Requirements Specification Document
SMOREI
(System for Monitoring Off-Shore Renewable Energy Installations)

Saltwater Savants

26th November 2023

Contents

Revision History

Name	Date	Reason for Changes	Version
Saltwater Savants	**23/10/23**	**Original Document**	**1.0**
OceanIntelligence (All)	**25/10/23**	**Client Commented**	**1.1**
Saltwater Savants	**06/11/23**	**Sequence Diagrams, ERD and Data Dictionary**	**2.0**
Saltwater Savants	**16/11/23**	**Mockups, Storyboards, DFD (0,1,2)**	**3.0**
OceanIntelligence (All)	**19/11/23**	**Client Comments**	**3.1**
Saltwater Savants	**24/11/23**	**Test Scenarios, Rationales, and Traceability Matrix**	**Final**

1 Introduction

1.1 Purpose

With the demand for renewable energy methods increasing, the number of offshore energy generators is steadily growing. With this increase in renewable energy stations, it is essential that such stations do not negatively impact their surrounding environments. SMOREI's goal is to remotely monitor and observe offshore energy installations to ensure that they are not negatively impacting their surrounding environments. This document's purpose is to deliver a succinct summary of the intended solution, and how we (Saltwater Savants) plan to implement said solution. This document aims to build off of the RD 1.0 with a more consistent description of the intended solution while delivering use cases for requirements to increase readability and understandability.

1.2 Project Scope

This project aims to develop an innovative technology for the surveillance of marine life and habitat within the vicinity of offshore renewable energy installations. By integrating advanced underwater sensors and data analytics, this system will provide data which will aid researchers in ensuring the sustainable coexistence of renewable energy generation and marine ecosystems.

1.3 Glossary of Terms

SMOREI	System for Monitoring Off-Shore Renewable Energy Stations
AWS	Amazon Web Services
RFP	Request for Proposal
RD	Requirements Document
RSD	Requirement Specification Document

1.4 References

[1] "Video Latency - A Crucial Factor in Live Streaming." DaCast [Online]. August 29, 2023. Available: https://www.dacast.com/blog/video-latency/#:~:text=A%20good%20latency%20for%20video%20streaming%20is%20about%20six%20seconds,between%205%20to%2018%20seconds.

1.5 Overview

1. General overview of document and introduction to the system
2. General description of product and business requirements
3. System features and functional requirements with use cases
4. Interface features and requirements
5. Other non-functional requirements

The goal of this document is to provide the reader with a greater and more accurate understanding of the design requirements of SMOREI compared to RD 1.0, and how these requirements will be implemented in the proposed solution.

2 Overall Description

2.1 Product Perspective

The SMOREI, an innovative initiative introduced by OceanIntelligence, is a groundbreaking solution designed to monitor offshore renewable energy installations. This product represents a critical advancement in our ongoing commitment to safeguarding both marine ecosystems and the well-being of communities dependent on these environments for their livelihoods and sustenance.

As a holistic project, the SMOREI comprises two key components: hardware and software. The hardware aspect involves the deployment of specialized sensors to track five vital parameters associated with offshore energy generation, addressing the primary concerns of local residents and environmentalists. These sensors are strategically placed within the targeted regions.

The software component of SMOREI plays an equally pivotal role by collecting, processing, and presenting the data in a user-friendly format. Researchers, environmentalists, and other stakeholders can easily access this data, enabling them to make well-informed decisions and conduct essential research on the effects of energy generation on these delicate ecosystems.

SMOREI Initiative	
Offshore Renewable Energy	
Hardware Component	**Software Component**
Sensors to Monitor Key Parameters	Data Collection & Processing
Installation of sensors for Environmental Monitoring	Provide weekly reports on observed data
Transmission of data on Marine Life & Livelihood Preservation	Alerts users in case of hardware failure.

Table 1: Project Perspective on SMOREI

2.2 Product Features

The SMOREI product offers a range of essential features to address the critical aspects of monitoring offshore renewable energy installations and their impact on ecosystems.

2.2.1 Remote Monitoring: The core feature of SMOREI is its remote monitoring system, eliminating the need for manual data collection. Users can access real-time video, weekly data reports, and warning alerts without physically traveling to the installation sites, ensuring convenience and efficiency.

2.2.2 Environmental Data Collection: The system continuously gathers data from strategically placed sensors, tracking key parameters related to energy generation. This data collection is essential for observing and analyzing the effects on the local ecosystem.

2.2.3 Ecosystem Impact Observation: SMOREI enables users to closely monitor and assess the environmental impact of offshore energy generation. This feature empowers researchers and environmentalists to make informed decisions and ensures the preservation of marine ecosystems.

2.2.4 External Interface Requirements: The application must be compatible with all operating systems, enabling users to access both weekly data and live-streamed cameras. It should also alert users to sensor failures.

2.3 User Classes and Characteristics

The SMOREI system caters to researchers with a distinct group of needs.

2.3.1 Researchers: Within the organization, researchers play a pivotal role. They will utilize the system to monitor the health and potential threats to ecosystems around offshore renewable energy installations. Their expertise and focus on ecosystem health make them the primary and favored user class.

2.4 Operating Environment

1. **Software**
   The software can be downloaded on multiple platforms (e.g. Windows/Linux). The software will provide seamless remote access for researchers to view and access any data needed for maintenance or checking Hazard levels. This approach allows stakeholders to interact with the system from anywhere with an internet connection.

2. **Hardware**
   The project utilizes a specialized sensor array, designed to endure harsh marine conditions and monitor offshore renewable energy installations. Some of the monitoring data includes salinity, temperature, pH, oxygen concentration, noise levels, and video feed for the underwater ecosystem. A data acquisition system

will ensure efficient real-time data processing, secure storage, and organized transmission to a central database or cloud server. Moreover, a sustainable power supply system, employing renewable sources like solar panels and wind turbines alongside backup batteries, provides consistent and reliable energy.

2.5 Design and Implementation Constraints

Several design and implementation constraints must be carefully considered in the development of the SMOREI:

1. **Real-Time Remote Monitoring**
   The system must provide real-time remote monitoring capabilities. This imposes demands on the speed and reliability of data transmission, requiring efficient data handling and robust communication technologies.

2. **Harsh Environmental Conditions:** Coastal regions can present challenging environmental conditions, including saltwater exposure, high humidity, and extreme temperatures. These conditions increase the risk of hardware corrosion, necessitating the use of rugged, corrosion-resistant components.

3. **Hardware Reliability:** Ensuring the hardware's reliability is paramount. The hardware components must function as promised, providing accurate and consistent data, even in the face of adverse conditions.

4. **Data Pipeline Integrity:** The data pipeline should be designed with meticulous attention to error prevention. Minimal data loss during transmission is a critical requirement to maintain data accuracy and integrity.

2.6 Assumptions and dependencies

The project's design and implementation are contingent on several key assumptions and dependencies:

1. **External Hardware Suppliers:** We assume the availability and reliability of external hardware suppliers for sourcing the required components. Any disruptions or delays in the supply chain may affect project timelines.

2. **In-House Hardware Setup:** The in-house team will be responsible for configuring and setting up the hardware. The successful execution of this task is assumed.

3. **Data Transmission Pipelines:** The effective operation of data transmission pipelines is crucial. Any unforeseen issues or bottlenecks in data transmission may impact the system's performance and functionality.

3 System Features

This section outlines the fundamental aspects of SMOREI that are relevant to its main functions within monitoring offshore renewable energy installations and their effects on ecosystems. It also employs use cases to exemplify how each function interacts.

3.1 Remote Monitoring

3.1.1 Description and Priority

The central function of SMOREI lies in its remote monitoring system which eliminates the necessity for manual data collection. Users can access real-time data without the need to physically travel to the installation sites, ensuring both convenience and efficiency. This is a core functionality, thus it is of high priority.

3.1.2 Functional Requirements

REQ-1-1: The application must provide data summary reports that are accessible by users. These data can be customized based on hourly, daily, weekly, monthly or yearly reports.

Rationale: Users need the ability to access data summary reports in order to remotely monitor these offshore renewable energy stations

REQ-1-2: The cameras surrounding the offshore renewable energy stations will stream in real-time with a maximum 10-15 second delay (industry standard [1]). The live-stream videos will be accessible on the application where the users can visually identify the current state of the marine water and life.

Rationale: Users need access to a continuous live video stream to remotely monitor these offshore renewable energy stations

REQ-1-3: Users need to enter a verification code upon registration.

Rationale: In addition to security enhancement, users must verify their identity.

3.1.3 Use Cases

UC-1-1: Users can remotely access data summary reports

Actors:

Primary: Users

Preconditions:

- Users are logged into the SMOREI system.
- Weekly data has been collected and processed.

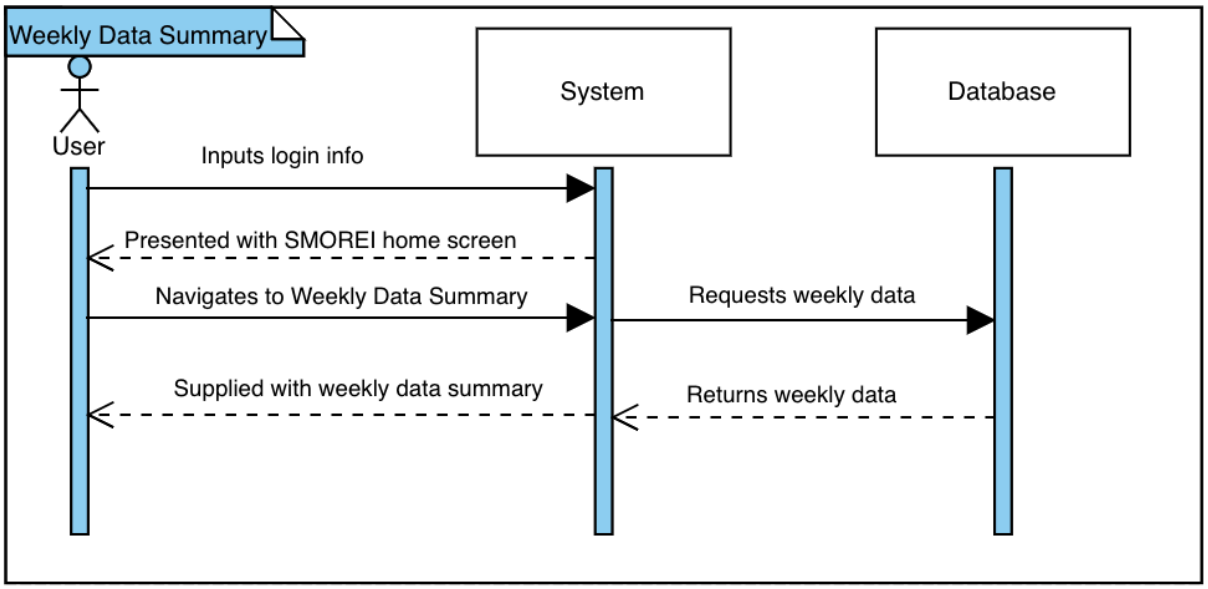
Postconditions:

- Users can access weekly data summary reports.

Main Flow:

1. Users log into the SMOREI system.
2. Users navigate to the "Remote Monitoring" section.
3. Users select the "Weekly Data Summary" option.
4. The system retrieves and displays the weekly data summary reports.
5. Users can view the reports, enabling remote monitoring of offshore renewable energy stations.

Sequence Diagram:



UC-1-2: Live Video Streaming

Actors:

Primary: Users

Preconditions:

- Users are logged into the SMOREI system.
- Live video streaming is available.

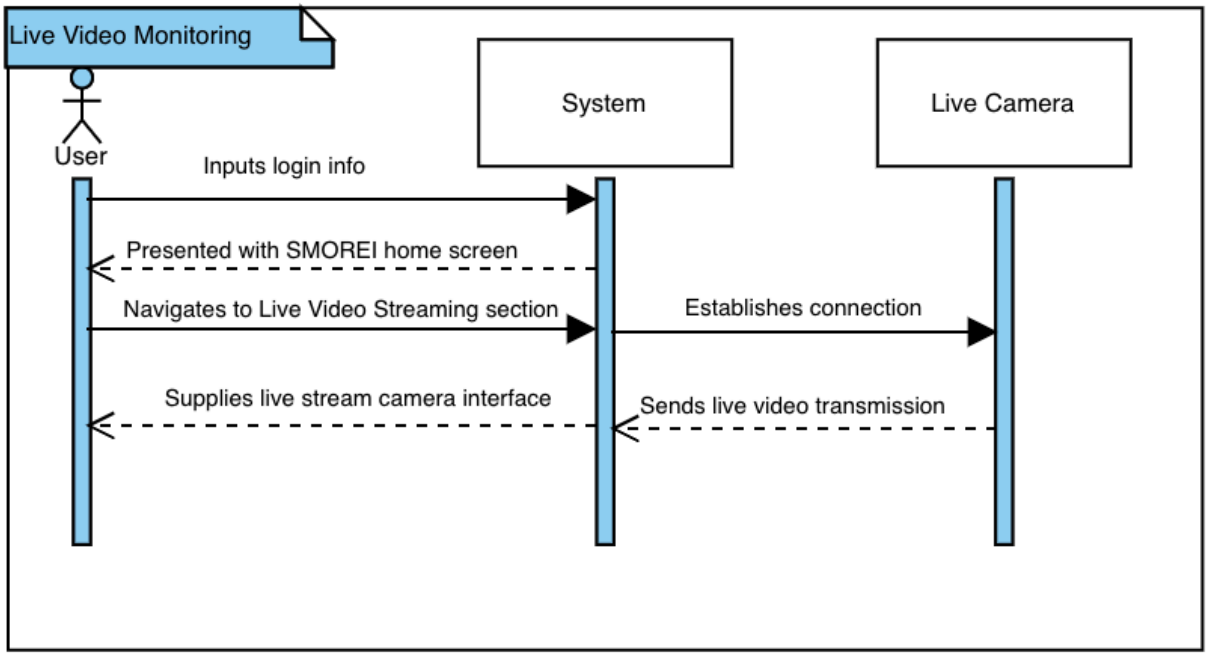
Postconditions:

- Users can access live video camera streaming with a 10-15 second delay.

Main Flow:

1. Users log into the SMOREI system.
2. Users navigate to the "Remote Monitoring" section.
3. Users select the "Live Camera View" option.
4. The system establishes a connection to the live video camera.
5. Users can view the live video stream with a 10-15 second delay, enabling remote monitoring of offshore renewable energy stations.

Sequence Diagram:



3.2 Environmental Data Collection

3.2.1 Description and Priority

The system continually collects data from strategically positioned sensors, tracking essential parameters related to energy generation. This data gathering process is vital for the observation and analysis of its impact on the local ecosystem. This is a core functionality, thus, it is of high priority.

3.2.2 Functional Requirements

REQ-2-1: The system should support an existing multiparameter water sensor which will detect pH, salinity, oxygen levels, and temperature as well as a sound sensor to measure the decibels levels in surrounding areas.

Rationale: The system must use sensors to collect data for the specified metrics in order to monitor the local ecosystem.

REQ-2-2: Data from sensors should be stored in third party cloud storage provide (i.e., AWS) and the application will retrieve the data to generate weekly reports

Rationale: Storing data in AWS will make data more accessible to people in different parts of Canada.

3.2.3 Use Cases

UC-2-1: Sensor Data Collection

Actors:

- System
- Multiparameter Water Sensor
- Sound Sensor

Secondary Use Case: N/A

Preconditions:

- The system is operational.
- Multiparameter water sensors and sound sensors are functioning.
- Data collection is ongoing.

Postconditions:

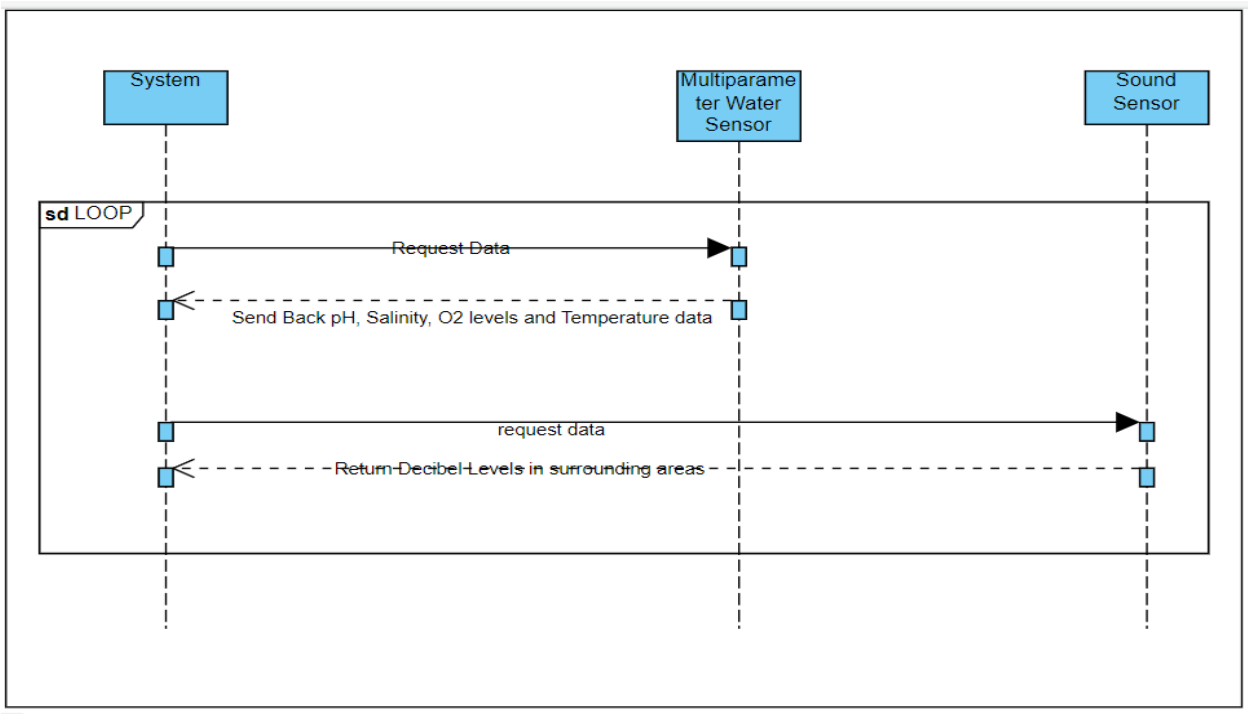
- Data collected from the sensors is available for further processing and storage.

Main Flow:

1. The system continuously collects data from multiparameter water sensors and sound sensors.

2. The multiparameter water sensor detects pH, salinity, oxygen levels, and temperature, while the sound sensor measures decibel levels in the surrounding areas.
3. The collected data is made available for subsequent actions, such as storage and analysis.

Sequence Diagram:



UC-2-2: Data Storage and Reporting

Actors:

- System
- Third-Party Cloud Storage (e.g., AWS)
- Users

Secondary Use Case: N/A

Preconditions:

- Data collection from sensors has been completed.
- Data is available for storage and retrieval.
- Third-party cloud storage (e.g., AWS) is accessible.

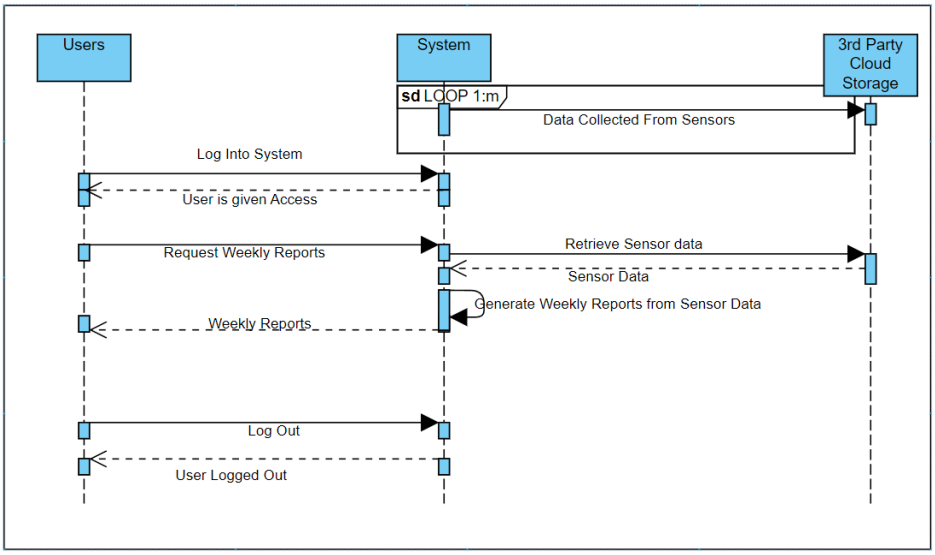
Postconditions:

- Sensor data is successfully stored in the third-party cloud storage.
- Weekly reports can be generated based on the collected data.

Main Flow:

1. Data collected from the sensors is transferred to a third-party cloud storage provider, such as AWS, for secure storage and accessibility.
2. Users log into the system and request the generation of weekly reports.
3. The application retrieves sensor data from the third-party cloud storage.
4. The system processes the collected data and generates weekly reports.
5. Users can access and review the weekly reports, enabling the observation and analysis of the local ecosystem's impact on energy generation.
6. User Logs out

Sequence Diagram:



3.3 Environmental Impact Assessment

3.3.1 Description and Priority

SMOREI empowers users to closely monitor and evaluate the environmental effects of offshore energy generation. This feature equips researchers and environmentalists with the knowledge needed to make informed decisions, ensuring the preservation of marine ecosystems. This functionality requires data collection to be implemented, thus, it is of medium priority.

3.3.2 Functional Requirements

REQ-3-3-1: The system should include data correlation tools to help users identify relationships between different parameters in the weekly reports

Rationale: Users monitoring these offshore renewable energy stations need access to data correlations tools in order to effectively identify cause and effect relationships within these ecosystems.

REQ-3-3-2: The application should provide a warning on the application if data levels are hazardous.

Rationale: User’s need to be notified if the system recognizes any of the data values as hazardous

REQ-3-3-3: Users are able to set filters on sensor ranges; if a sensor reports data outside a certain range, the user will be alerted about anomalies.

Rationale: Allowing users to set filters on sensor ranges is crucial as it permits tailored monitoring in dynamic marine environments, ensuring early detection of anomalies that could signal ecological harm, equipment malfunctions, or other issues. This customization enhances resource efficiency and reduces the likelihood of false alarms, enabling a more focused and effective environmental impact assessment.

3.3.3 Use Cases

UC-3-3-1: Data Correlation Tools

Actors:

Primary: The personnel responsible for monitoring offshore renewable energy stations.

Preconditions:

- The system is operational and connected to the data sources of the offshore renewable energy stations.
- Weekly reports containing various parameters of the offshore renewable energy stations are available in the system.

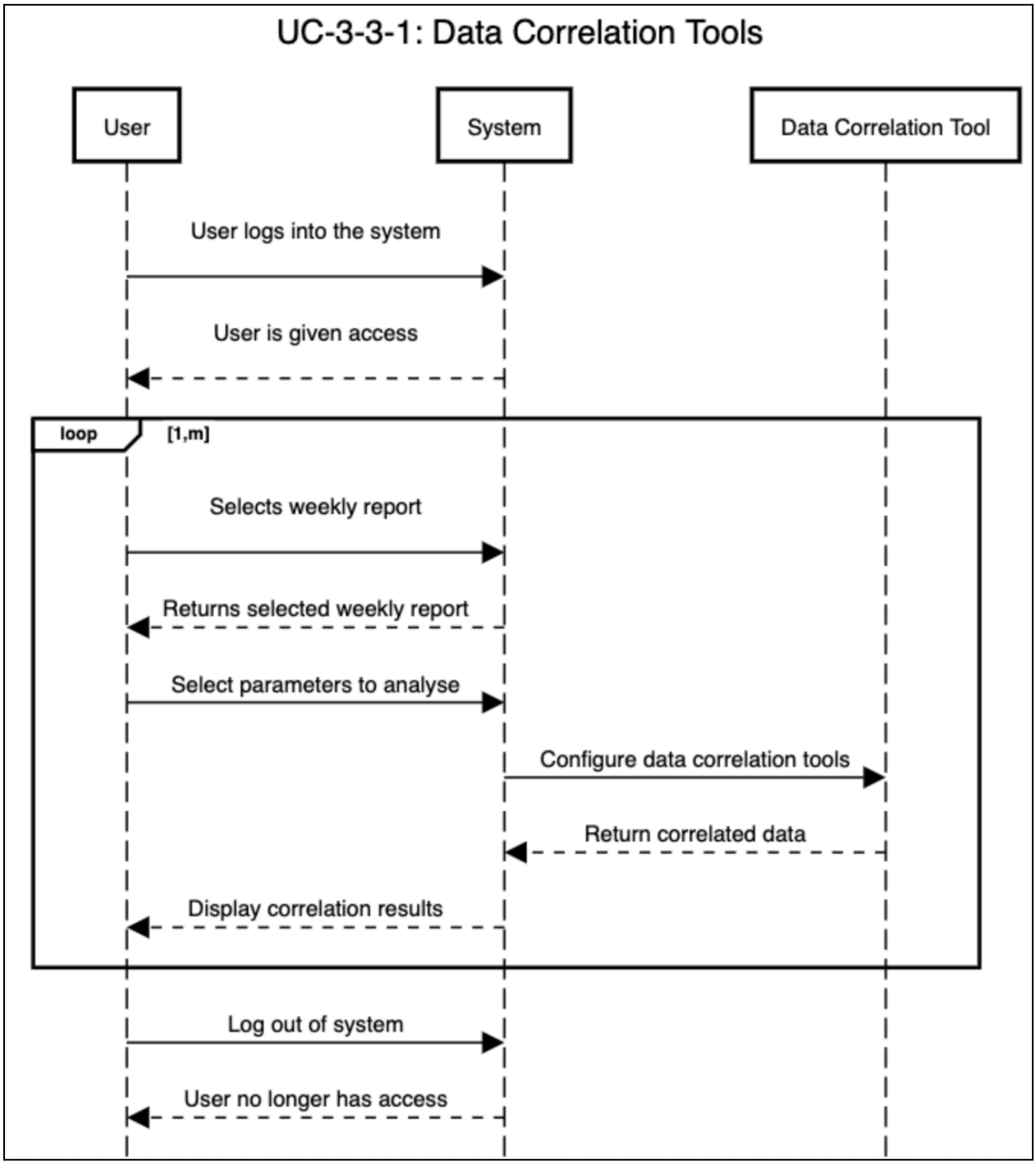
Postconditions:

- The user is provided with the ability to identify relationships and correlations between different parameters in the weekly reports.

Main Flow:

1. User logs in.
2. Selects a weekly report.
3. Chooses parameters to analyze.
4. Configures data correlation tools.
5. System generates correlation results.
6. User reviews and saves results.
7. Optionally, select another report.
8. User logs out.

Sequence Diagram:



UC-3-3-2: Hazardous Data Levels Alert

Actors:

Primary: The individuals using the application.

Preconditions:

- The application is operational and receiving data.
- Data from various sources is available for analysis by the system.

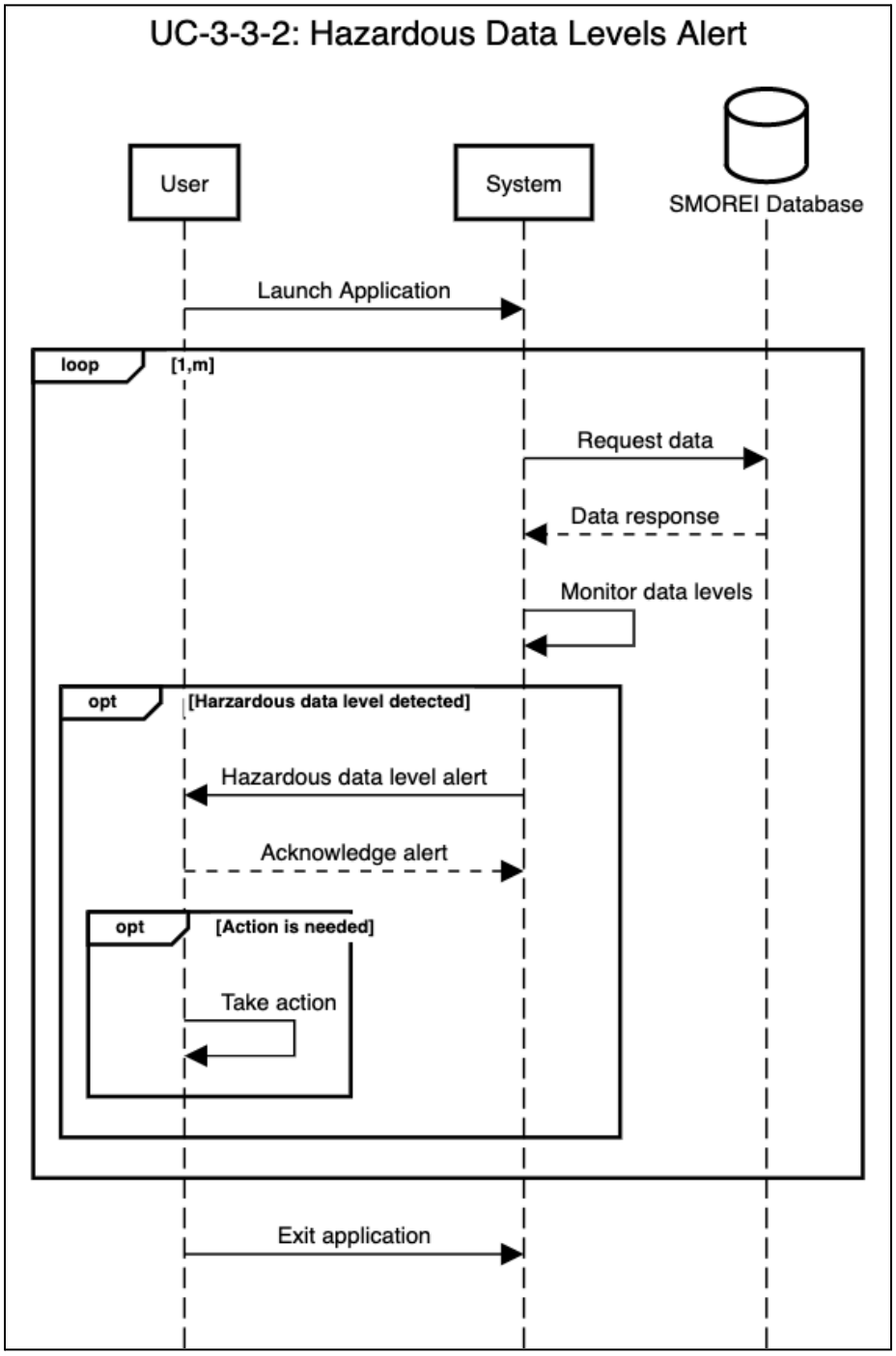
Postconditions:

- Users are informed of hazardous data levels if detected by the system.

Main Flow:

- User launches the application.
- The system continuously monitors data levels.
- If hazardous data levels are detected, the system triggers a warning.
- The user receives and acknowledges the warning.
- User takes appropriate actions or configures notification preferences if necessary.
- The system continues to monitor and issue warnings as needed.
- User exits the application when done.

Sequence Diagram:



UC-3-3-3: Sensor Range Filters

Actors:

Primary: User - The individuals using the system to customize sensor data filtering.
Secondary: Sensor System - The hardware or software responsible for data collection and reporting.

Preconditions:

- The system is operational and connected to sensor systems.
- Sensor data is available for analysis and filtering.

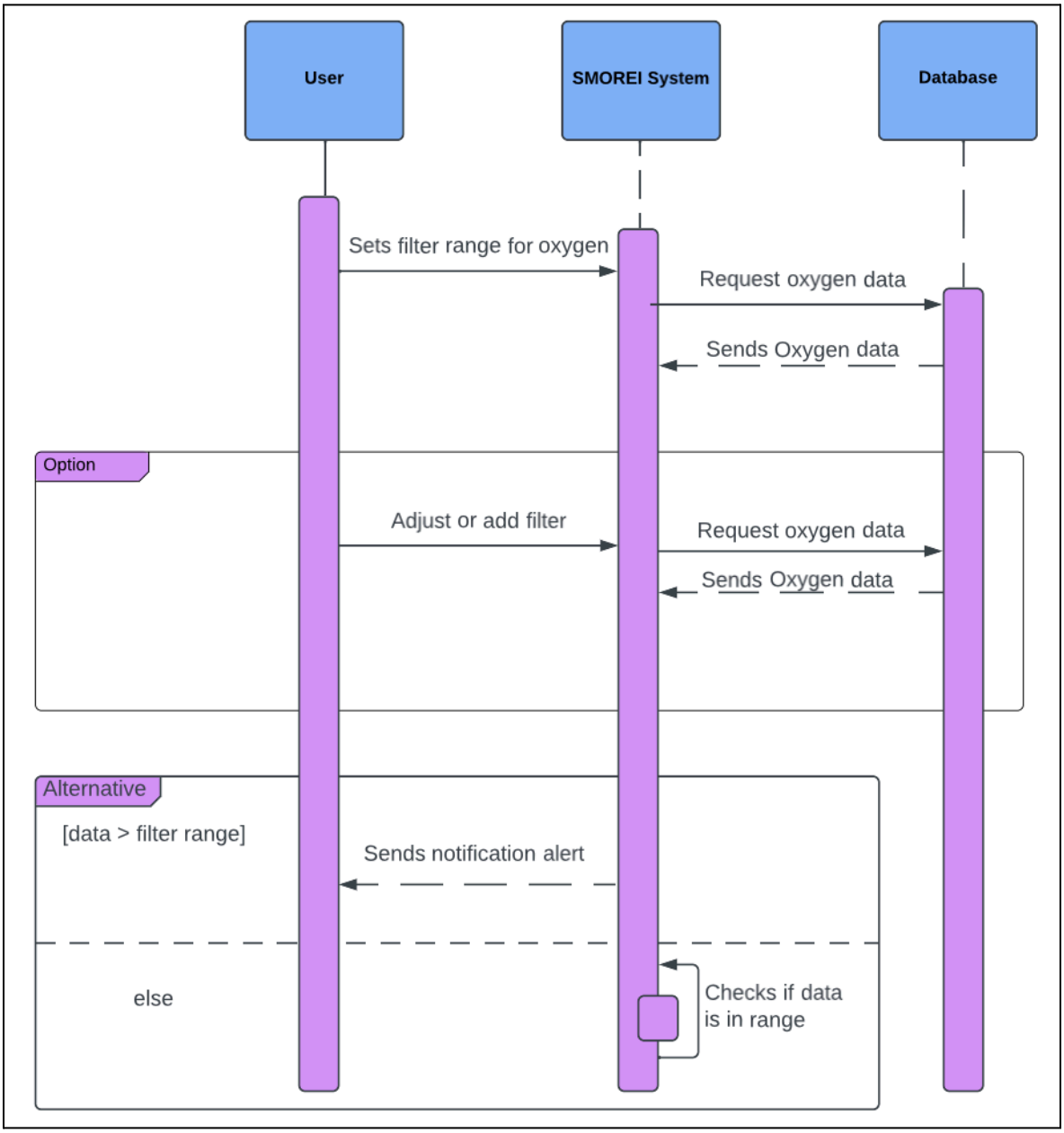
Postconditions:

- Users have set custom filters for sensor data ranges, and the system alerts them about anomalies if data falls outside these ranges.

Main Flow:

1. User customizes sensor range filters for specific data parameters.
2. The system continuously checks data against the user-defined filters.
3. If data falls outside the defined range, the system triggers an anomaly alert.
4. User receives and acts upon the anomaly alert.
5. Users can adjust or add filters as needed.
6. System maintains ongoing monitoring and alerting.
7. User logs out when done.

Sequence Diagram:



3.4 External Interface Requirements

3.4.1 Description and Priority

The application should be cross-platform and accessible on all operating systems. It should enable users to view both weekly data summaries and live-streamed camera feeds. The application must provide access to comprehensive weekly data collection, making all collected data available to users. Additionally, the application should promptly notify users of sensor failures, whether they are related to cameras or multi-parameter water sensors, ensuring the uninterrupted and accurate monitoring of the environment.

3.4.2 Functional Requirements

REQ-3-4-1: An application should be provided to users that is available on all operating systems with capability to view live streamed cameras.

Rationale: This ensures broad accessibility and user-friendliness, improving user engagement.

REQ-3-4-2: The application must provide weekly data collection of all data that was collected over the week that is accessible by users

Rationale: Weekly data access empowers users with historical insights for better decision-making.

REQ-3-4-3: The application should notify users if there is a sensor failure (camera or data sensors)

Rationale: Prompt notifications maintain system reliability and data accuracy, ensuring uninterrupted monitoring.

3.4.3 Use Cases

UC-3-4-1: Cross-Platform Access and Data Viewing

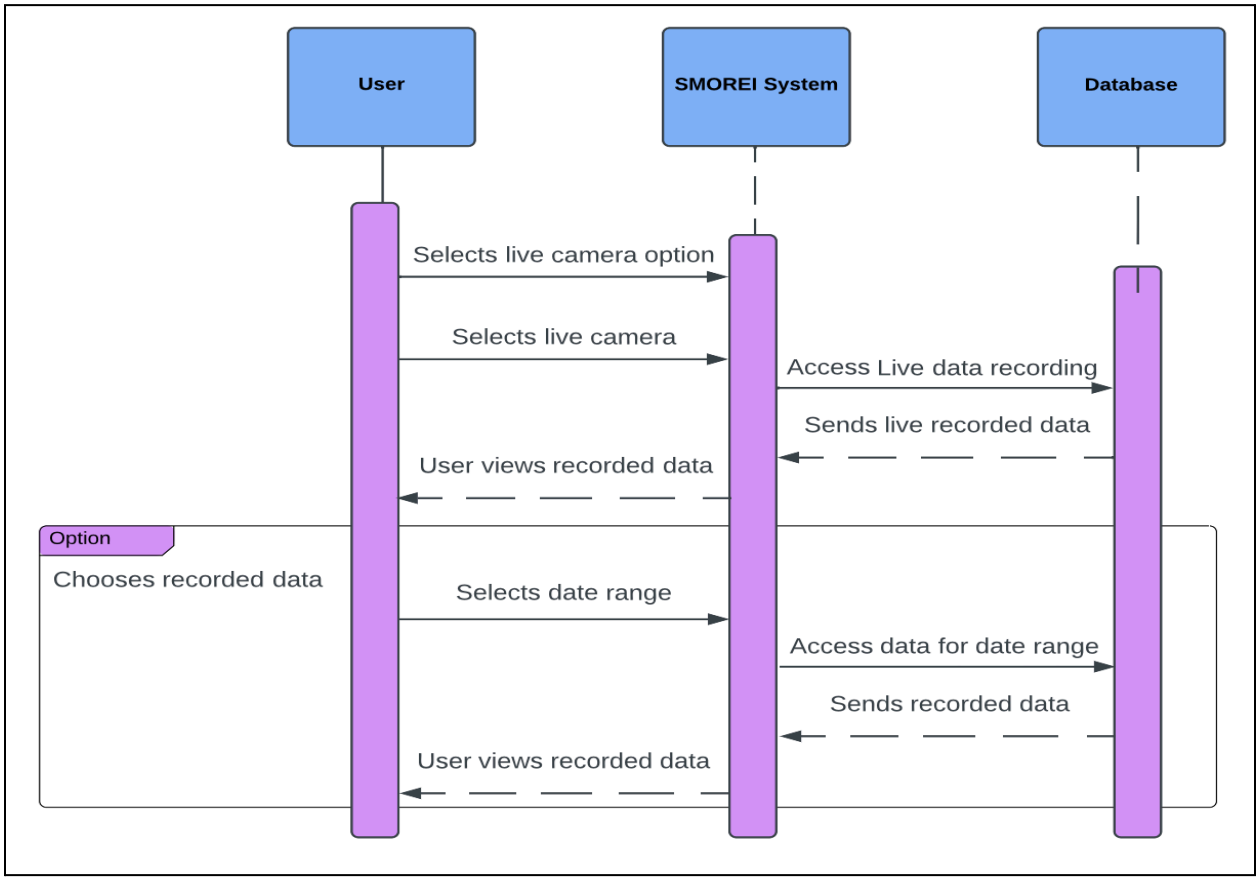
Actors:
User: The individuals using the application to access data and live camera feeds.

Preconditions:
- The application is installed and running on the user's device.
- Data sources for both weekly data and live camera streams are available and accessible.

Postconditions:
- Users can access data and live camera feeds through the application on all operating systems.

Main Flow:
1. The application displays a user-friendly interface that accommodates all operating systems.
2. Users select the desired mode, either to access live-streamed camera feeds.
3. If the user chooses to view weekly data, the application retrieves and displays the relevant data summaries from the designated source.
4. If the user opts for live camera feeds, the application establishes a connection to the camera source and provides real-time video streams.
5. Users interact with the displayed data or camera feeds as needed.

Sequence Diagram:



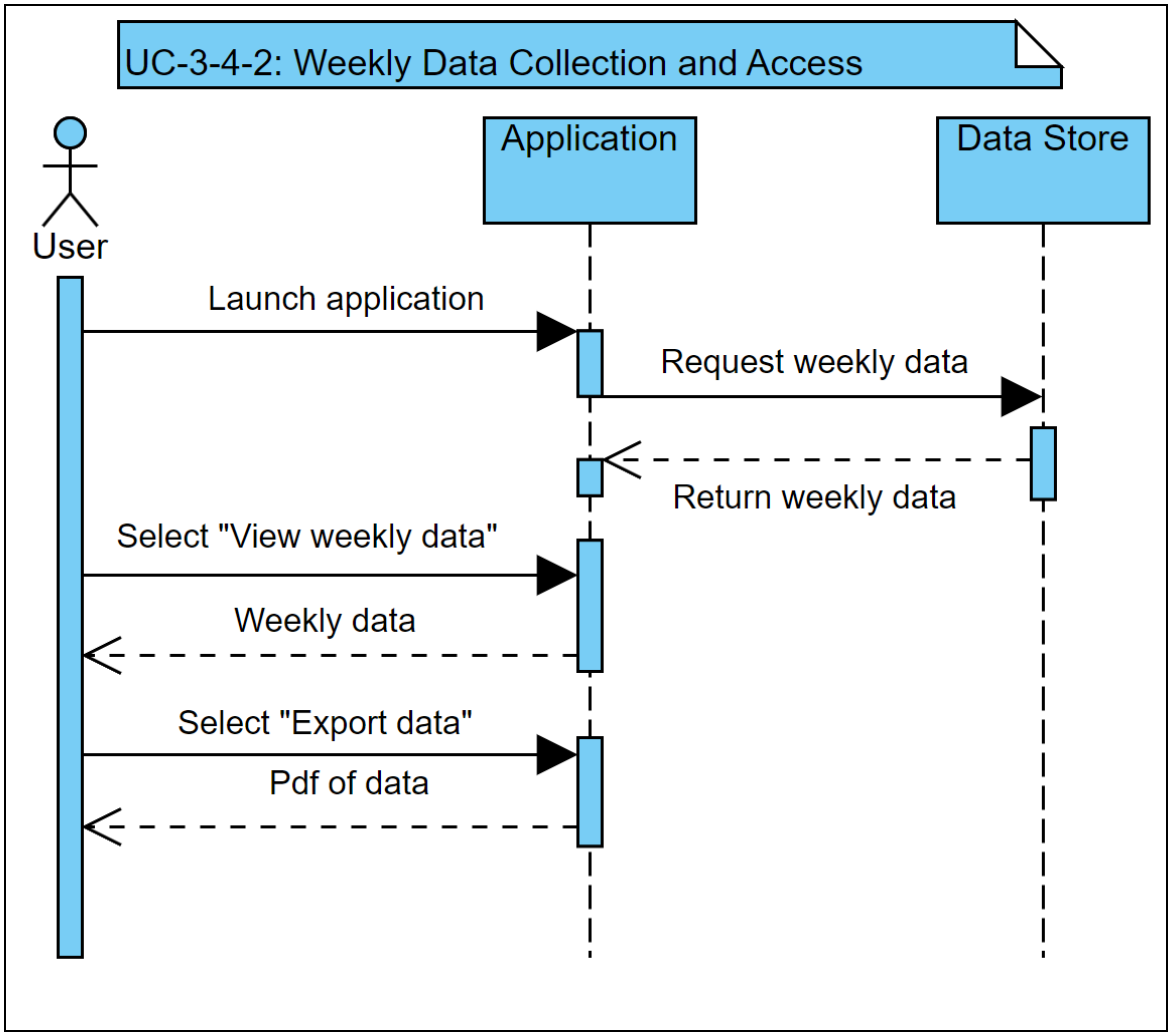
UC-3-4-2: Weekly Data Collection and Access

Actors:
User: The individuals utilizing the application to access weekly data collections.

Preconditions:
- The application is installed and operational on the user's device.
- The system has been collecting data over the week.

Postconditions:
- Users can access and review the weekly data collection through the application..

Main Flow:
1. Users launch the application on their device.
2. The application connects to the data storage or collection system where weekly data is archived.
3. The user selects the option to view the weekly data collection.
4. The application retrieves and displays the weekly data, providing access to all data collected over the past week.
5. Users can interact with the displayed data, such as viewing, analyzing, and exporting it as needed.
6. The application ensures that users have the ability to navigate through the weekly data effectively, offering insights into historical trends and variations.
7. When the user is done using the application, they exit the application.


UC-3-4-2: Weekly Data Collection and Access
User
Application
Data Store
Launch application
Request weekly data
Return weekly data
Select "View weekly data"
Weekly data
Select "Export data"
Pdf of data

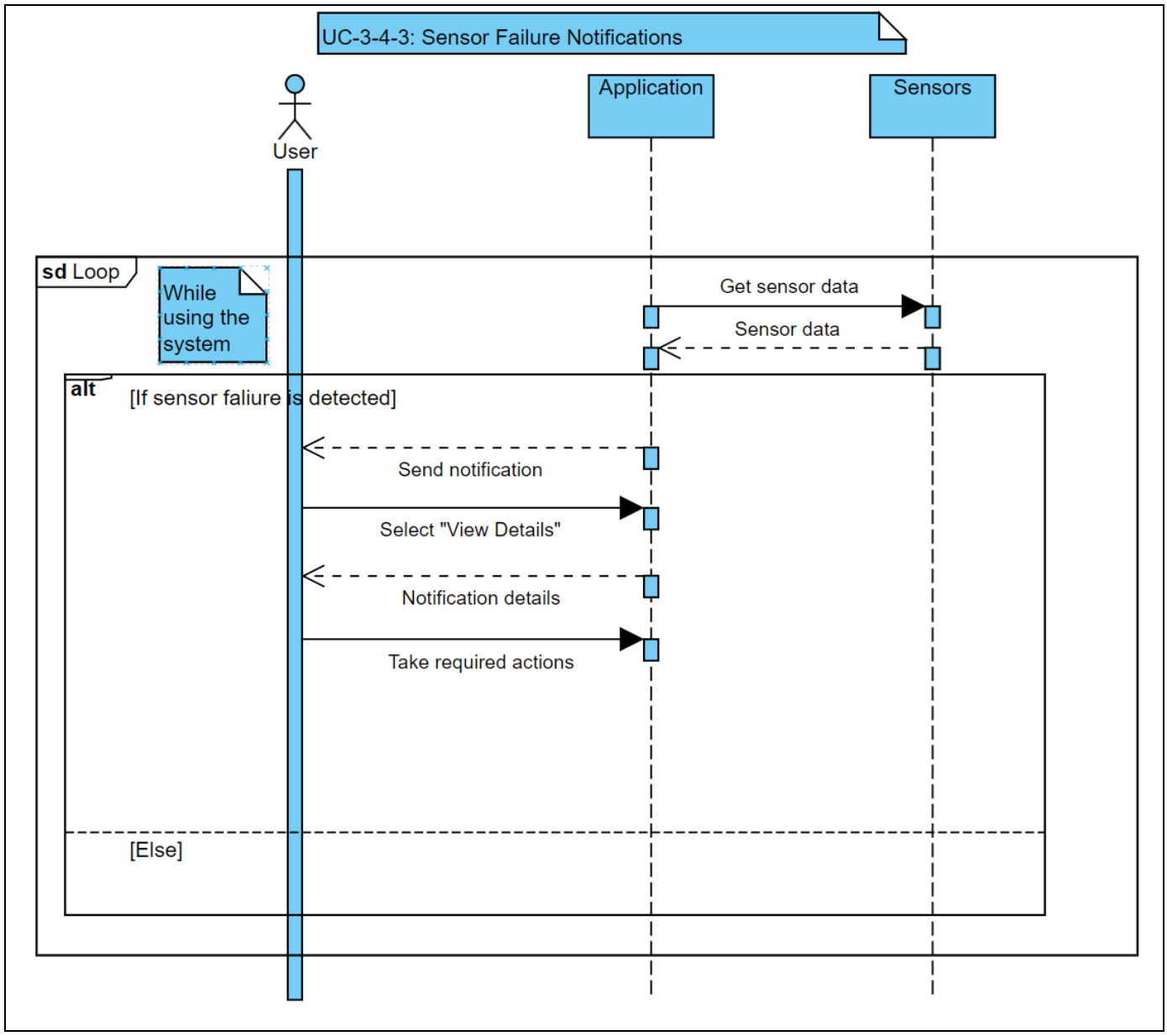
UC-3-4-3: Sensor Failure Notifications

Actors:
User: The individuals utilizing the application to receive notifications about sensor failures.

Preconditions:
- The application is installed and operational on the user's device.
- Sensors, including cameras and multi-parameter water sensors, are actively monitoring data.

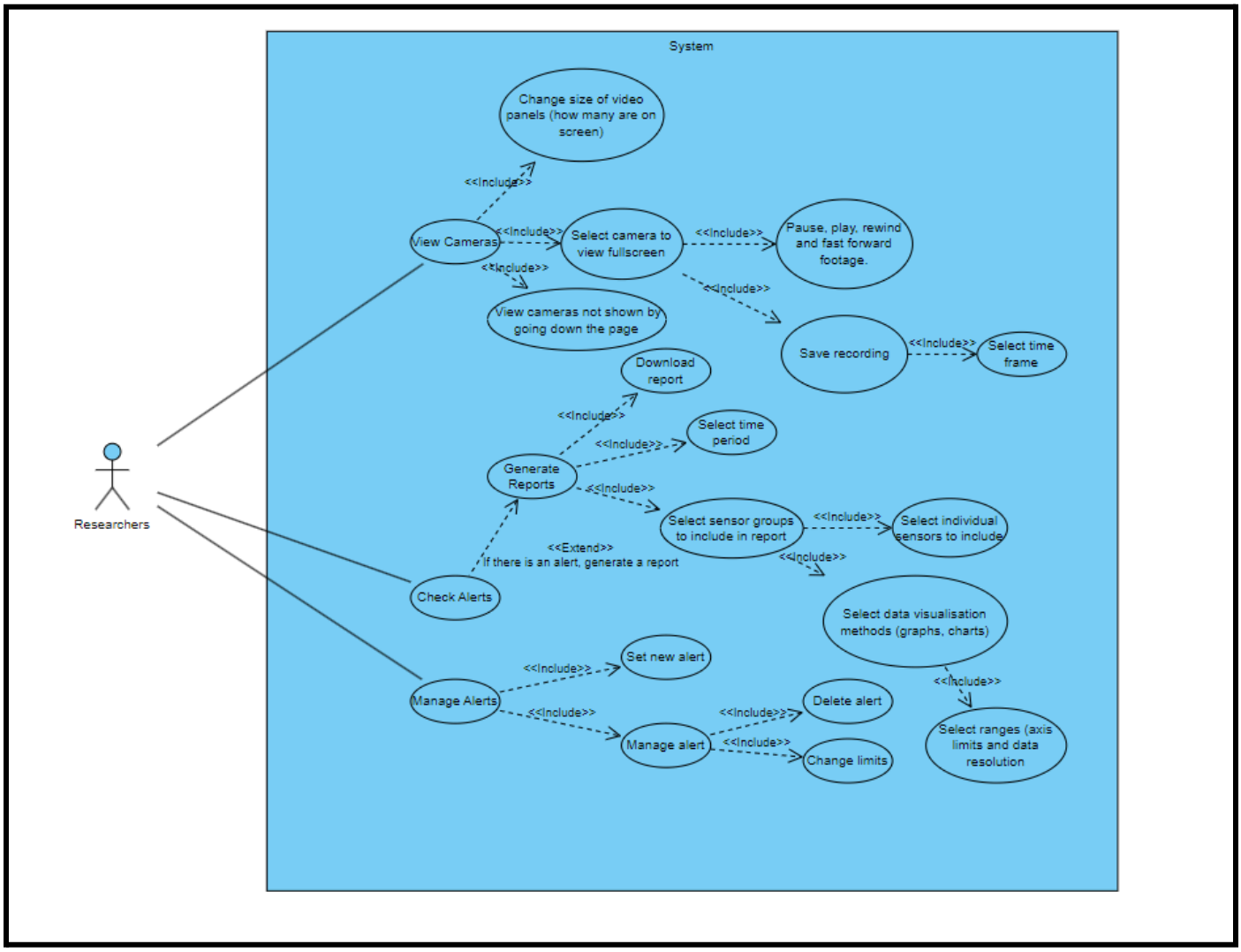
Postconditions:
- Users receive timely notifications regarding sensor failures in the system.

Main Flow
1. Users have the application running on their device.
2. The application continuously monitors the status of sensors, including cameras and multi-parameter water sensors.
3. If a sensor failure is detected, the application promptly triggers a notification mechanism.
4. The user receives an alert or notification, specifying the type of sensor that has experienced a failure (e.g., camera or multi-parameter water sensor).
5. The notification provides additional details, such as the nature of the failure and any relevant information regarding the affected sensor.
6. Users acknowledge and review the notification.
7. Upon receiving the notification, the user may take appropriate actions, which may include initiating further diagnostics, repairs, or reporting the issue to relevant personnel.
8. The application continues to monitor sensor status and promptly notifies the user of any additional sensor failures.
9. If the user is finished or the issue is resolved, they can exit the application.


UC-3-4-3: Sensor Failure Notifications
User
Application
Sensors
sd Loop
While using the system
Get sensor data
Sensor data
alt
[If sensor faliure is detected]
Send notification
Select "View Details"
Notification details
Take required actions
[Else]

4 External Interface Requirements

Use Case Diagram



4.1 User Interfaces

The system will need to collect data from the sensors, provide a way to set alerts and generate reports from this data, and provide a way to interact with the cameras. As such we will need an application with a user interface. The user interface will have three main components; a way to view a live feed of all cameras, a way to set alerts for when a sensor is outside a defined range, and a way to generate reports to view and analyze past data. This will be best done by having three separate sections in the user interface for alerts, surveillance, and reports.

4.1.1 Alerts

The user should be able to select an individual sensor or a group of sensors from a drop down list, and then specify a range for that data. When the data falls outside of the acceptable range, the user will be alerted. When a user is alerted while using the application, a notification will pop up describing the alert. There will also be a tab in the top right of the interface where the user can see the list of all alerts. When an alert is clicked on, the user will be taken to the report generation section of the interface with the sensor in the alert selected as a data point to include in the report.

4.1.2 Surveillance

When initially selected, the screen should display all the camera feeds in the system on one page, each with a label below the feed of the camera's name. If there are too many to fit on one page, the user should be able to scroll down on the page to continue to view more cameras.

The user interface should also support multi monitor setups.The user should then be able to click on a camera feed to make it full screen. When looking at a single camera, the user should be able to pause, navigate and resume the footage, as well as save a recording of a defined time frame to the local computer.

4.1.3 Reports

The final component of the user interface is the report generation section. The system will generate weekly reports to display a breakdown of the overall sensor data. These reports will summarize the environmental impact findings, as well as the extreme and average values of each sensor group in that time range. As such there should be three sections and thus individual pages to each report; overview, sensor data, and notable incidents.

Users should also be able to generate custom reports. There will be two kinds of custom reports; system generated and user generated. For the system generated report, the user can specify a time frame and the system will generate a report similar to the weekly reports for that time frame. For the user generated reports, the user will be able to select what data they want to see. The user should be able to select which sensors they want the data for, which format they want the data in (graphs, tables) and the user should be able to customize the data presentation (zoom on the graph, max/min of each axis, data resolution).

4.2 Software Interfaces

The program’s primary job is to take input from many sensors, store and process that data, and display the result to the user. As such we will need various tools and libraries

to extract the data from the many kinds of sensors we will be using. The specifics of these sensors (which brand to use) is yet to be determined and as such it is unclear which software tools will be needed.

The system will need to store the data it is collecting, so that it is accessible off site. Storing the data off the site of the energy plant is necessary to ensure the data is backed up and to ensure the system does not run out of storage. Therefore, a third party cloud storage provider will be used to store this data. Live sensor data will be stored locally in the program, as well as the data being used to generate the reports. The data that is currently saved in the program to generate reports will be regularly backed up (possibly hourly or more frequent) to limit data loss risk.

4.3 Communications Interfaces

There are two kinds of communication the platform will need, sensor to program communication and program to user communication. Sensor to program communication is how the sensors will send their data to the program. The system will use many kinds of sensors, which should all be connected to the system via a wired connection.

The second form of communication (program to user communication) involves the program sending alerts to relevant people when something is out of order in the system. When a sensor is outside of the alert range people need to be alerted instantly. The program should send an alert with a few relevant details of the incident to the list of users that have access to the system.

The system should also send a pdf version of the weekly reports that are generated to each user that is signed up to receive them, so that everyone can view the reports without actually being at the site where the system is set up. These reports can be sent by email automatically to the list of people who have access to the system.

5 Other Non Functional Requirements

5.1 Performance Requirements

REQ-P-1: The software component of SMOREI must process and display sensor data in real-time with a latency of 10-15 seconds [1]

Rationale: Users need to have access to up to date information for timely decision making.

REQ-P-2: The software should be scalable to 50% growth in number of sensors and data inputs as the deployment expands.

Rationale: The solution must be scalable as users will be monitoring an increasing number of offshore renewable energy stations past the initial release version.

5.2 Safety Requirements

REQ-Sa-1: The hardware sensors must be designed and installed in a way that minimizes any potential harm to the marine ecosystem. Safeguards should be in place to protect marine life from harm due to sensor deployment.

Rationale: The function of SMOREI is to monitor ecosystems in the vicinity of offshore renewable energy stations. Therefore, the solution should not negatively impact the ecosystems in any way.

REQ-SA-2: The project must adhere to all relevant environmental and safety regulations, including those pertaining to the installation and operation of offshore renewable energy installations

Rationale: Regulatory compliance is essential to protect the environment, ensure safety, maintain stakeholder confidence, mitigate risks, and promote the long-term viability of the project.

5.3 Security Requirements

REQ-Se-1: Data Encryption: All data transmitted and stored by the SMOREI software must be encrypted to protect sensitive information and ensure data privacy.

Rationale: Encryption of all data handled by SMOREI is essential to safeguard sensitive information, maintain data privacy and mitigate the risk of unauthorized access or breaches

REQ-Se-2: User Authentication: The software should require user authentication to access the data, ensuring that only authorized individuals can view and analyze the information.

Rationale: Allowing access only to authorized user's is required to enforce data security and protect sensitive information from unauthorized access.

REQ-Se-3: Compliance with Data Protection Regulations: The project must adhere to data protection and privacy regulations to safeguard user data and information collected by the system.

Rationale: Compliance with data protection regulations is crucial to ensure the project's adherence to legal and ethical standards.

5.4 Software Quality Attributes

REQ-So-1: The software must be user-friendly and intuitive to users with varying levels of technical expertise. can easily access and interpret the data.

Rationale: User's of SMOREI will have varying levels of technical expertise. Therefore it is important for the software to be accessible and produce easily interpreted data for all users.

REQ-So-2: The software should be designed in a modular and maintainable way to allow for updates, bug fixes, and future enhancements without significant downtime.

Rationale: Maintainability of the software's design is essential to minimize operational disruptions and reduce the cost of ownership by facilitating updates and bug fixes while ensuring reliability and longevity.

REQ-So-3: The system should have a high level of reliability, with an uptime of at least 99.9%, to ensure continuous access to critical data.

Rationale: Availability of 99.9% is essential to ensure the continuous collection of accurate data and reliable data access.

REQ-So-4: Robustness: The software and hardware components must be able to withstand adverse weather conditions and harsh marine environments without frequent failures or breakdowns.

Rationale: The system's resilience to adverse weather and harsh marine environments is essential to preventing frequent failures and breakdowns that could disrupt operations and incur costly repairs.

5.5 Internationalization Requirements

REQ-In-1: During development, local laws of the area we are implementing the solution and international maritime laws will be considered, such as compliance of environmental standards

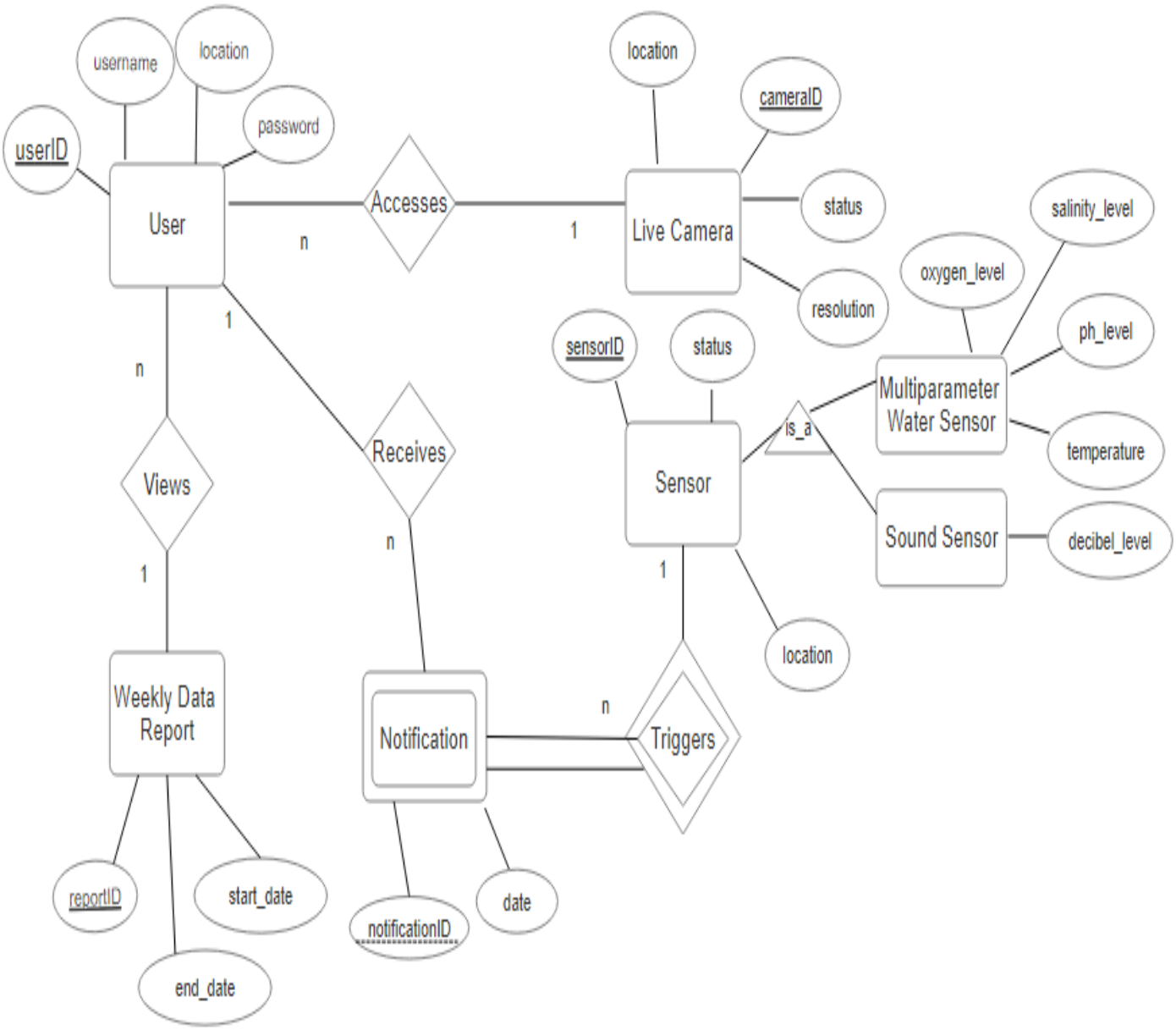
Rationale: It is important the solution does not violate any laws, leading to legal issues and damage of the reputation of the solution and team

REQ-In-2: The application must support multiple languages

Rationale: To be able to scale the project, we must allow users around the world to use the application in the languages they understand

6 Entity Relationship Diagrams

6.1 Entity Relationship Diagram



6.2 Data Dictionary

Object Class	Attributes
User	userID (varchar), username (varchar), location (varchar), password (varchar)
Live Camera	location (varchar), cameraID (INT), status (boolean), resolution (varchar)
Sensor	sensorID (INT), status (boolean), location (varchar), type (varchar)
Weekly Data Report	reportID (INT), start_date (varchar), end_date (varchar)
Notification	notificationID (INT), date (varchar)

Unique Keys

Type	Table	Columns
Primary	User	userID
Primary	Live Camera	cameraID
Primary	Sensor	sensorID
Primary	Weekly Data Report	reportID
Partial	Notification	notificationID

Foreign Keys

Table	Column	Reference Table	Reference Column
Notification	sensorID	Sensor	sensorID
Notification	userID	User	userID

7 Data Flow Diagrams

7.1 DFD Level 0

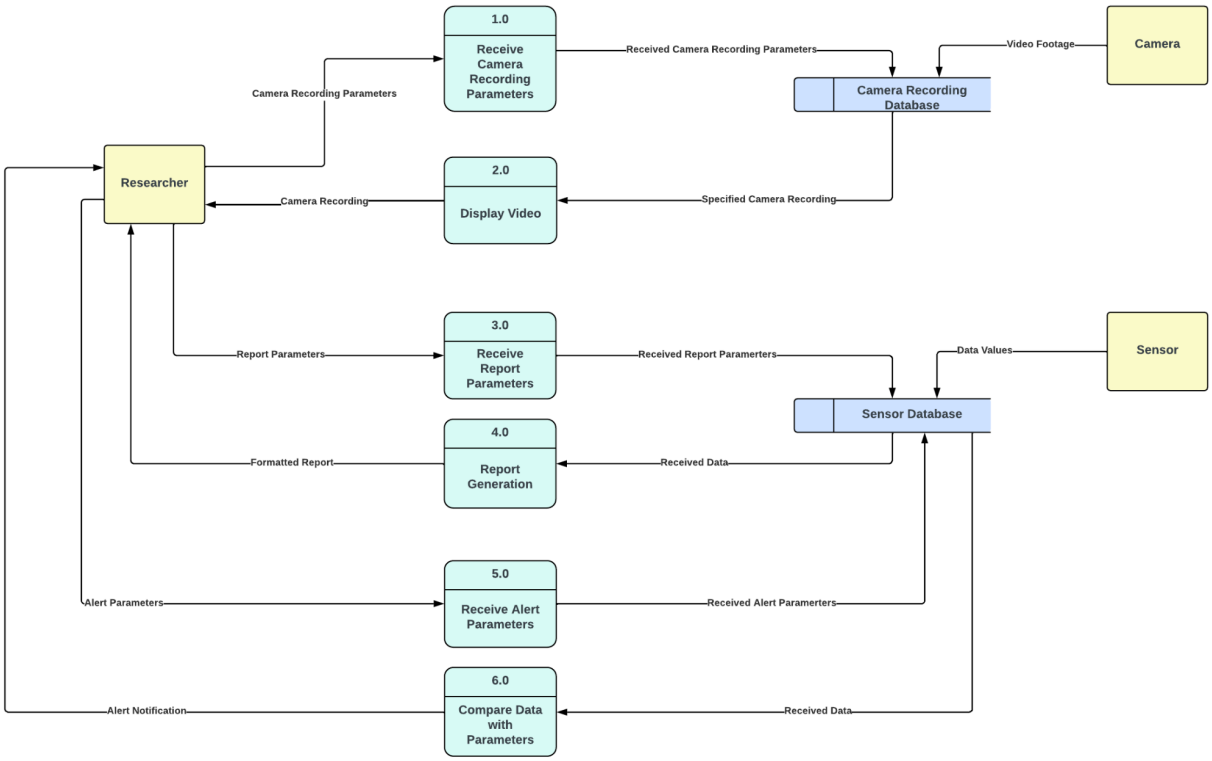
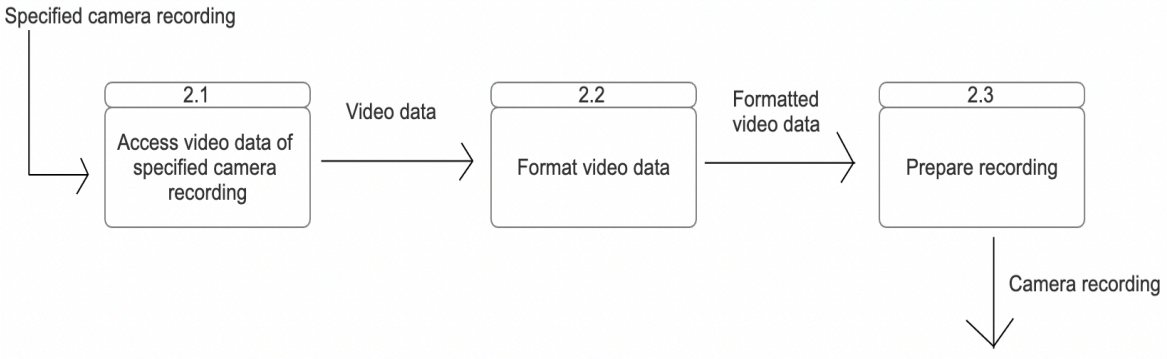


Figure 7.1 DFD-0:

In this system level DFD, data is shown flowing from the external entities researcher, camera and sensor into various processes and databases in order to allow researchers to remotely monitor offshore energy installations

7.2 DFD Level 1

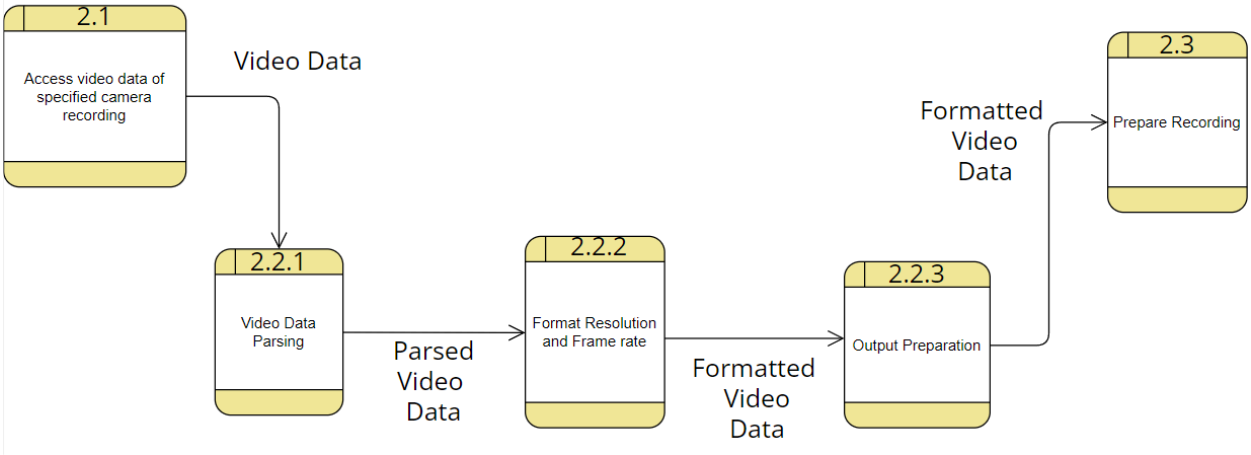
Level 1 diagram of process 2.0, Display Video.



2.1 - The video data of the specified camera recording is accessed from the database
2.2 - The video data is then formatted into a compatible format for viewing
2.3 - The recording of the formatted video is then prepared and sent to the researcher for viewing

7.3 DFD Level 2

Level 2 diagram of process 2.2, format video data.

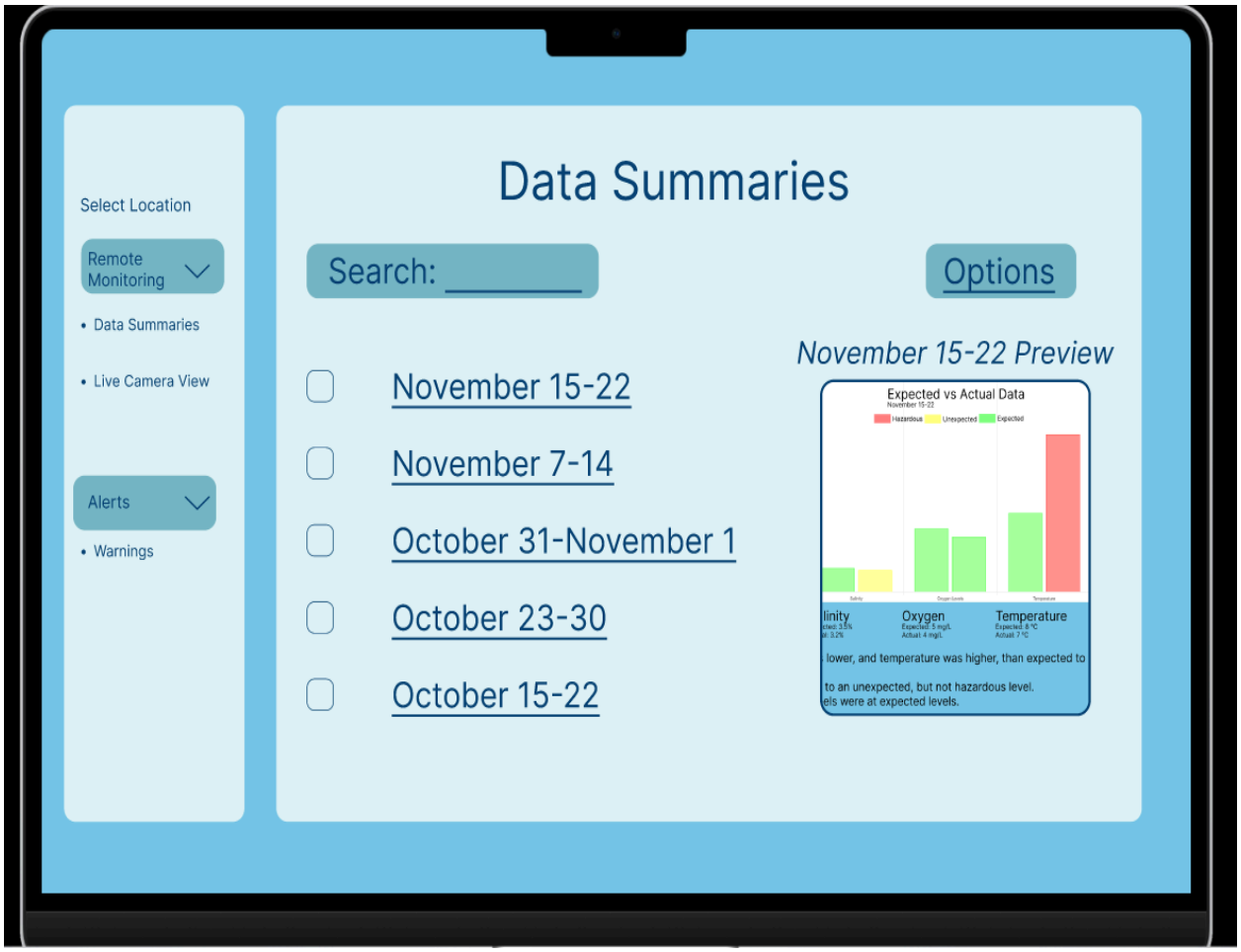


2.2.1 - Video Data Parsing: analyzing video data from 2.1, and identifying key elements and metadata, such as resolution, frame rate, and duration.
2.2.2 - Format Resolution and Frame Rate: In this step, the parsed video data undergoes transformation, where the resolution and frame rate are adjusted to meet specified standards. Codecs may be applied for compatibility, ensuring the video is suitable for viewing.
2.2.3 - Output Preparation: The formatted video data from the previous step is finalized and prepared for viewing. This involves creating a viewing-ready file, performing quality control checks, and integrating metadata. The output is then made ready for secure transmission to the researcher.

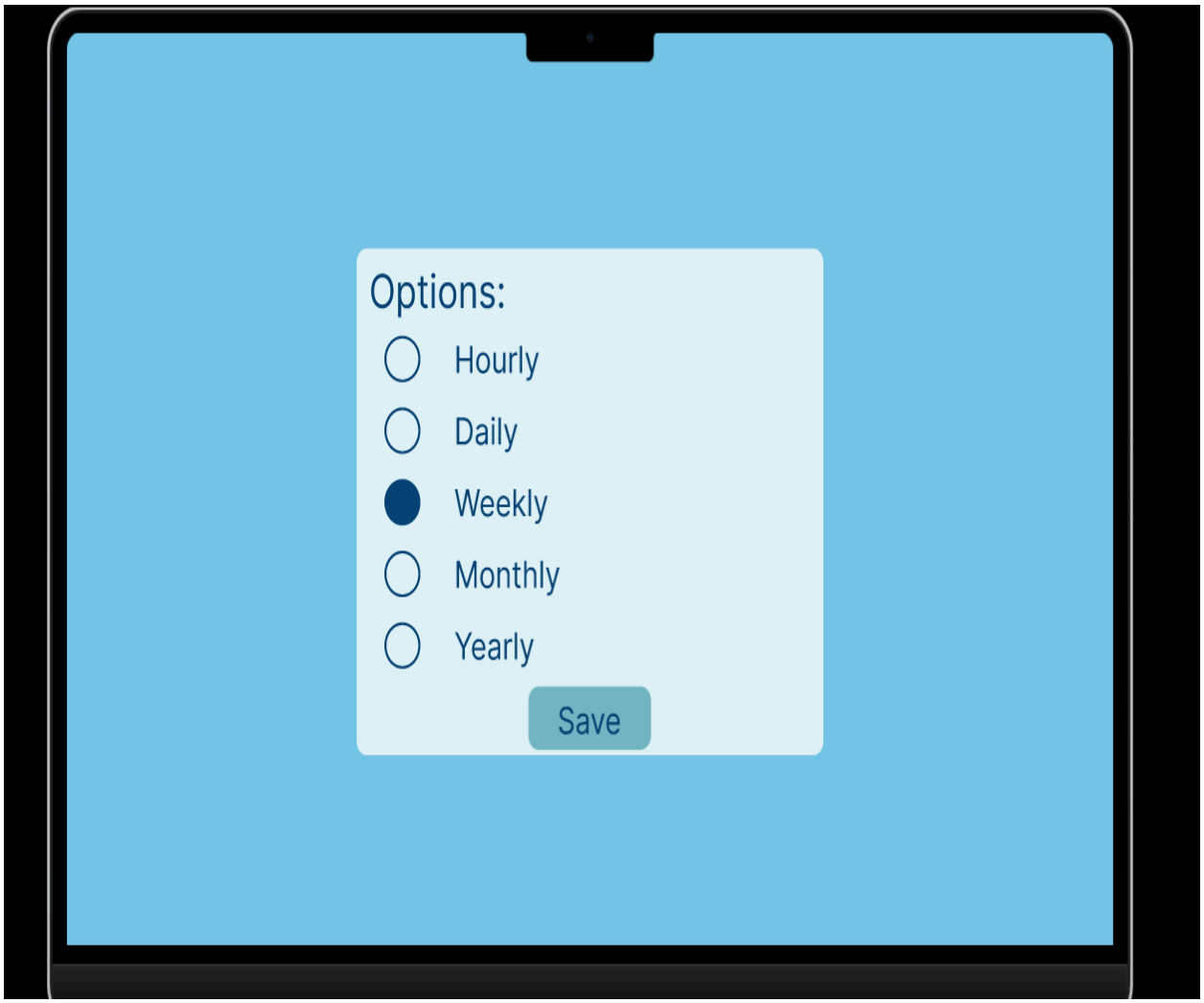
8 Prototype User Interfaces

8.1 Welcome page

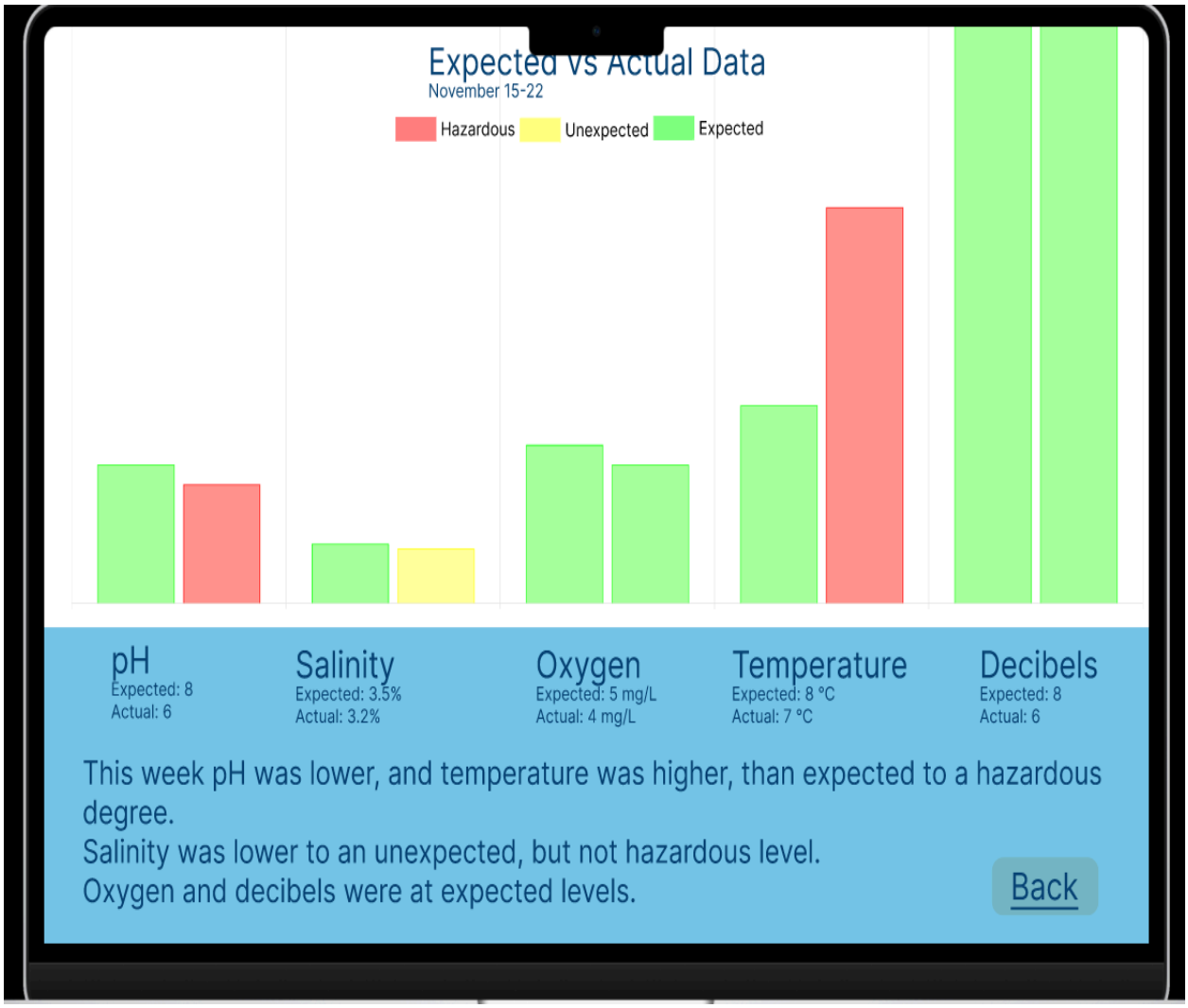
8.2 Data Summaries



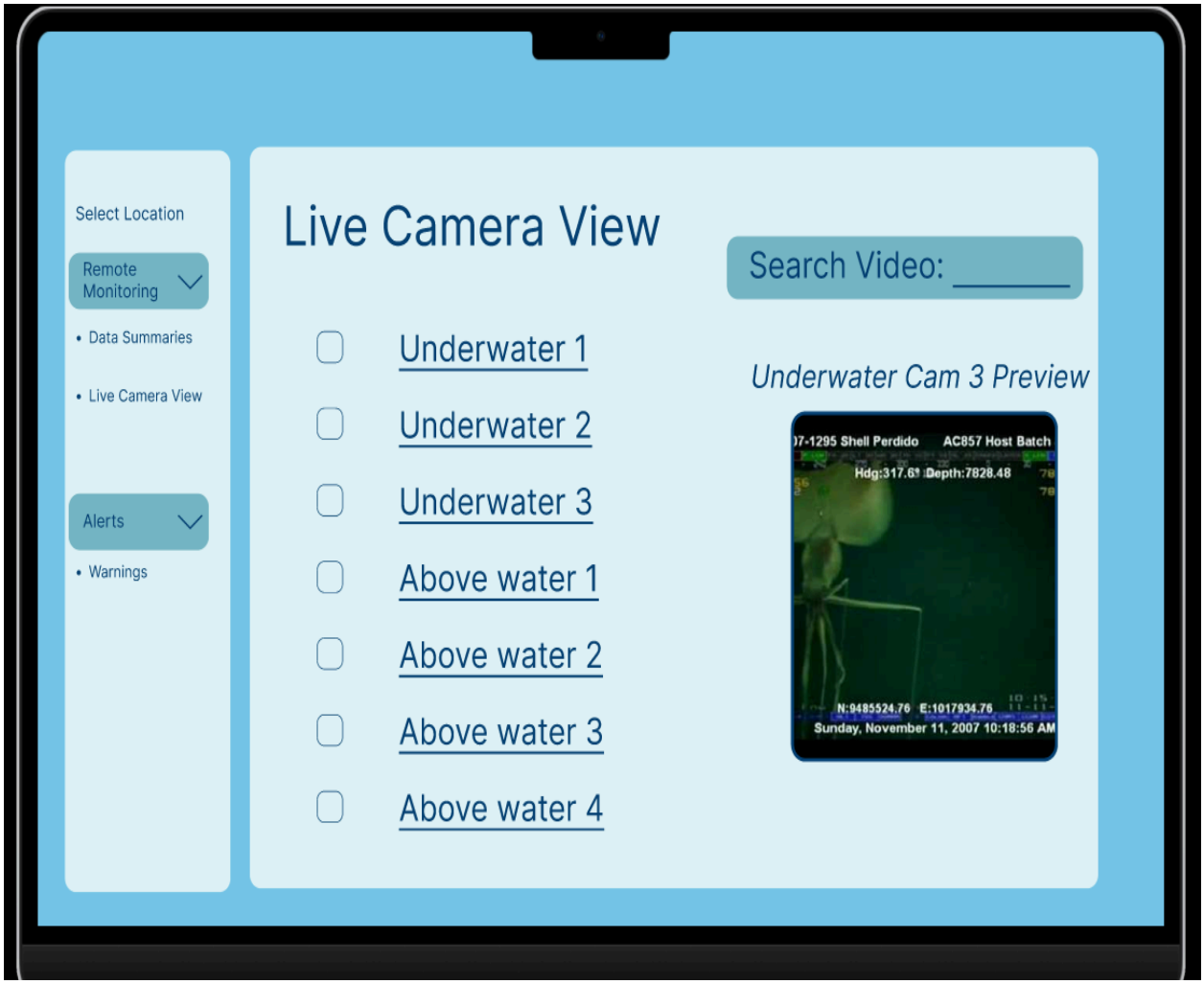
8.3 Options regarding data range of data summaries



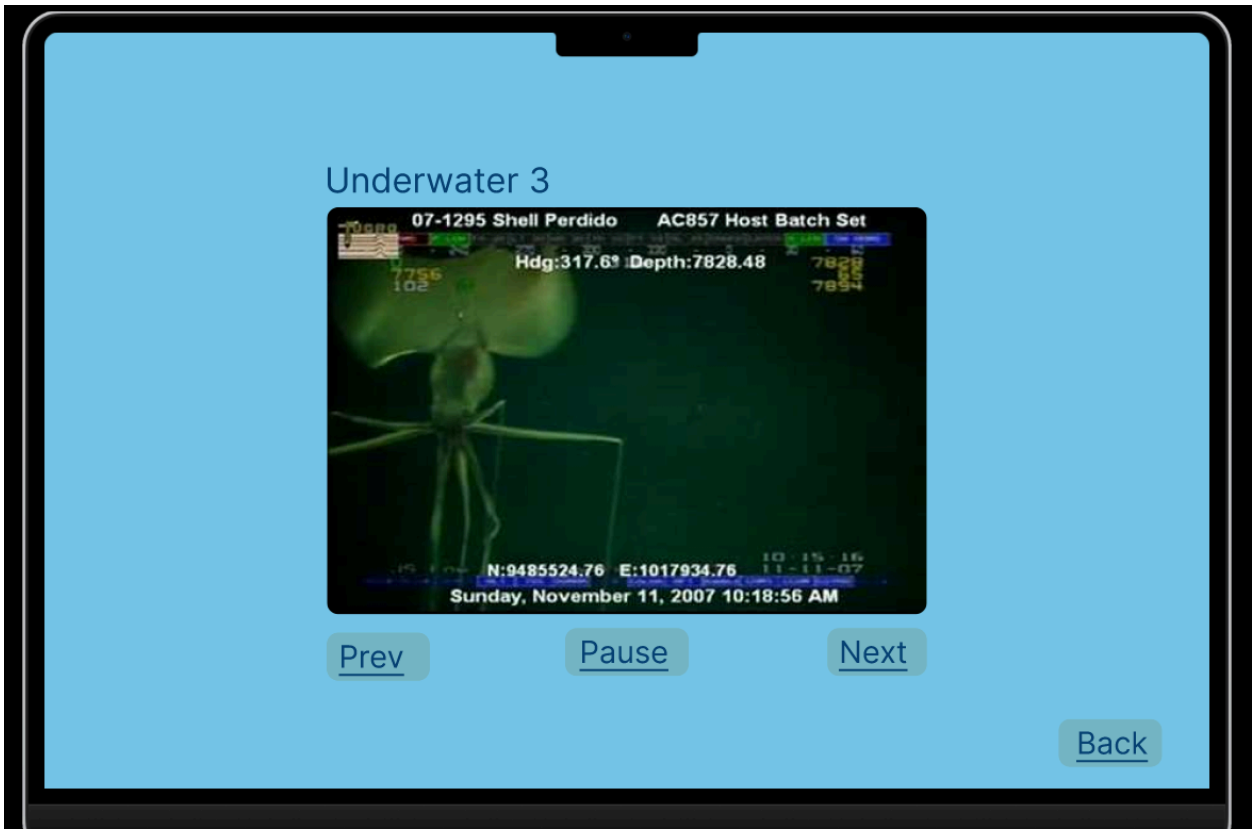
8.4 Analysis of data collected



8.5 Live camera view

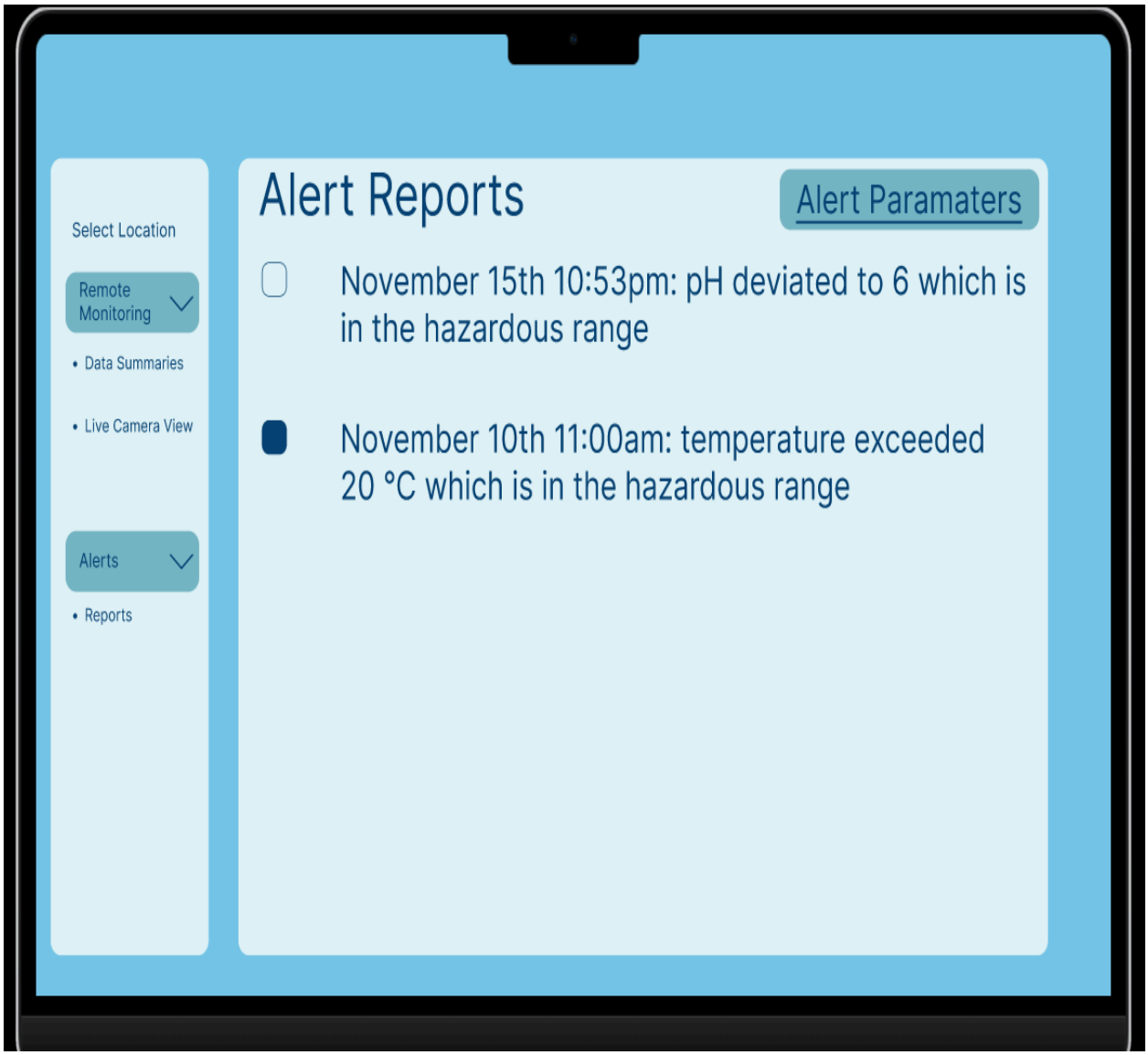


8.6 Full camera view of specific camera

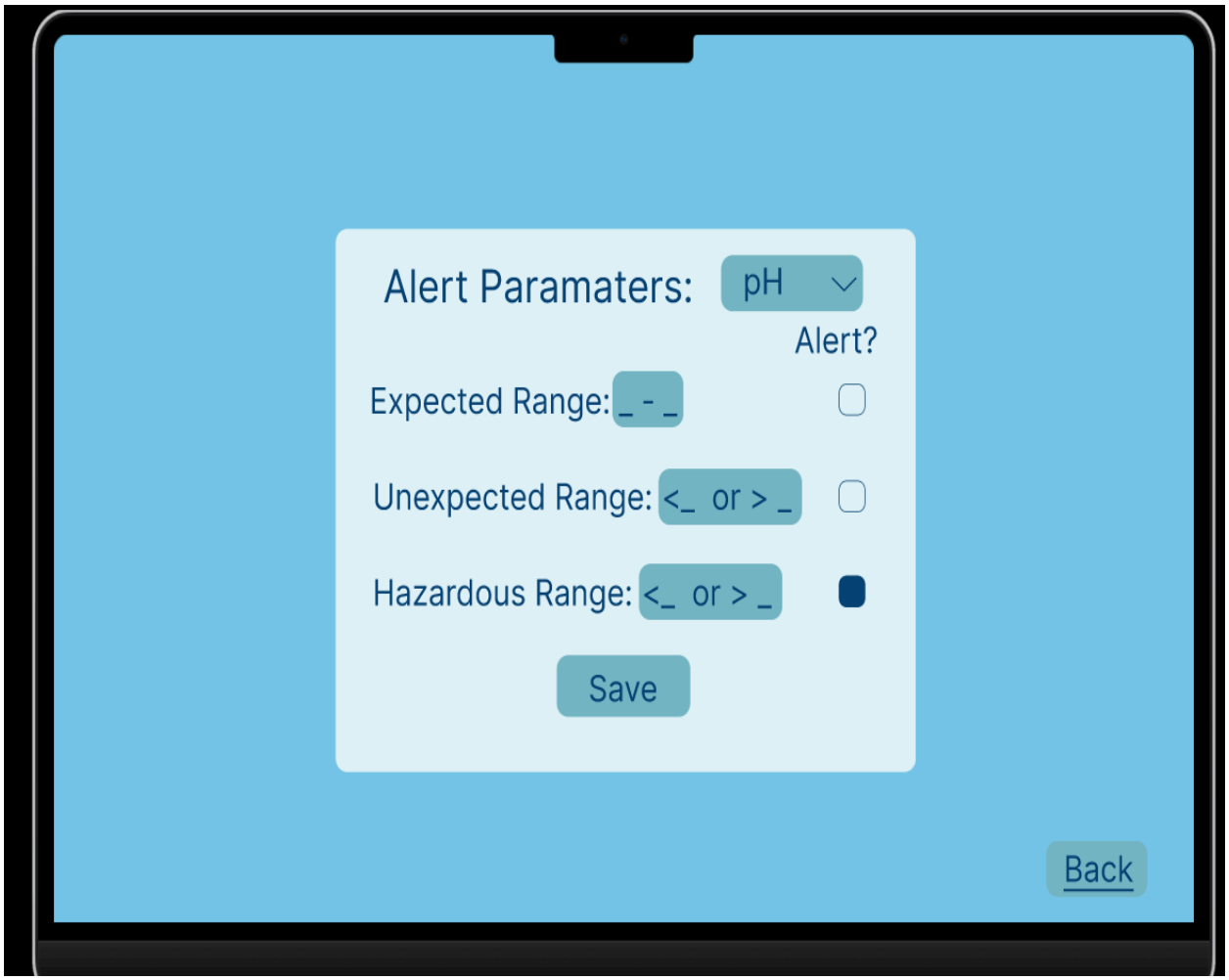


8.7 Alert Notification

8.8 History of reports



8.9 Adjust range for sensor alert



9 Mockups

9.1 Dashboard

Figure 8.1.1 Dashboard Mockup:
Dashboard shown after logging in. From here the user will select which offshore renewable energy plant to monitor.

9.2 Data Summaries

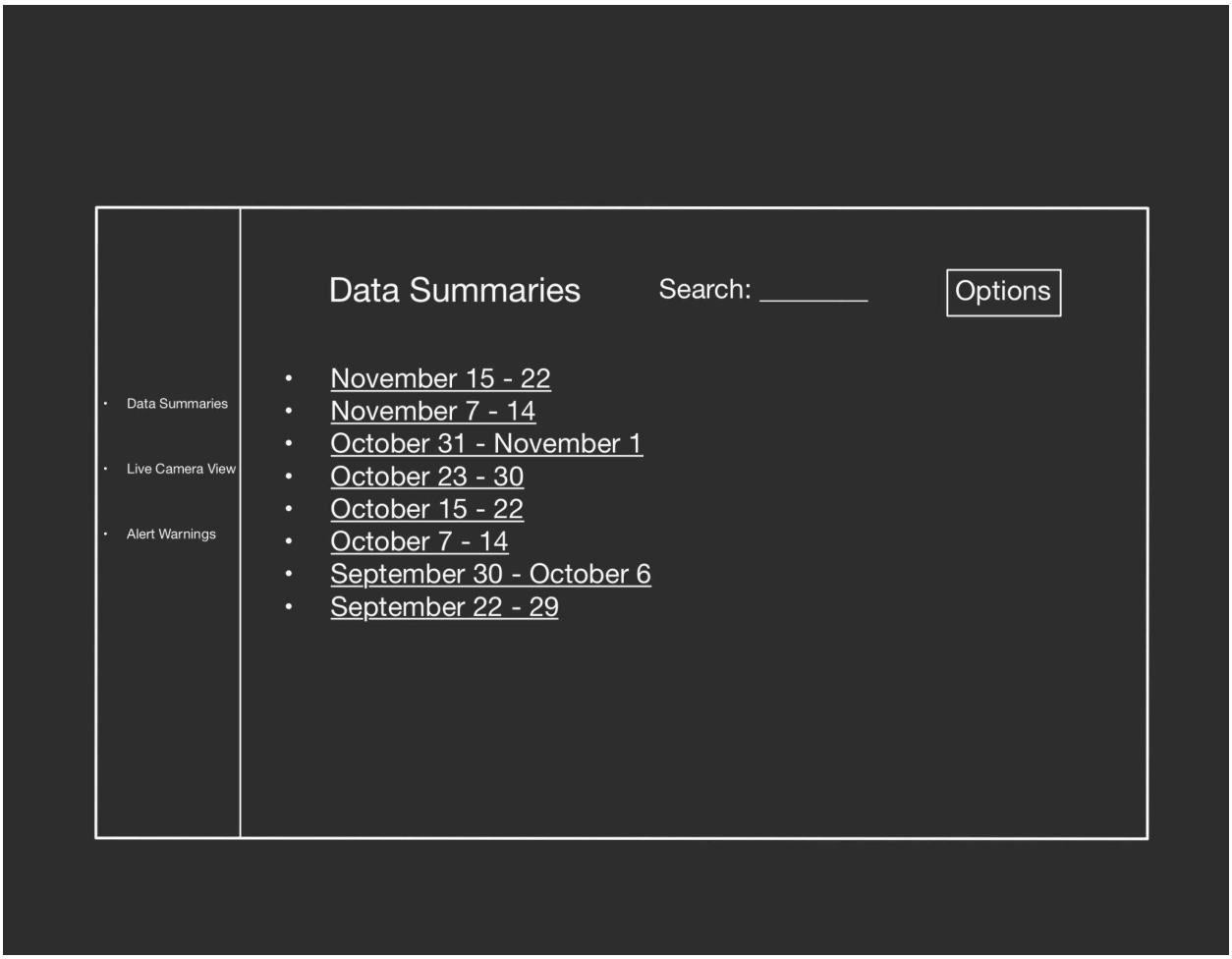


Figure 8.1.2 Data Summaries Mockup:
Data Summaries page shown after selecting a offshore renewable energy plant to monitor. The user can customize the summary time intervals via options, search for a specific summary and select a data summary to view

9.3 Live Camera View

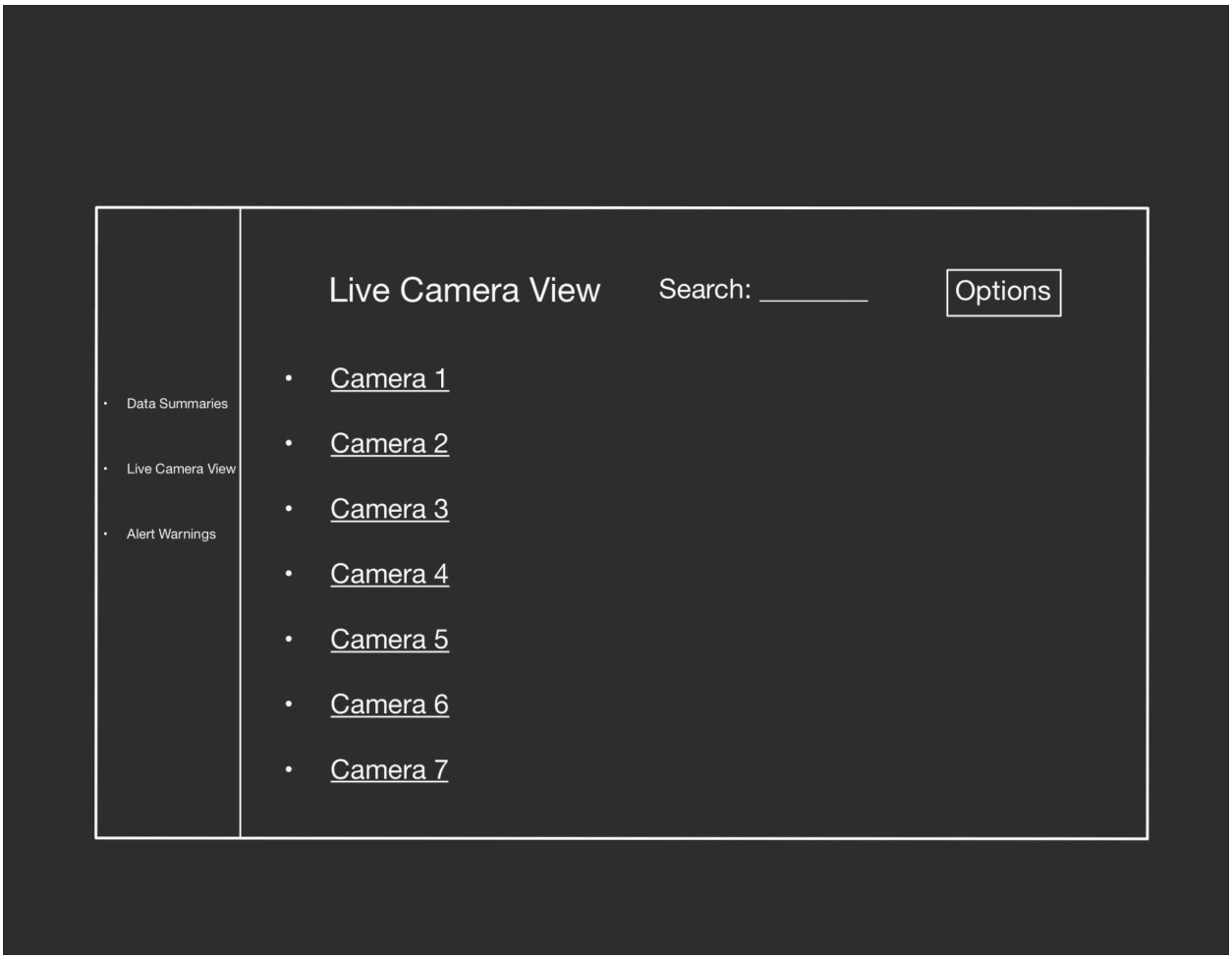


Figure 8.1.3 Live Camera View Mockup: List of live cameras monitoring a specific offshore renewable energy plant. The user can select a camera to view its live stream and stored recordings

9.4 Alerts

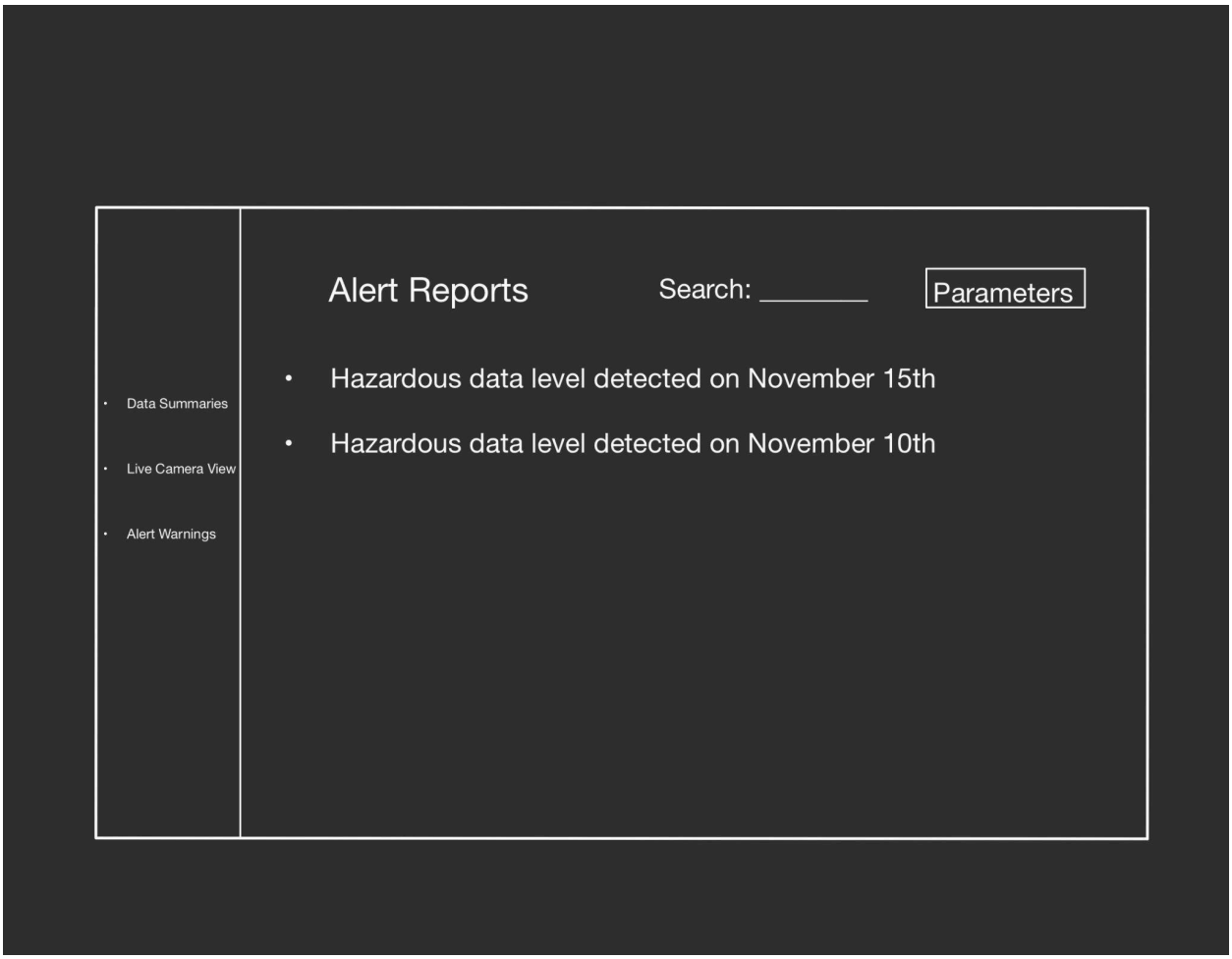


Figure 8.1.4 Alert Warnings Mockup: List of alerts generated from a given offshore renewable energy plant's collected sensor data.

10 Storyboards

10.1 UC-1-1: Users can remotely access data summary reports

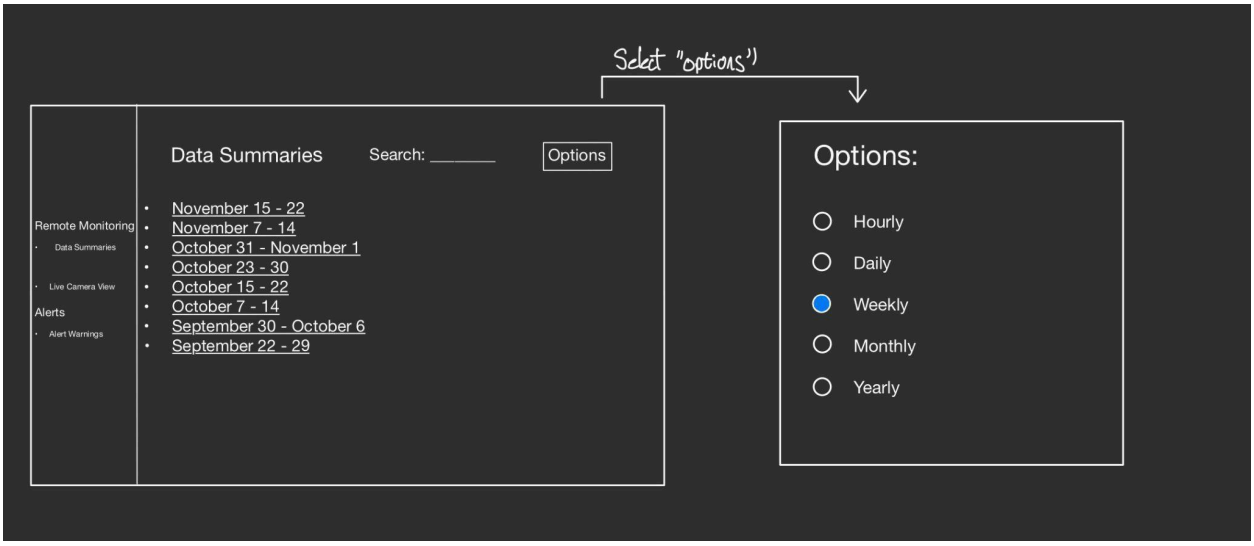


Figure 8.2.1 UC-1-1 Storyboard:
The user selects “Remote monitoring” then “Data Summaries” to access the data summaries page. From the data summaries page, the user can select options to alter the time interval for which the data summaries are broken into.

10.2 UC-1-2: Live Video Streaming

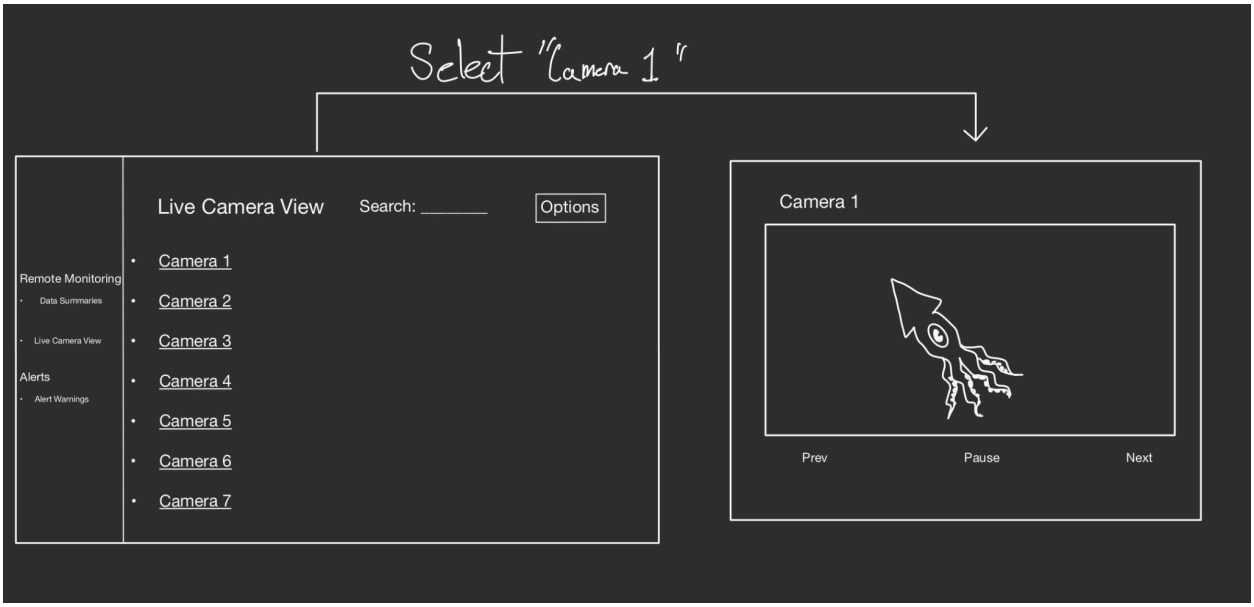


Figure 8.2.2 UC-1-2 Storyboard:
The user selects “Remote Monitoring” then “Live Camera View” to access the live camera view page. From the live camera page the user can select which camera to view. Once a camera is selected, the user has access to a live view of the camera.

10.3 UC-2-2: Data Storage and Reporting

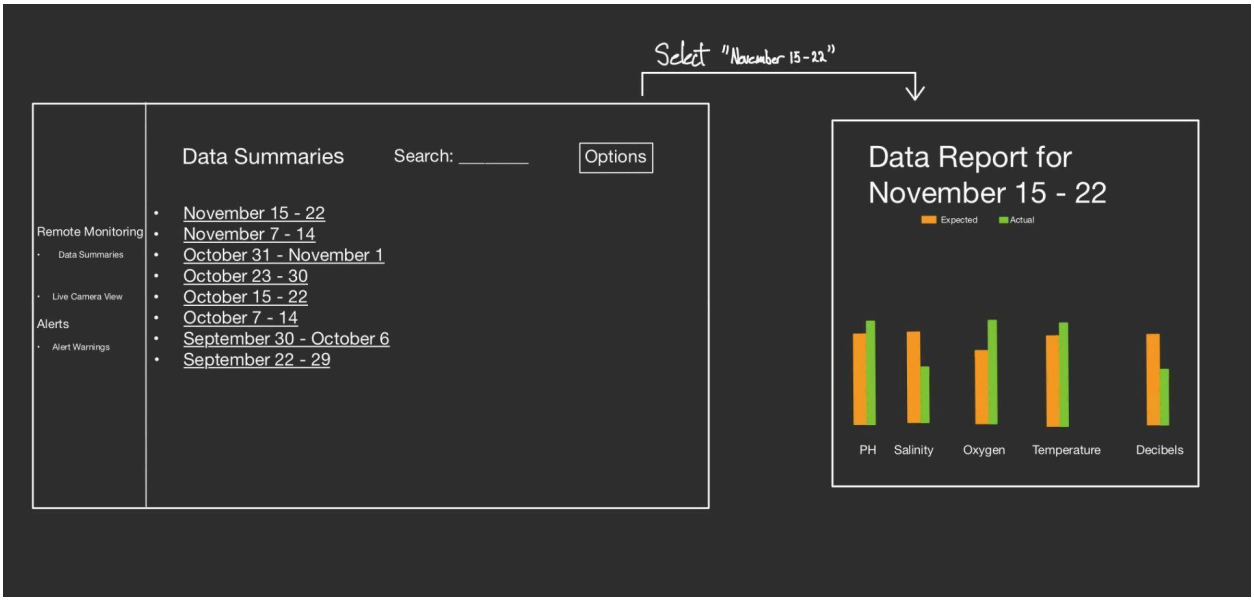
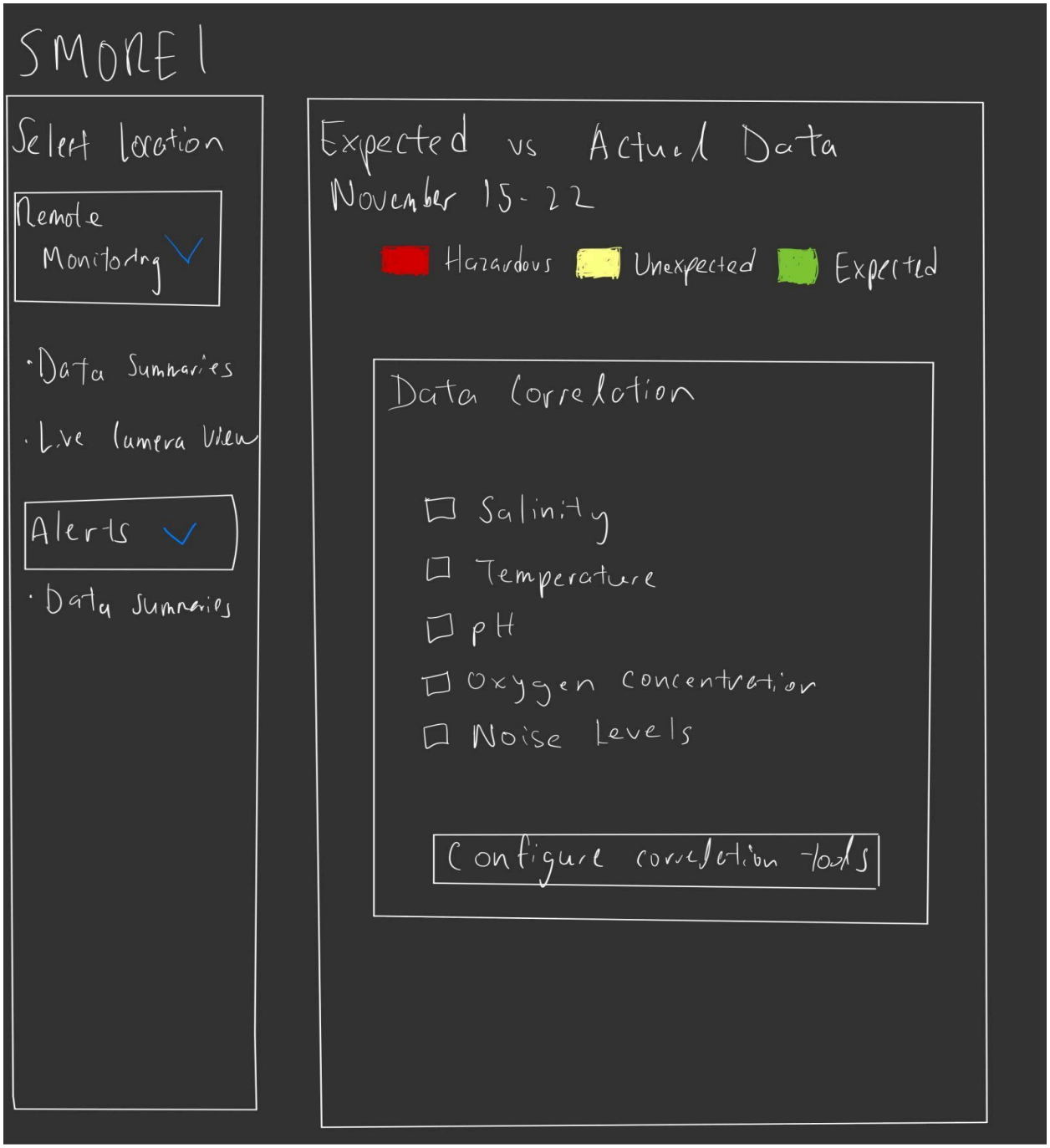


Figure 8.2.3 UC-2-2:

From the Data Summaries screen, the user can select which data summary to view. Once a data summary is selected the user has access to a view of the expected data values versus the actual data values of the collected data within a given time interval.

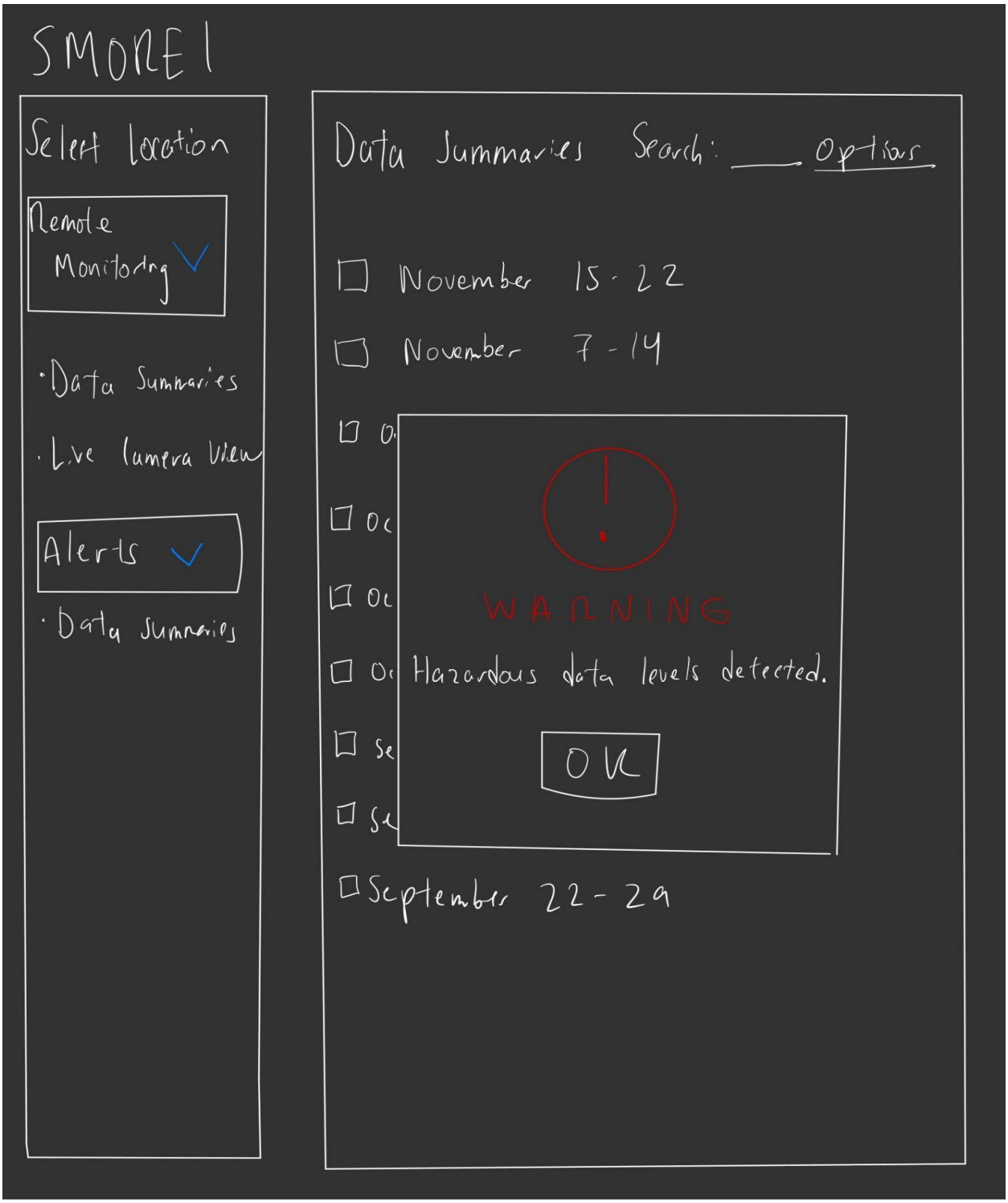
10.4 UC-3-3-1: Data Correlation Tools

As the user is viewing a specific data report, an option to apply data correlation tools will be displayed. This will also allow users to further analyze the specifics of any report. Once the option is clicked on, a pop-up will display where the user can select which parameters to include in the data correlation. Once the user checks which parameters to include, the user can click on “Configure correlation tools”.



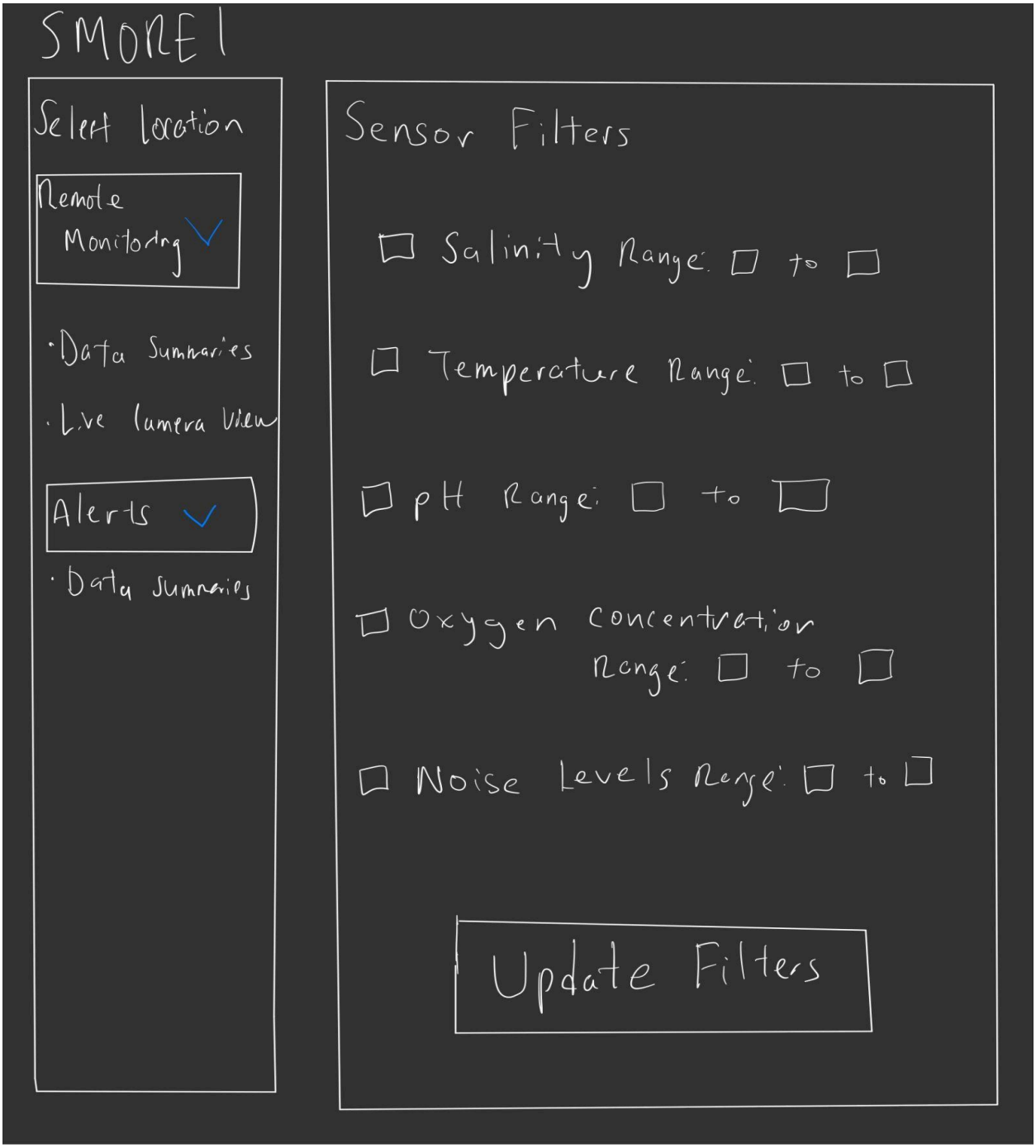
10.5 UC-3-3-2: Hazardous Data Levels Alert

As soon as a hazardous data level is detected by the sensors, an alert will be generated. In this case, it doesn't matter which part of the application the user is viewing. A warning pop-up will display with the message "Hazardous data levels detected", where the user will click on "Ok" to remove the message from the screen.



10.6 UC-3-3-3: Sensor Range Filters

When viewing the data summaries, the user will have the option to set filters for the sensors. The user can select specific parameters to filter for and specify the range. The user can fill the range with a specific number and once “Update filters” is clicked on, the sensor range filters will be set.

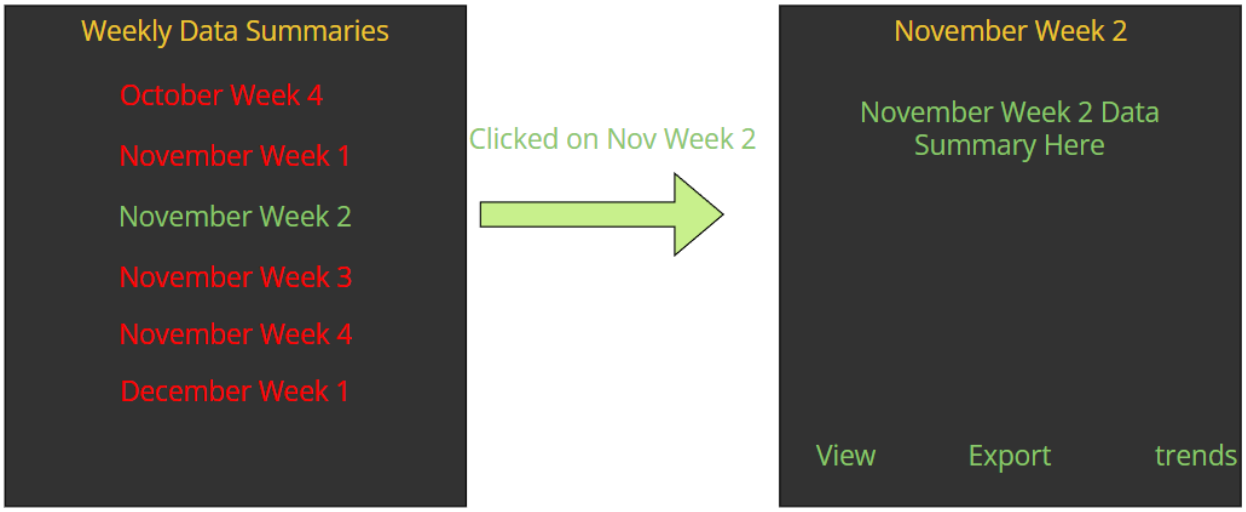


10.7 UC-3-4-1: Cross-Platform Access and Data Viewing

User selects desired mode, either to access live streamed camera feeds or view weekly data summaries.

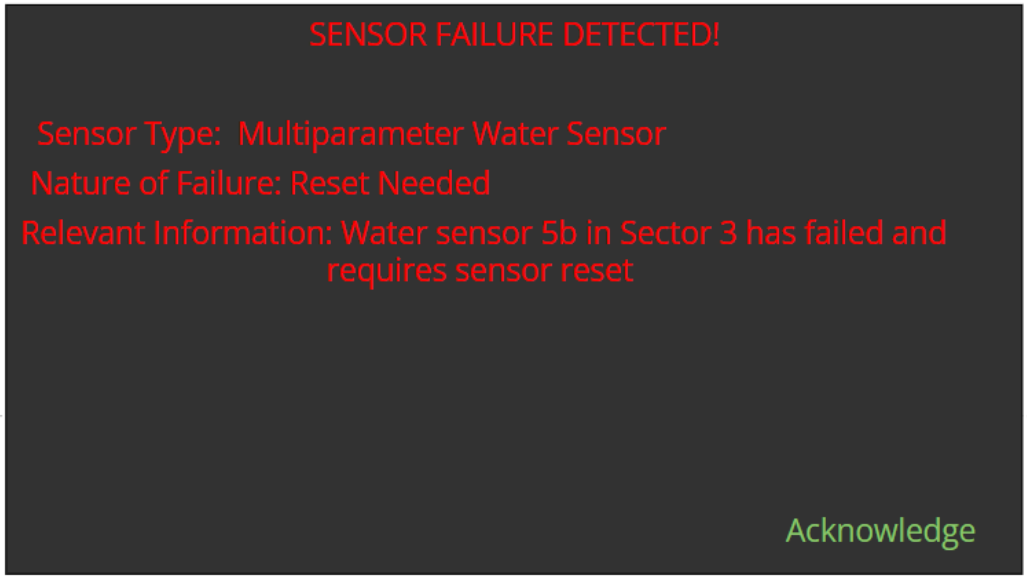
10.8 UC-3-4-2: Weekly Data Collection and Access

Users should be able to access any weekly data summary by clicking on a week in the Weekly Data Summaries Tab.



10.9 UC-3-4-3: Sensor Failure Notifications

The application continues to monitor sensor status and promptly notifies the user of any additional sensor failures. If a sensor fails it sends a notification to the users and they must acknowledge the alert to which they can then repair or reboot or do whatever is necessary to fix the sensor failure.



11 Test Scenarios

11.1 Remote Access to Weekly Data Summary Reports (REQ-1-1)

Test Case ID: TC-1-1
Title: Verify Remote Access to Weekly Data Summary Reports
Description: Ensure that users can successfully access and view weekly data summary reports remotely in the "Remote Monitoring" section of the SMOREI system.

Preconditions:
1. Users are logged into the SMOREI system.
2. Weekly data has been collected and processed.

Test Steps:
1. Users log into the SMOREI system using valid credentials.
2. Users navigate to the "Remote Monitoring" section.
3. Users select the "Weekly Data Summary" option.
4. Verify that the system retrieves and displays the weekly data summary reports.
5. Users view the reports to ensure the data corresponds to the weekly activities of offshore renewable energy stations.

Expected Results: Users should be able to successfully log in, navigate to the "Remote Monitoring" section, select the "Weekly Data Summary" option, and view the reports without encountering any errors.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.2 Live Video Streaming Functionality (REQ-1-2)

Test Case ID: TC-1-2
Title: Verify Live Video Streaming Functionality
Description: Ensure that users can successfully access live video camera streaming with a 10-15 second delay in the "Remote Monitoring" section of the SMOREI system.

Preconditions:
1. Users are logged into the SMOREI system.
2. Live video streaming is available.

Test Steps:
1. Users log into the SMOREI system using valid credentials.
2. Users navigate to the "Remote Monitoring" section.
3. Users select the "Live Camera View" option.
4. Verify that the system establishes a connection to the live video camera without errors.

5. Confirm that users can view the live video stream with a 10-15 second delay.

Expected Results:
1. Users successfully log into the SMOREI system.
2. Users can navigate to the "Remote Monitoring" section without encountering any issues.
3. Users can select the "Live Camera View" option without errors.
4. The system successfully establishes a connection to the live video camera.
5. Users can view the live video stream with a 10-15 second delay.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.3 Sensor Data Collection (REQ-2-1)

Test Case ID: TC-2-1
Title: Verify Sensor Data Collection
Description: Ensure that the system successfully collects data from multiparameter water sensors and sound sensors, making the collected data available for further processing and storage.

Preconditions:
1. The system is operational.
2. Multiparameter water sensors and sound sensors are functioning.
3. Data collection is ongoing.

Test Steps:
1. Verify that the system is operational and able to communicate with multiparameter water sensors and sound sensors.
2. Ensure that the system continuously collects data from the multiparameter water sensors, detecting pH, salinity, oxygen levels, and temperature.
3. Confirm that the system continuously collects data from sound sensors, measuring decibel levels in the surrounding areas.
4. Validate that the collected data is made available for subsequent actions, such as storage and analysis.

Expected Results:
1. The system is operational and can communicate with sensors without errors.
2. The system successfully collects data from multiparameter water sensors, including pH, salinity, oxygen levels, and temperature.
3. The system successfully collects data from sound sensors, measuring decibel levels.
4. The collected data is available for further processing and storage without any issues.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.4 Data Storage and Reporting Functionality (REQ-2-2)

Test Case ID: TC-2-2
Title: Verify Data Storage and Reporting Functionality
Description: Ensure that sensor data is successfully stored in a third-party cloud storage (e.g., AWS), and users can generate and access weekly reports based on the collected data.

Preconditions:
1. Data collection from sensors has been completed.
2. Data is available for storage and retrieval.
3. Third-party cloud storage (e.g., AWS) is accessible.

Test Steps:
1. Transfer data collected from sensors to the third-party cloud storage provider (e.g., AWS).
2. Confirm that the data transfer is successful and the sensor data is securely stored in the third-party cloud storage.
3. Users log into the system using valid credentials.
4. Users request the generation of weekly reports.
5. Verify that the application successfully retrieves sensor data from the third-party cloud storage.
6. Ensure the system processes the collected data and generates accurate weekly reports.
7. Users access and review the generated weekly reports to observe and analyze the local ecosystem's impact on energy generation.
8. User logs out of the system.

Expected Results:
1. The data transfer from sensors to the third-party cloud storage is successful without errors.
2. Sensor data is securely stored in the third-party cloud storage.
3. The system successfully retrieves sensor data from the cloud storage.
4. The system processes the collected data and generates accurate weekly reports.
5. Users can access and review the generated reports without encountering any errors.
6. User successfully logs out of the system.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.5 Data Correlation Functionality (REQ-3-1)

Test Case ID: TC-3-1
Title: Verify Data Correlation Functionality
Description: Ensure that the personnel responsible for monitoring offshore renewable energy stations can successfully use data correlation tools to identify relationships between different parameters in the weekly reports.

Preconditions:
1. The system is operational and connected to the data sources of the offshore renewable energy stations.
2. Weekly reports containing various parameters of the offshore renewable energy stations are available in the system.

Test Steps:
1. The user logs into the system with valid credentials.
2. The user selects a weekly report from the available options.
3. The user chooses parameters to analyze within the selected report.
4. The user configures data correlation tools, specifying the parameters to be correlated.
5. Verify that the system generates correlation results without errors.
6. The user reviews the generated correlation results.
7. The user saves the correlation results for future reference.
8. Optionally, the user selects another report and repeats steps 3-7.
9. The user logs out of the system.

Expected Results:
1. The user successfully logs into the system.
2. The user can select a weekly report without encountering any issues.
3. The user can choose parameters to analyze within the selected report.
4. Data correlation tools are configured successfully without errors.
5. The system generates correlation results based on the specified parameters.
6. The user can review the correlation results without any issues.
7. The user successfully saves the correlation results.
8. Optionally, the user can select another report and repeat the correlation process.
9. The user successfully logs out of the system.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.6 Hazardous Data Levels Alert Functionality (REQ-3-2)

Test Case ID: TC-3-2
Title: Verify Hazardous Data Levels Alert Functionality
Description: Ensure that users are properly informed of hazardous data levels, and the system triggers warnings appropriately.

Preconditions:
1. The application is operational and receiving data.
2. Data from various sources is available for analysis by the system.

Test Steps:
1. The user launches the application.
2. Verify that the system continuously monitors data levels without errors.
3. Introduce hazardous data levels to simulate a triggering condition.
4. Confirm that the system triggers a warning when hazardous data levels are detected.
5. The user receives and acknowledges the warning.
6. The user takes appropriate actions or configures notification preferences if necessary.
7. Verify that the system continues to monitor and issue warnings as needed.
8. The user exits the application when done.

Expected Results:
1. The user successfully launches the application.
2. The system continuously monitors data levels without encountering any issues.
3. The system properly triggers a warning when hazardous data levels are introduced.
4. The user receives and acknowledges the warning without any errors.
5. The user can take appropriate actions or configure notification preferences successfully.
6. The system continues to monitor and issue warnings as needed.
7. The user successfully exits the application.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.7 Sensor Range Filters Functionality (REQ-3-3)

Test Case ID: TC-3-3
Title: Verify Sensor Range Filters Functionality
Description: Ensure that users can customize sensor range filters, and the system properly alerts them about anomalies when data falls outside the defined ranges.

Preconditions:
1. The system is operational and connected to sensor systems.
2. Sensor data is available for analysis and filtering.

Test Steps:
1. The user launches the system and logs in with valid credentials.
2. The user customizes sensor range filters for specific data parameters.
3. Verify that the system continuously checks data against the user-defined filters without errors.
4. Introduce data outside the defined range to simulate an anomaly condition.
5. Confirm that the system triggers an anomaly alert when data falls outside the defined range.
6. The user receives and acts upon the anomaly alert.
7. Verify that the user can adjust or add filters as needed.
8. Confirm that the system maintains ongoing monitoring and alerting.
9. The user logs out when done.

Expected Results:
1. The user successfully launches the system and logs in.
2. The user can customize sensor range filters without encountering any issues.
3. The system continuously checks data against the user-defined filters.
4. The system properly triggers an anomaly alert when data falls outside the defined range.
5. The user receives and acts upon the anomaly alert without errors.
6. The user can adjust or add filters as needed successfully.
7. The system maintains ongoing monitoring and alerting.
8. The user successfully logs out of the system.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.8 Cross-Platform Access and Viewing of Camera Feeds (REQ-3-4-1)

Test Case ID: TC-3-4-1

Title: Verify Cross-Platform Access and Viewing of Live Camera Feeds

Description: Ensure that the application allows users to live camera feeds on any operating system.

Preconditions:
1. The application is installed and running on the user's device.
2. Data sources for both weekly data and live camera streams are available and accessible.

Test Steps:
1. The user launches the system and successfully logs in with valid credentials.

2. The user selects the “Live Camera View” page from the menu on the left-hand side and is shown a list of all camera feeds.
3. Starting with “Camera 1” and ending with the last camera, the user selects each camera one at a time to observe the live feed. For each camera, the application displays the live feed.
4. The user selects “Camera 1”, and then selects the most recent stored recording from the list.
5. The application connects to the data storage system, then retrieves and displays the selected video recording.
6. The user logs out of the system.

Expected Results:
1. The video recordings are securely stored in third-party cloud storage.
2. Live camera feeds maintain connection and are displayed when selected.
3. The video recording is retrieved from storage and displayed when selected.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.9 Weekly Data Collection (REQ-3-4-2)

Test Case ID: TC-3-4-2

Title: Verify Weekly Data Collection and Access

Description: Ensure that users can use the application to view and download weekly data reports.

Preconditions:
1. The application is installed and operational on the user's device.
2. The system has been collecting data over the week.

Test Steps:
1. The user launches the system and successfully logs in with valid credentials.
2. The user will be taken to the data summaries page, at which point they select the most recent data summary.
3. The application connects to the data storage system, then retrieves and displays the selected data summary.
4. The user selects the second most recent data summary, and the system retrieves and displays the data summary.
5. The user selects “Export data”. The system converts the data summary to a pdf and a file saving window pops up.

6. The user uses the popup to select a location to save the pdf file. The user names the file, clicks save, and then the file is downloaded.
7. The user logs out of the system.

Expected Results:
1. The weekly data reports are securely stored in third-party cloud storage.
2. Data reports are retrieved from storage and displayed when selected.
3. The data report the user selected to export is converted to a pdf and saved at the specified location with the given name.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.10 Sensor Failure Notifications (REQ-3-4-3)

Test Case ID: TC-3-4-3
Title: Verify Sensor Failure Notification Functionality

Description: Ensure that the system displays a notification when a sensor is not functioning, and that the notification disappears when the sensor functionality resumes.

Preconditions:
1. The application is installed and operational on the user's device.
2. Sensors, including cameras and multi-parameter water sensors, are actively monitoring data.
3. There must be two people to perform this test, one using the application and one to manipulate the sensors.
4. The people performing the test have some method of communicating with each other.

Test Steps:
1. Person 1 launches the system and successfully logs in with valid credentials.
2. Person 2 person goes to the SMOREI main sensor interface to manipulate inputs.
3. While person 1 is monitoring the application, person 2 should unplug a single sensor or camera from the interface.
4. Person 1 verifies that a notification is displayed which indicates the sensor or camera that is not working.
5. Person 2 reinstalls the sensor or camera to the main interface, and person 1 verifies that the notification disappears.
6. Repeat steps 3, 4, 5 for all sensors and cameras.
7. The user logs out of the system.

Expected Results:
1. The system displays a notification when each camera or sensor is unplugged.
2. Each notification disappears when the corresponding sensor or camera is reinstalled.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.11 System Latency (REQ-P-1)

Test Case ID: TC-P-1

Title: Verify System Latency

Description: Ensure that the latency of the system is within a maximum range of 10-15 seconds for sensors and cameras.

Preconditions:
1. The application is installed and operational on the user's device.
2. Sensors, including cameras and multi-parameter water sensors, are actively monitoring data.
3. The user performing the testing must have a clock, and a mobile computer capable of installing the application and connecting to the internet.
4. Depending on the location of the most easily accessed camera, the clock and computer used for testing may need to be capable of functioning underwater.

Test Steps:
1. The user goes to the camera, which is most easily accessed, with a clock that displays seconds.
2. The user launches the system and successfully logs in with valid credentials.
3. The user navigates to the “Live camera view” page and selects the camera that has been selected for this test.
4. The user holds the clock up to the camera, and looks at the camera feed using the application, noting the difference in time.
5. The user navigates to the hydrophone which is most easily accessed.
6. The user looks at the clock while either tapping on the microphone or making some noise, noting the exact time this was performed.
7. The user selects the “Data Summaries” page and selects the corresponding data summary to when the sensor was manipulated.
8. The user inspects the report, noting the time where there is the expected spike in the data for the hydrophone being tested.
9. The user notes the difference between the time recorded when manipulating the hydrophone and the time the input appeared in the data report.

10. The user logs out of the system.

Expected Results:
1. The time difference between the time on the clock and the time shown on the live camera feed should be less than 15 seconds.
2. The time difference between the time noted when manipulating the hydrophone and the time showed on the data report should be less than 15 seconds.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.12 System Scalability (REQ-P-2)

Test Case ID: TC-P-2

Title: Verify System Scalability
Description: Ensure that the application can be scaled a minimum of 50% in number of sensors and data inputs without additional modifications.

Preconditions:
1. Application functionality has been verified and is functioning correctly.
2. There must be additional free input space in the sensor and camera hardware interface. This could be achieved by building an interface with more inputs or using several hardware interfaces.
3. 50% more cameras and sensors than the current installed amount must be owned and in possession.

Test Steps:
1. Power down the local SMOREI hardware system.
2. Count and note the number of cameras and sensors for each sensor group.
3. Multiply these counts by 1.5 and note the difference between this value and the original value for each sensor group and the number of cameras to get the number of additional cameras and sensors to be installed.
4. Plug in the number of cameras and sensors that were previously calculated to the hardware interface.
5. Restore power to the system.
6. Log in to the system and successfully log in with valid credentials.
7. Navigate to the “Live Camera View” page and verify functionality of each newly installed camera by selecting the camera from the list and viewing the live feed that is displayed.
8. Navigate to the “Data Summaries” page and select “Generate Custom Report”.
9. Generate a custom report from the time the system was rebooted until the current time.
10. View the report and verify that all the newly installed sensors are recording data.

11. Log out of the system.

Expected Results:
1. The system handles the 50% increase in camera inputs without problems, extending the list of live feeds automatically.
2. The system handles the 50% increase in sensor inputs without problems, extending the list of sensors automatically. The data from the new sensors is recorded and stored automatically, and the additional data is added to the generated reports.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.13 Marine Ecosystem Safety for Hardware Sensors (REQ-Sa-1)

Test Case ID: TC-Sa-1
Title: Marine Ecosystem Safety Test for Hardware Sensors

Description: This test case ensures that hardware sensors are designed and installed to minimize potential harm to the marine ecosystem, with safeguards in place to protect marine life during sensor deployment.

Preconditions:
1. The hardware sensors are prepared for deployment in a marine environment.
2. The deployment area has been assessed for potential impact on the marine ecosystem.

Test Steps:
1. Examine hardware sensors for any sharp edges, protrusions, or materials that could harm marine life.
2. Verify that the sensor casing is securely sealed to prevent leaks.
3. Confirm that the installation team follows guidelines to avoid sensitive areas such as coral reefs or seagrass beds.
4. Ensure installation depth is within safe limits to prevent disturbances to the seabed.
5. Simulate sensor deployment in a controlled environment (e.g., test tank).
6. Observe and evaluate any potential impact on nearby organisms, ensuring it is within acceptable limits.
7. Validate the functionality of emergency shutdown mechanisms to immediately halt sensor operations.
8. Confirm that the shutdown process does not introduce additional risks to marine life.

Expected Results:
1. Hardware sensors have no sharp edges, protrusions, or hazardous materials.
2. The sensor casing is securely sealed.
3. The installation team adheres to guidelines, avoiding sensitive areas during deployment.
4. Installation depth is within safe limits.
5. Simulated sensor deployment shows minimal to no impact on marine life within acceptable limits.
6. Emergency shutdown mechanisms function as intended, stopping sensor operations promptly.
7. The shutdown process does not introduce additional risks to marine life.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.14 Environmental and Safety Guideline Compliance (REQ-Sa-2)

Test Case ID: TC-Sa-2
Title: Environmental and Safety Compliance Test for Offshore Renewable Energy Project

Description: This test case ensures that the project strictly adheres to all relevant environmental and safety regulations, specifically those related to the installation and operation of offshore renewable energy installations.

Preconditions:
1. The offshore renewable energy project is in the planning or execution phase.
2. Relevant environmental and safety regulations are identified and documented.

Test Steps:
1. Verify that the project documentation includes a comprehensive list of relevant environmental and safety regulations.
2. Confirm that the project team is aware of and understands the identified regulations.
3. Examine the installation procedures for offshore renewable energy installations.
4. Ensure that installation processes align with safety and environmental regulations.
5. Confirm that safety measures specified in the regulations are implemented during the installation phase.
6. Validate that safety equipment is provided and accessible as per regulatory requirements.
7. Review the project's environmental impact assessment to ensure compliance with regulations.
8. Confirm that measures are in place to minimize and mitigate potential environmental impacts.

9. Assess the safety protocols during the operational phase of offshore renewable energy installations.
10. Verify that ongoing operations adhere to safety regulations and standards.

Expected Results:
1. Project documentation includes a comprehensive list of relevant regulations.
2. The project team is aware of and understands identified regulations.
3. Installation procedures align with safety and environmental regulations.
4. Safety measures specified in regulations are implemented during installation.
5. Adequate safety equipment is provided and accessible.
6. Project's environmental impact assessment demonstrates compliance with regulations.
7. Measures are in place to minimize and mitigate potential environmental impacts.
8. Safety protocols during operations adhere to regulations and standards.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.15 Data Encryption (REQ-Se-1)

Test Case ID: REQ-Se-1
Title: Data Encryption Test for SMOREI Software

Description: This test case ensures that data transmitted and stored by the SMOREI software is encrypted, aligning with the requirement to protect sensitive information and ensure data privacy.

Preconditions:
1. The SMOREI software is installed and configured for data transmission and storage.
2. Sensitive information is available for testing within the software.

Test Steps:
1. Transmit test data through the SMOREI software.
2. Verify that the transmitted data is encrypted during the process.
3. Store test data using the SMOREI software.
4. Confirm that the stored data is encrypted in the storage location.

Expected Results:
1. The transmitted data is encrypted during the process.
2. The stored data is encrypted in the storage location.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.16 User Authentication (REQ-Se-2)

Test Case ID: REQ-Se-2
Title: User Authentication Test for Software

Description: This test case ensures that the software requires user authentication to access data, thereby ensuring that only authorized individuals can view and analyze information.

Preconditions:
1. The software is installed and configured for user authentication.
2. User accounts with varying levels of access permissions are set up for testing.

Test Steps:
1. Attempt to access the software without providing valid login credentials.
2. Verify that access is denied and an appropriate authentication error message is displayed.
3. Provide valid login credentials for an authorized user.
4. Confirm that access to the data is granted.

Expected Results:
1. Access is denied when invalid login credentials are provided.
2. An appropriate authentication error message is displayed.
3. Access to the data is granted when valid login credentials are provided.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.17 Compliance with Data Protection Regulations (REQ-Se-3)

Test Case ID: REQ-Se-3
Title: Data Protection Regulations Compliance Test for Project

Description: This test case ensures that the project adheres to data protection and privacy regulations, safeguarding user data and information collected by the system.

Preconditions:

1. The project is implemented and operational.
2. Data protection and privacy regulations applicable to the project are identified and documented.

Test Steps:
1. Examine project documentation to confirm the identification of relevant data protection and privacy regulations.
2. Verify that the project team is aware of and understands the identified regulations.
3. Evaluate how user data and information are collected, processed, and stored by the system.
4. Confirm that the project adheres to regulations regarding data protection and privacy.
5. Check for mechanisms in place to obtain user consent for data collection and processing.
6. Confirm that user consent is appropriately obtained as per regulatory requirements.

Expected Results:
1. Project documentation includes a comprehensive list of relevant data protection and privacy regulations.
2. The project team is aware of and understands identified regulations.
3. User data and information are collected, processed, and stored in compliance with data protection and privacy regulations.
4. Mechanisms are in place to obtain user consent for data collection and processing.
5. User consent is appropriately obtained as per regulatory requirements.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.18 User-friendly System (REQ-So-1)

Test Case ID: TC-So-1
Title: Verify user friendliness
Description: User's of SMOREI will have varying levels of technical expertise. Therefore it is important for the software to be accessible and produce easily interpreted data for all users.

Preconditions:
1. SMOREI Application is fully developed and operational.
2. A group of test participants is selected.

Test Steps:
1. Introduce software to each participant without in-depth instructions.
2. Assign a set of tasks to each participant.
3. Observe participants and take notes of any difficulties.

4. Record time taken to complete each task.
5. Ask participants for feedback.
6. Analyze data recorded and find areas where the system didn't meet user-friendliness.

Expected Results:
1. Participants understand instructions and tasks needed to be completed.
2. Participants do not face any difficulties while using the software.
3. Participants give positive feedback.
4. Data recorded implies user friendliness.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.19 System Maintainability & Modularity (REQ-So-2)

Test Case ID: TC-So-2
Title: Verify modularity and maintainability of system
Description: Maintainability of the software's design is essential to minimize operational disruptions and reduce the cost of ownership by facilitating updates and bug fixes while ensuring reliability and longevity.

Preconditions:
1. Access to software's source code and documentation.
2. Set of test updates.

Test Steps:
1. Assess level of modularity by reviewing the documentation and format of source code.
2. If bugs are found, prepare updates.
3. If no bugs are found, then prepare the set of test updates.
4. Apply each update one by one.
5. Measure downtime of each update and time taken for the system to be fully operational.
6. Analyze recorded data to check if system's performance is degraded after updates.

Expected Results:
1. Software components are separated.
2. Documentation clearly describes how each module interacts with each other.
3. Updates to individual modules do not affect the entire system.
4. System is functional and fully operational after each update.
5. Data recorded implies performance is not degraded.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.20 System Reliability and Uptime (REQ-So-3)

Test Case ID: TC-So-3
Title: Verify reliability of software
Description: Availability of 99.9% is essential to ensure the continuous collection of accurate data and reliable data access.

Preconditions:
1. SMOREI System is fully developed and operational.
2. Test period to evaluate 99.9% uptime.
3. Set of potential disruption test cases.

Test Steps:
1. Implement a system that continuously monitors the system's uptime.
2. Any instance of downtime is recorded with the cause and duration.
3. Simulate the set of potential disruption test cases.
4. Record and analyze performance.

Expected Results:
1. No instances of downtime.
2. System remains available after applying test cases of potential disruptions
3. Data recorded implies successful reliability and uptime.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.21 System Robustness (REQ-So-4)

Test Case ID: TC-So-4
Title: Verify robustness of system
Description: The system’s resilience to adverse weather and harsh marine environments is essential to preventing frequent failures and breakdowns that could disrupt operations and incur costly repairs.

Preconditions:
1. Access to hardware and software components.
2. Controlled environment to simulate harsh conditions (i.e., extreme temperature).

Test Steps:
1. Expose hardware components to extreme temperature conditions, saltwater, and high humidity.
2. Monitor hardware for any signs of damages
3. Document any instances of hardware or software failure.

Expected Results:
1. Hardware showcases no signs of damages.
2. Software and hardware components remain fully functional.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.22 Legal and Regulatory Compliance (REQ-In-1)

Test Case ID: TC-In-1
Title: Verify system complies to local laws and international maritime laws
Description: During development, local laws of the area we are implementing the solution and international maritime laws will be considered, such as compliance of environmental standards

Preconditions:
1. List of relevant local laws and international maritime regulations
2. Access to design, documentation, and future plans of solution
3. Legal expertise/consultation

Test Steps:
1. Compile list of applicable local and international laws and regulations, especially environmental.
2. Review and cross-reference the design, documentation, and future plans with the compiled list.
3. Consult with legal experts to ensure correct understanding.
4. Identify which (if any) areas of the system are potential risks.

Expected Results:

1. Design, documentation, and future plans display compliance with laws and regulations.
2. Legal experts advise that the system is compliant to local and international maritime laws.
3. No parts of the system are potential risks.

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.23 Multilingual Support (REQ-In-2)

Test Case ID: TC-In-2
Title: Verify that the system supports multiple languages
Description: To be able to scale the project, we must allow users around the world to use the application in the languages they understand

Preconditions:
1. Access to multilingual support features.
2. Participants who are proficient in languages the application supports.
3. List of tasks to perform.

Test Steps:
1. Ask participants to select their native language.
2. Assign participants tasks to perform within the application.
3. Record time taken for participants to complete tasks.
4. Note down any components of the app that don't support the respective language.
5. Once the task is completed, interview the participants.

Expected Results:
1. Application successfully supports multiple languages.
2. All UI elements, content, and data are correctly translated.
3. Participants experience no difficulties to navigate app in their native language

Actual Results: [To be filled during the test execution]

Status: Pass/Fail (based on the actual results)

11.24 Traceability Matrix

Requirement ID	Priority	Use Case ID	Test Case ID
REQ-1-1	High	UC-1-1	TC-1-1
REQ-1-2	High	UC-1-2	TC-1-2
REQ-2-1	High	UC-2-1	TC-2-1
REQ-2-2	Medium	UC-2-2	TC-2-2
REQ-3-3-1	Low	UC-3-3-1	TC-3-3-1
REQ-3-3-2	High	UC-3-3-2	TC-3-3-2
REQ-3-3-3	Medium	UC-3-3-3	TC-3-3-3
REQ-3-4-1	High	UC-3-4-1	TC-3-4-1
REQ-3-4-2	Medium	UC-3-4-2	TC-3-4-2
REQ-3-4-3	High	UC-3-4-3	TC-3-4-3
REQ-P-1	High	N/A	TC-P-1
REQ-P-2	Low	N/A	TC-P-2
REQ-Sa-1	High	N/A	TC-Sa-1
REQ-Sa-2	High	N/A	TC-Sa-2
REQ-Se-1	High	N/A	TC-Se-1
REQ-Se-2	High	N/A	TC-Se-2
REQ-Se-3	High	N/A	TC-Se-3
REQ-So-1	High	N/A	TC-So-1
REQ-So-2	Medium	N/A	TC-So-2
REQ-So-3	Medium	N/A	TC-So-3
REQ-So-4	Medium	N/A	TC-So-4
REQ-In-1	High	N/A	TC-In-1
REQ-In-2	Low	N/A	TC-In-2

Appendix: Issues List

No further issues at this moment.