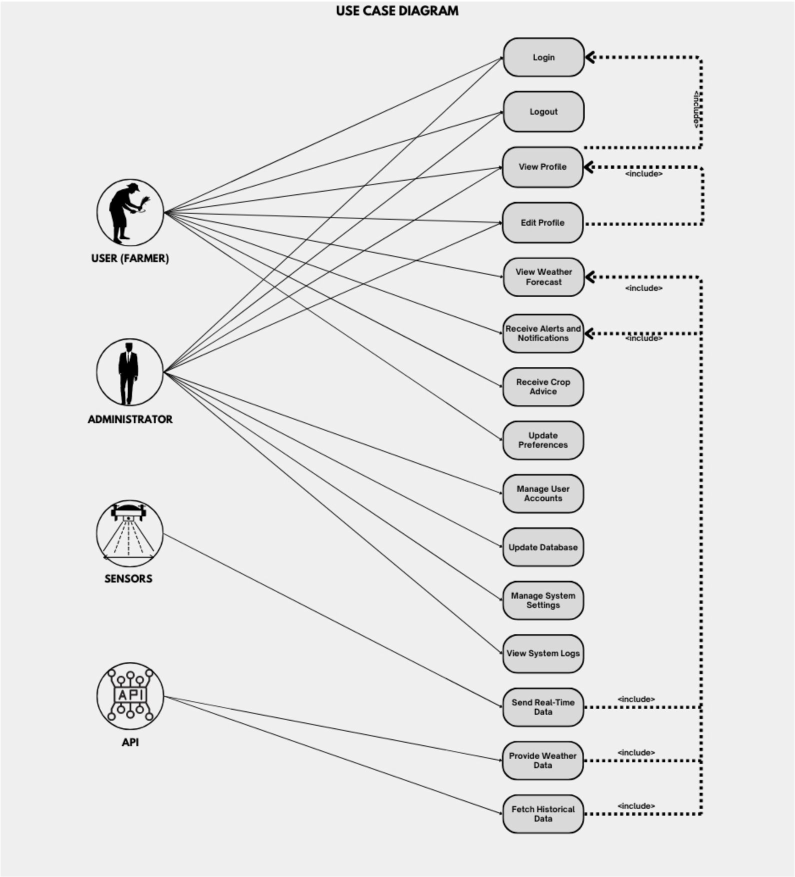


Figure 10: Activity Diagram

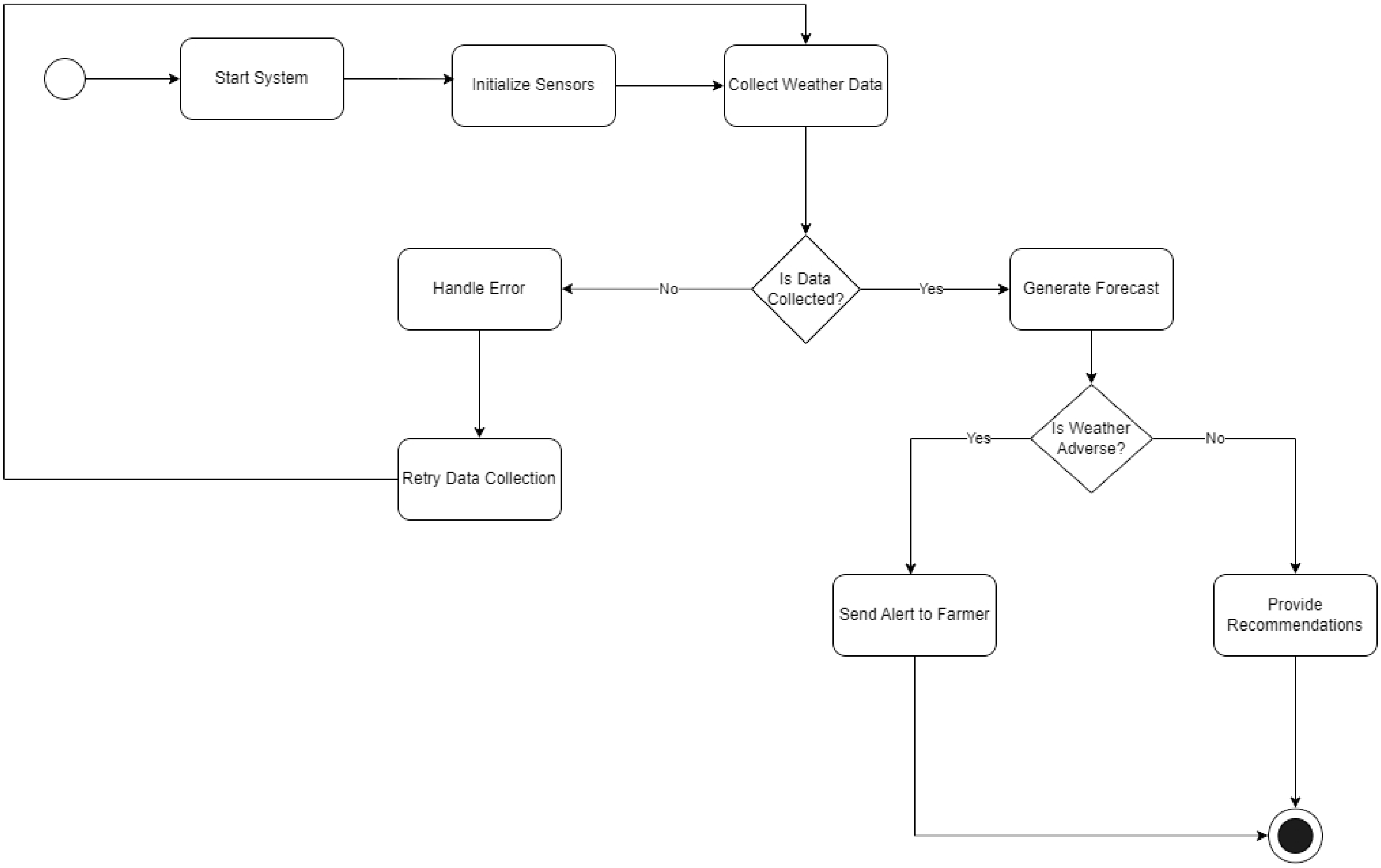


Figure 11: Sequence Diagram

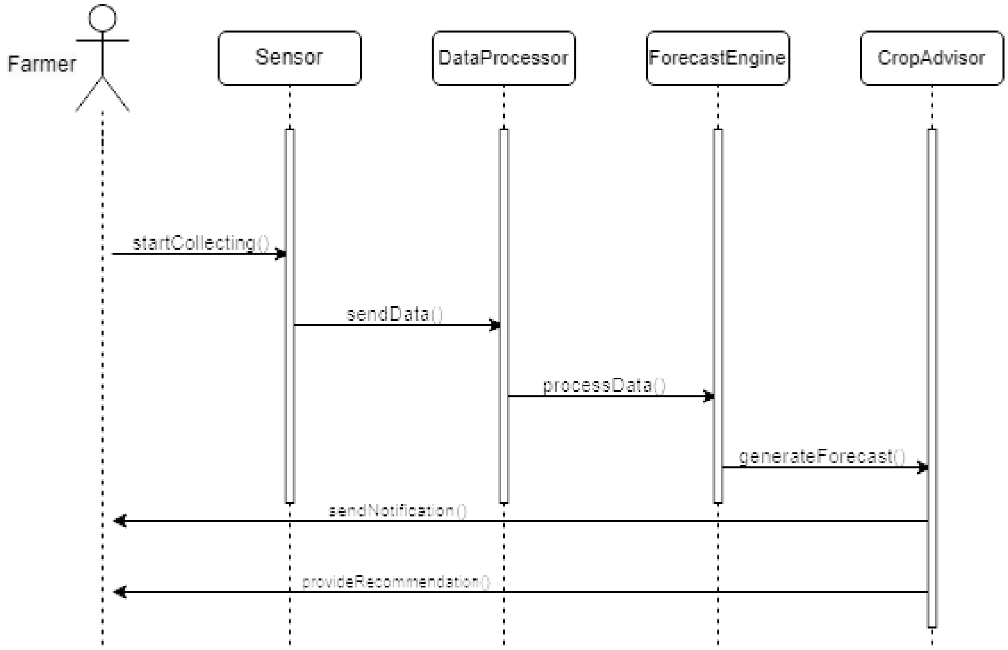


Figure 12: Class Diagram

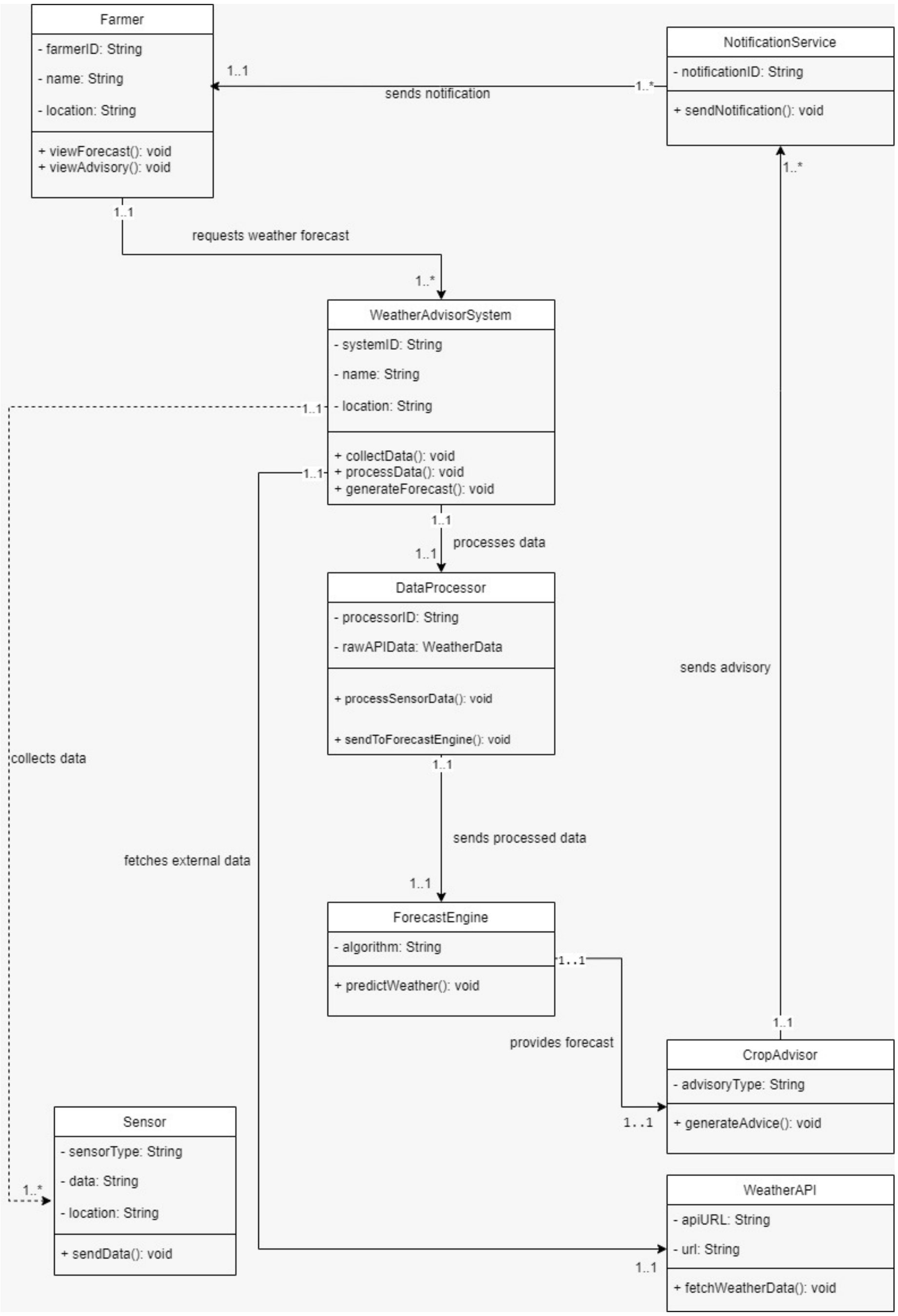


Figure 13: Collobration Diagram

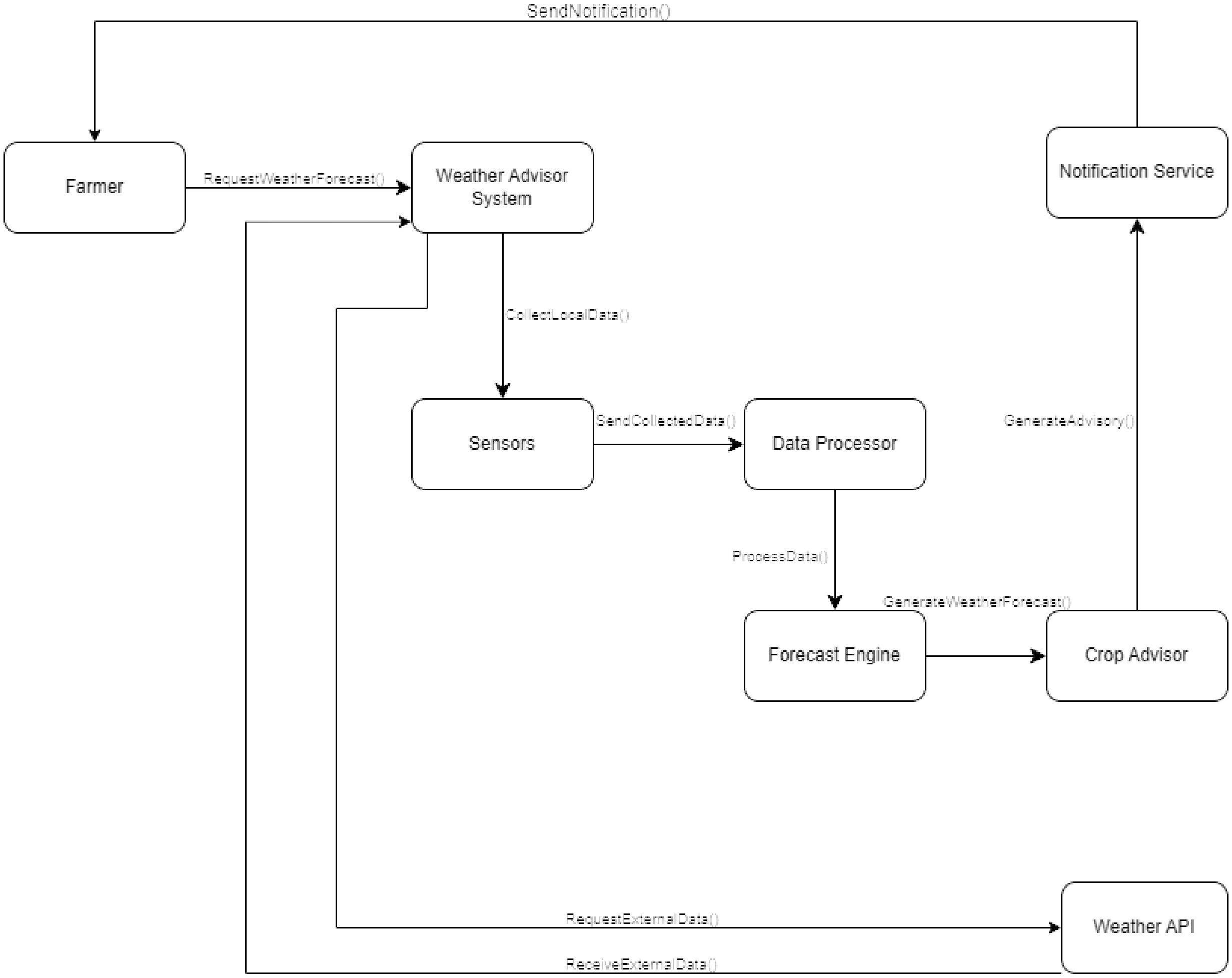
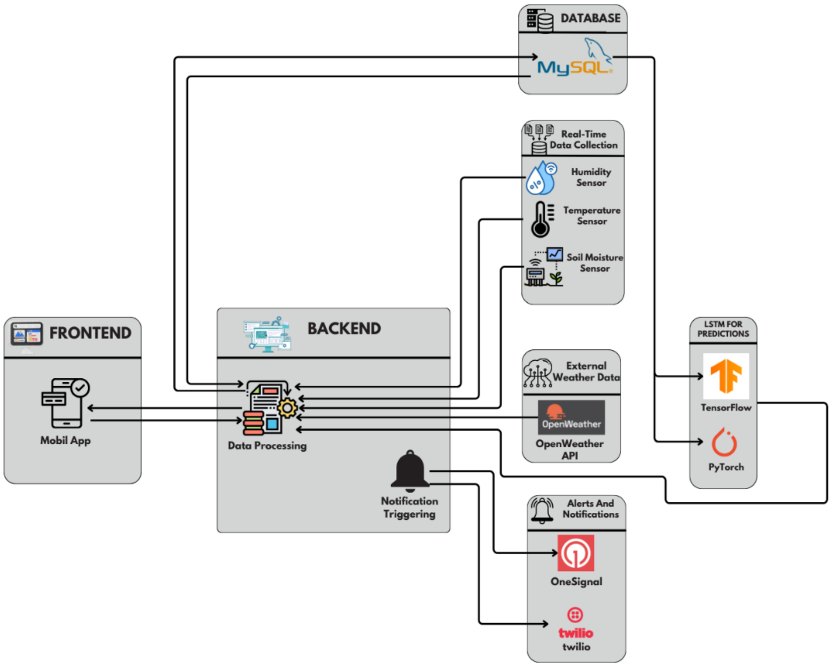


Figure 14: System Architecture Diagram



GEN AI TOOLS USE DETAILS

1. Introduction and Conclusion
   - Tool Used: Chatgpt
   - Purpose: Helped summarize Introduction, Related work, and Methodology. Helped brainstorm main ideas and create preliminary drafts of report and introduction.
   - Percentage of Use: 5%
2. Related Work
   - Tool Used: None
3. Methodology
   - Tool Used: None
4. Planned Activities and Contributions
   - Tool Used: None
5. References
   - Tool Used: Chatgpt
   - Purpose: References were generated manually and formatted by AI.
   - Percentage of Use: 20%
6. Grammar and Spelling Checks

- Tool Used: Quillbot and Translate
- Purpose: The tool was employed to identify and correct grammatical errors, spelling mistakes, and improve sentence clarity throughout the report.
- Percentage of Use: 15%