Software Requirement Specifications

Aabi Zaraat.ai

Version: 1.00

Project Code	F23-163B
Supervisor	Ms. Sania Urooj
Co Supervisor	Mr. Farukh Shahid
Project Team	K200286 - Syed Aun Ali K200441 - M. Fahad Zahid K200273 - M. Mudabbir
Submission Date	11-12-2023 (DD-MM-YYYY)

Document History

Version	Name of Person	Date	Description of change
1.00	Syed Aun Ali	26/11/2023	*Initial Addition*

Distribution List

Name	Role
Ms. Sania Urooj	*Supervisor*
Mr. Farukh Shahid	*Co- Supervisor*

Document Sign-Off

Version	Sign-off Authority	Sign-off Date
1.00	M. Farrukh Shahid	8-12-2023 (DD-MM-YYYY)

Table of Contents

1. Introduction

1.1. Purpose of Document

The aim of this document is to articulate the software requirements for Aabi Zaraat.ai. It serves as a comprehensive guide for the development team, stakeholders, and other involved parties throughout the project lifecycle.

1.2. Intended Audience

The primary audience for this document includes the software/application development team, project supervisor and co-supervisor, the FYP jury, and other stakeholders invested in the development of the project. This report will serve the purpose of facilitating effective communication between all relevant parties and understanding of the software requirements.

1.3 Abbreviations

- SRS: Software Requirements Specification

1.4 Document Convention

- Font: Times New Roman
- Font Size: 16pt

2. Overall System Description

2.1. Project Background

In recent years, significant advancements in Artificial Intelligence (AI), particularly in Deep Learning (DL) and Computer Vision (CV), have fueled the development of AI-powered mobile applications. Our focus lies at the intersection of these technologies and the crucial sectors of agriculture and aquaculture in Pakistan. Agriculture is the backbone of Pakistan's economy, but it faces challenges like nutrient-depleted soil and traditional farming practices. This backdrop drives our project—a mobile application leveraging AI, machine learning, and computer vision to revolutionize farming. Current agricultural practices in Pakistan heavily rely on chemical fertilizers, leading to soil degradation and environmental issues. Our proposed mobile app addresses this by allowing farmers to identify and classify soil types and fish species through smartphone cameras. It promotes sustainable practices by leveraging fish organic fertilizer and providing insights for soil improvement. The app caters to B2B users, acting as a knowledgeable ally for soil classification and fish assessment. It guides users on optimal nutrient extraction procedures, enhancing soil health and promoting sustainable agriculture. In the realm of fish classification, the app utilizes local datasets to train the model. It offers extensive information about fish, guiding users on ideal combinations of fish species, additional ingredients, and compatible soil types. The project aims to simplify agriculture, automate nutrient extraction, and provide accessible agricultural insights. The core goal is to promote intelligent and sustainable farming practices, bringing this vision closer to reality.

2.2. Project Scope

Aabi Zaraat.ai focuses on developing a mobile application that will utilize modern day AI, machine learning, and computer vision algoirtms to address specific challenges within Pakistani agriculture and aquaculture. The primary scope involves implementing features such as soil classification, fish assessment, and guidance on nutrient extraction procedures. The application is designed for B2B users, offering valuable insights to streamline agricultural process. The objectives encompass the creation of a mobile application with user-friendly interface, integration of AI and ML models in the backend for accurate classification, provision of comprehensive insights for sustainable agriculture, and guidance through nutrient extraction processes. The project's deliverables include a fully functional mobile application, trained ML models for classification, and comprehensive documentation outlining the app's usage and features. Constraints involve adherence to the defined scope, with data collection limited to local Karachi markets. Assumptions include users possessing smartphones with functional cameras and access to internet connectivity for real-time data retrieval.

2.3. Not In Scope

This app is not intended for end consumers but focuses specifically on B2B interactions. The project does not aim to explore alternative energy sources or elaborate on broader environmental sustainability practices beyond its specific agricultural context. It only focuses on the scenario where nutrients are extracted from aquaculture of Pakistan and are used as input material for revitalizing the soil of Pakistan for agricultural practices.

2.4. Project Objectives

- Develop a mobile application utilizing machine learning, computer vision, and artificial intelligence for the agricultural and aquaculture sectors in Pakistan.

- Revolutionize nutrient extraction in agriculture by providing a user-friendly interface for soil classification and fish assessment through smartphone cameras.

- Facilitate farmers and soil inspectors in identifying diverse soil types and gaining insights into each soil's unique properties.

- Offer recommendations for the most compatible fish species based on soil type, creating a knowledgeable ally for users.

- Collect and utilize local datasets for both soil and fish classification, specifically focusing on halal (edible) and haram (non-edible) fishes found in Karachi's fish markets.

- Provide extensive information about scrutinized fish, guiding users on ideal combinations of fish species, additional ingredients, and compatible soil types for optimal results.

- Simplify nutrient extraction procedures in agriculture through automation, making farming practices more intelligent, efficient, and accessible.

- Foster sustainable agricultural practices by promoting the use of fish organic fertilizer as a valuable source for soil conditioning and enhancing overall soil health.

- Target business-to-business (B2B) users within the agricultural landscape of Pakistan, offering practical insights and recommendations to enhance farming endeavors.

2.5. Stakeholders

The success of our system relies on collaboration and engagement from various stakeholders, encompassing both business users and technical experts. This section delineates the key stakeholders and their roles in the system:

2.5.1 Business User Classes

Farmers:

- Primary end-users of the mobile application.
- Interact with the system to classify soil types, identify fish species, and receive agricultural recommendations.

Soil Inspectors:

- Utilize the application for in-depth soil analysis and provide expert insights.
- Contribute to the accuracy of soil classification through their expertise.

Fisheries and Aquaculture Experts:

- Leverage the application for fish classification, obtaining information on diverse fish species.
- Collaborate to enhance the accuracy of the fish classification module.

Agricultural Researchers:

- Utilize data gathered by the application for agricultural research purposes.
- Contribute insights into sustainable farming practices.

Government Agricultural Departments:

- Use the system data for policy-making and agricultural planning.
- Collaborate in the development of guidelines and standards.

2.5.2 Technical Experts

AI Researchers:

- Engage in the development and improvement of AI algorithms for soil and fish classification.
- Contribute to the evolution of the system's core intelligence.

Database Administrators:

- Manage and maintain the integrity of soil, fish, and agricultural practices databases.
- Ensure efficient data retrieval and storage for optimal system performance.

Mobile App Developers:

- Responsible for the design, development, and maintenance of the mobile application.
- Implement user-friendly interfaces and integrate AI modules seamlessly.

System Architects:

- Define the overall system architecture and ensure the integration of different modules.
- Oversee the scalability and robustness of the entire system.

In essence, the collaboration between these stakeholder groups ensures a effective system that caters to the diverse needs of end-users while maintaining the technological excellence of the underlying infrastructure.

2.6. Operating Environment

The operating environment of our application encompasses various aspects, including hardware platforms, operating systems, network configurations, and compatibility with other software components. A detailed overview of these elements is presented below:

1. Hardware Platform:

Aabi Zaraat.ai’s mobile application is designed to operate seamlessly on contemporary smartphones equipped with standard hardware components. The application leverages the processing power and camera capabilities of modern mobile devices. The recommended specifications include smartphones with a minimum of 2GB RAM and a multi-core processor to ensure optimal performance.

2. Operating System:

The application is compatible with widely used mobile operating systems, including but not limited to:

Android: The application is designed to run on Android smartphones with versions 6.0 (Marshmallow) and above.

iOS: Compatibility extends to iOS devices, including iPhones and iPads, with versions 10 and above.

3. Network Environment:

The application requires access to a stable internet connection for certain functionalities such as real-time data retrieval, cloud-based processing, and updates. It is optimized to operate efficiently in 3G, 4G, and Wi-Fi environments. The application employs secure communication protocols to ensure the confidentiality and integrity of user data during data transfer.

4. Software Components and Applications:

The FYP software interacts with several software components and applications to enhance its functionalities:

- *AI Libraries and Frameworks:* The application integrates with AI libraries and frameworks such as TensorFlow and PyTorch to implement advanced machine learning algorithms for soil and fish classification.
- *Database Management System (DBMS):* The software interacts with a DBMS to manage and retrieve data efficiently. Compatibility with popular SQL/Non-SQL based system is ensured.
- *Mobile App Development Frameworks:* The application is built using industry-standard frameworks such as Swift or Flutter, ensuring cross-platform compatibility and streamlined development processes.

5. External APIs:

To enrich the user experience and provide up-to-date information, the application may integrate with external APIs. For instance, agricultural databases, or fish classification datasets.

6. Security Considerations:

Our application adheres to secure coding practices and encryption standards to safeguard user data. It complies with the security protocols of the underlying operating systems and utilizes secure connections for data transmission.

7. Environmental Factors:

The application is designed to function effectively in varying environmental conditions, considering factors such as ambient light for camera operations and network connectivity stability.

8. Compatibility Testing:

Regular compatibility testing is conducted to ensure the application's smooth operation across different device models, screen sizes, and resolutions.

The operating environment described above is pivotal in ensuring the Aabi Zaraat.ai’s effectiveness, user accessibility, and seamless integration with contemporary technology.

2.7. System Constraints

The system constraints for the FYP encompass various external factors that impose limitations on the software's development, functionality, and deployment. These constraints are categorized into different aspects:

Software Constraints:

1. *Compatibility:* The application must ensure compatibility with a variety of mobile devices and operating system versions.
2. *Performance:* The software should exhibit efficient performance even on devices with limited processing power and memory.
3. *Security:* Adherence to robust security measures, including data encryption and secure communication protocols, is crucial.
4. *Scalability:* The system should be designed to accommodate future updates and expansions without compromising performance.

Hardware Constraints:

1. *Device Specifications*: The software is constrained by the hardware specifications of mobile devices, necessitating optimization for varying device capabilities.
2. *Camera Quality:* The effectiveness of image processing and AI algorithms is contingent on the camera quality of the user's device.

Cultural Constraints:

1. *Language Support:* The application should offer support for multiple languages, addressing diverse user demographics and linguistic preferences.

Knowledge and Dataset Constraints:

1. *Lack of Knowledge Base:* The project faces constraints related to a limited existing knowledge base in the domain, necessitating extensive research and exploration.
2. *Mapping Knowledge Constraints:* Challenges may arise in mapping the acquired knowledge to the practical implementation of AI algorithms and image processing techniques.
3. *Dataset Limitations:* Availability of a comprehensive and diverse dataset for training AI models may pose constraints, influencing the accuracy of classification algorithms.

Legal Constraints:

1. *Data Protection:* Compliance with data protection laws and regulations, ensuring user privacy and data security.
2. *Intellectual Property*: Adherence to intellectual property laws, especially in the utilization of third-party libraries, APIs, and datasets.

Environmental Constraints:

1. *Network Reliability:* The system may face constraints related to the reliability of internet connectivity, especially in regions with intermittent network access.
2. *Ambient Conditions*: The application should function optimally under various environmental conditions, considering factors like lighting for image capture.

User Constraints:

1. *User Interface:* The application should be designed with a user-friendly interface, considering the diversity in user age groups and technological familiarity.
2. *Accessibility*: Ensuring accessibility features for users with disabilities, such as screen readers and voice commands.

Off-the-Shelf Components:

1. *Library/API Constraints*: Constraints imposed by the functionalities and limitations of third-party libraries or APIs integrated into the system.
2. *License Agreements:* Adherence to license agreements associated with off-the-shelf components.

Academic Constraints:

1. *Compliance with Standards:* The project should adhere to academic standards and guidelines defined by the educational institution.

These system constraints play a crucial role in shaping the development and functionality of the FYP software, ensuring alignment with external factors and stakeholder expectations.

2.8. Assumptions & Dependencies

This section aims to highlight the key assumptions made during the planning and development of the FYP, along with dependencies on external factors crucial for the system's functionality.

Assumptions:

1. *User Interaction Competence:* The assumption is that end-users possess basic competence in interacting with smartphone applications, including the usage of camera features.
2. *Data Accessibility*: It is assumed that relevant datasets for soil and fish classification, along with agricultural practices, are accessible for training AI models. Stable Internet
3. *Connectivity*: The application assumes a stable internet connection for real-time interactions and data updates, especially during the recommendation phase.
4. *Device Compatibility:* The software assumes compatibility with a range of contemporary mobile devices commonly used in the target region.
5. *Regulatory Compliance:* Assumption that the application aligns with relevant regulatory and ethical standards in the field of agriculture and aquaculture.

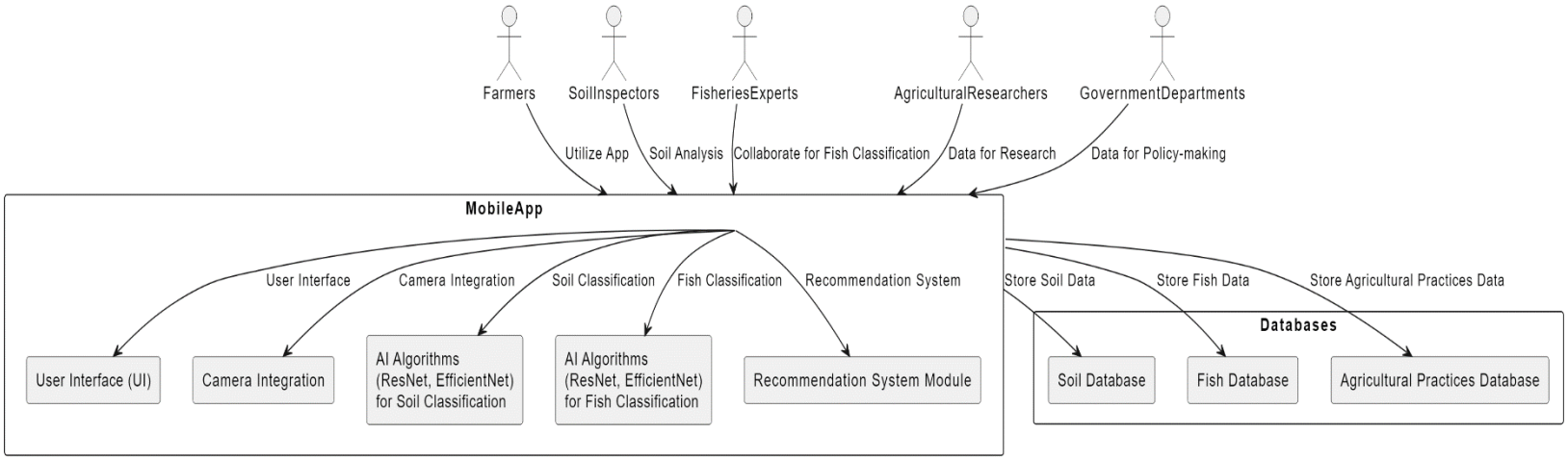
Dependencies*:*

1. *API and Library Dependencies:* The system is dependent on the functionality and updates of third-party APIs and libraries integrated for image processing, AI algorithms, and database interactions.
2. *Database Availability:* The functionality of the application is dependent on the availability and reliability of the soil, fish, and agricultural practices databases.
3. *Continuous Dataset Enrichment*: The effectiveness of AI models is dependent on the continuous availability and enrichment of datasets to enhance classification accuracy.

4. *Operating System Updates:* Dependencies on updates and features introduced by mobile operating systems may impact the application's compatibility and performance.
5. *User Feedback*: The system is dependent on user feedback for continuous improvement, requiring user engagement and responsiveness to reported issues.
6. *Research and Development:* Dependencies on ongoing research and developments in the field of AI, computer vision, and agricultural practices to incorporate the latest advancements.
7. *Collaboration with Agricultural Experts:* The system's effectiveness in recommending agricultural practices is dependent on collaboration with agricultural experts to ensure accuracy and relevance.
8. *Environmental Factors*: Dependencies on factors like ambient lighting and environmental conditions during image capture may influence the accuracy of classification.

Identifying these assumptions and dependencies is essential for understanding the contextual landscape in which the FYP operates, facilitating effective decision-making and risk management throughout the project's lifecycle.

3. External Interface Requirements



3.1. Hardware Interfaces

a. *Smartphone:*

   • *The mobile application should be compatible with commonly used smartphones, specifying minimum hardware specifications (e.g., camera quality, processing power).*

b. *Camera:*

   • *The application relies on the smartphone camera for soil and fish identification. Specify any specific camera requirements for optimal performance.*

c. *Internet Connectivity:*

   • *The application may require internet connectivity for real-time data processing, updates, and accessing additional information. Specify the minimum network speed or connectivity requirements. Software Interfaces*

3.2. Software Requirements:

a. *Operating System:*

   • *Clearly state the supported operating systems for your mobile application (e.g., Android, iOS).*

b. *Minimum Software Versions:*

   • *Specify the minimum required versions of the operating system and any additional software dependencies.*

c. *Database Requirements:*

   • *Specify if the application relies on a database and the compatibility requirements with database management systems.*

d. Security Software:

• Outline any security software requirements, such as encryption protocols, for securing data during transmission and storage.

3.3. Communications Interfaces

a. Camera Interface:

• Describe how the application interacts with the smartphone camera, including the integration of camera APIs.

b. APIs for Soil and Fish Data:

• If your application interacts with external databases or APIs for soil and fish data, specify the protocols and methods used for data retrieval.

c. Internet Communication:

• Detail the communication protocols (e.g., HTTP, HTTPS) used for internet-based interactions and data exchange.

d. User Authentication:

• If the application involves user accounts, specify the authentication methods and protocols used.

e. External Integration:

• If your application integrates with other systems or services, provide details on how this integration is achieved.

4. Functional Requirements

4.1. Functional Hierarchy

1. User Registration and Login

1.1. Add a new user entry in the database

1.2. Verify user credentials at login.

2. Image Upload/Capture

2.1. Acquire input images from cameras in real-time or saved in phone storage.

3. Image Classification

3.1. Classify image as fish image or soil image.

4. Fish Classification

4.1. Classify fish species.

4.2. Show relevant details of the identified fish species.

5. Soil Classification

5.1. Classify soil type.

5.2. Show relevant details of the identified soil type.

6. Fish-to-Soil and Soil-to-Fish recommendations

6.1. Map the classified fish specie to the most suitable soil types with application.

6.2. Map the classified soil to the most suitable fish species and highlight procedures.

7. Access Control

7.1. Allow only registered users to allow usage of the application.

8. Data Security

8.1. Implement secure data storage and transmission protocols.

4.2. Use Cases

4.2.1. User

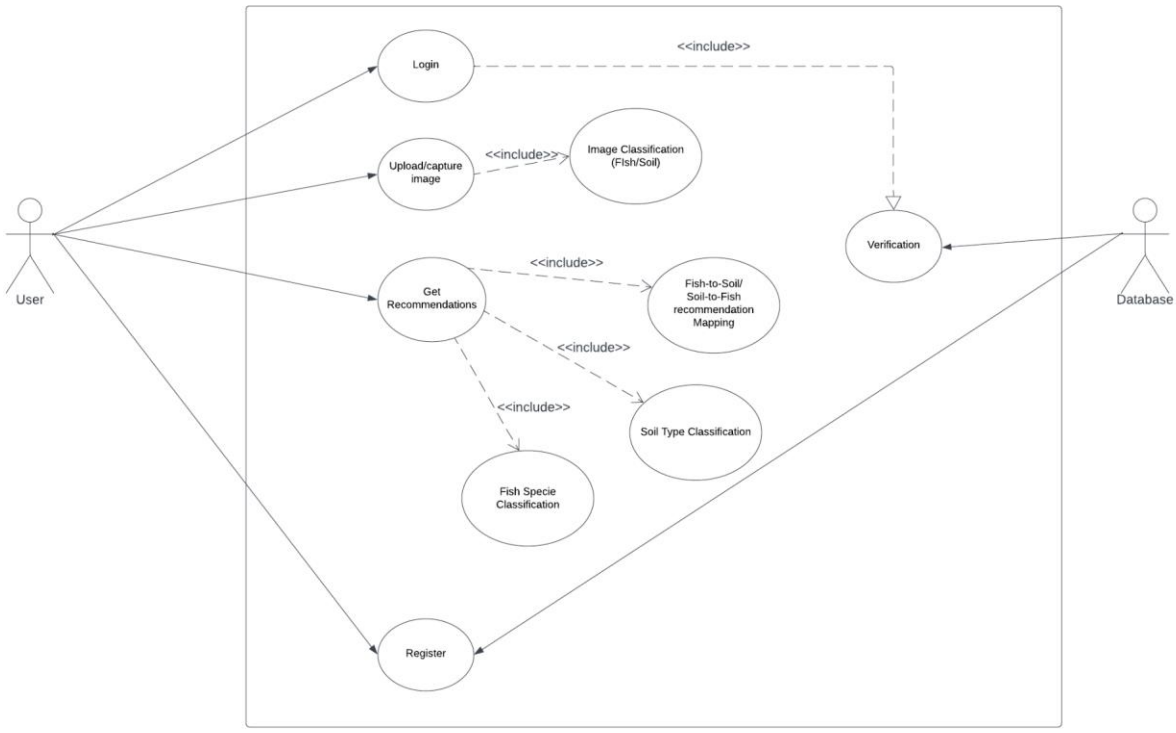


Figure N: User Use Case

Use Case 1: Login

Use case Id:	**AZ1**
Actors: User	
Feature: User Registration and Login	
Pre-condition:	1. Application is correctly installed and configured. 2. User is registered in the database.

Scenarios

Step#	Action	Software Reaction
1.	User enters login credentials	
2.	System checks credentials with existing database entries	Logs in the user to the application.

Alternate Scenarios:

1a: Error due to empty fields or incorrect format of input.

2a: Login request is denied if credentials do not match database entries.

Post Conditions

Step#	Description
1.	User is logged in and the dashboard is displayed.
2.	

Use Case Cross referenced	

Use Case 2: Upload/Capture image

Use case Id:	**AZ2**
Actors: User	
Features: Image Upload/Capture, Image Classification	
Pre-condition:	1. User is logged in. 2. Application has storage and camera access privileges.

Scenarios

Step#	Action	Software Reaction
1.	User uploads image from phone storage or use the built-in camera to capture images.	
2.	System performs image classification.	Relevant details of fish specie health are displayed.
3.		

Alternate Scenarios:

1a: Error due to unsupported file type during upload.

2a: Classification error due to blurry or low quality image.

Post Conditions

Step#	Description
1.	On successful recognition, the image is passed on to either fish species or soil type classification module.
2.	

Use Case Cross referenced	

Use Case 3: Image Classification (FIsh/Soil)

Use case Id:	**AZ3**
Actors: User	
Feature: Image Classification	
Pre-condition:	Image is correctly captured or uploaded to the application.

Scenarios

Step#	Action	Software Reaction
1.	Image is input to the model via capture or upload	
2.	Module determines image as fish image or soil image	Relevant image details are displayed, i.e: fish health analysis or soil details
3.		

Alternate Scenarios:

1a: Classification error due to image not falling in defined classes.

2a:

Post Conditions

Step#	Description
1.	Image is processed further to define a fish species or soil type it belongs to.

Use Case Cross referenced	Upload/Capture image, Get Recommendations

Use Case 4: Get Recommendations

Use case Id:	**AZ4**
Actors: User	
Feature: Fish Classification, Soil Classification, Fish-to-Soil and Soil-to-Fish recommendations	
Pre-condition:	Image is correctly classified as either a fish image or soil image.

Scenarios

Step#	Action	Software Reaction
1.	Image is input to fish/soil modules	
2.	Module determines image class (40 fish species and 3 soil types)	Classified fish specie/ soil type information is displayed.
3.	Fish specie is mapped to most suitable soil application while soil type is mapped to most suited fish species.	Relevant procedures are displayed along with the recommendations for both processes.

Alternate Scenarios:

1a: Classification error due to the fish specie or soil type not falling in trained classes.

2a: Information not being displayed to database error.

Post Conditions

Step#	Description
1.	User can re-initiate the process by uploading or capturing new images.

Use Case Cross referenced	Image Classification (Fish/Soil), Upload/Capture image

Use Case 5: Fish Specie Classification		
Use case Id:	**AZ5**	
Actors: User		
Feature: Fish Classification		
Pre-condition:	Image is correctly classified as either a fish image.	
Scenarios		
Step#	**Action**	**Software Reaction**
1.	Image is input to the module	
2.	Module performs classification	Classified fish specie information is displayed.
3.		
Alternate Scenarios:		
1a: Classification error due to the fish specie not falling in trained classes. **2a:** Information not being displayed to database error.		
Post Conditions		
Step#	**Description**	
1.	Fish specie is mapped to most suitable soil type and applications are highlighted	
Use Case Cross referenced	Fish-to-Soil/ Soil-to-Fish recommendation Mapping, Get Recommendations	

Use Case 6: Soil Type Classification		
Use case Id:	**AZ6**	
Actors: User		
Feature: Soil Classification		
Pre-condition:	Image is correctly classified as either a fish image.	
Scenarios		
Step#	**Action**	**Software Reaction**
1.	Image is input to the module	
2.	Module performs classification	Classified soil type information is displayed.
3.		
Alternate Scenarios:		
1a: Classification error due to the soil type not falling in trained classes. **2a:** Information not being displayed to database error.		
Post Conditions		
Step#	**Description**	
1.	Soil type is mapped to most suitable fish species and procedures are highlighted.	
Use Case Cross referenced	Fish-to-Soil/ Soil-to-Fish recommendation Mapping, Get Recommendations	

Use Case 7: Fish-to-Soil/ Soil-to-Fish recommendation Mapping		
Use case Id:	**AZ7**	
Actors: User		
Feature: Fish-to-Soil and Soil-to-Fish recommendations		
Pre-condition:	Fish specie or Soil type are correctly identified.	
Scenarios		
Step#	**Action**	**Software Reaction**
1.	Image is input to the module	
2.	Module performs mapping	Relevant feasible applications for best soil types or most suitable fish species for given soil are recommended.
3.		
Alternate Scenarios:		
1a: Information not being displayed to database error. **2a:**		
Post Conditions		
Step#	**Description**	
1.	Soil type is mapped to most suitable fish species and procedures are highlighted.	
Use Case Cross referenced	Get Recommendations	

Use Case 8: Register		
Use case Id:	**AZ08**	
Actors: User		
Feature: User Registration and Login		
Pre-condition:	1. Application is correctly installed and configured.	
Scenarios		
Step#	**Action**	**Software Reaction**
1.	User enters information and credentials	
2.	System adds new user entry in the database	User data is saved.
3.		
4.		
Alternate Scenarios:		
1a: Error due to incorrect format of data entered. **2a:** Error due incomplete information for registration(empty fields)		
Post Conditions		
Step#	**Description**	
1.	User is logged in and the dashboard is displayed.	
Use Case Cross referenced		

5. Non-functional Requirements

5.1. Performance Requirements

Speed:

The system must provide species recommendations within a response time of 10 seconds or less after receiving input data.

Precision:

The accuracy of recommendations should be at least 90%, based on validation testing with diverse datasets.

Capacity:

The system must be capable of processing a minimum of 1,000 images daily, ensuring scalability to accommodate increasing user demands.

Reliability:

The system should maintain an uptime of 99.9%, minimizing downtime for maintenance or updates.

5.2. Safety Requirements

Loss Prevention:

The system must have safeguards to prevent data loss or corruption, ensuring the integrity of both input and output data.

Harm Mitigation:

The system should not recommend fish species that pose known health risks to the soil, crops, or the broader ecosystem.

Regulatory Compliance:

The system must comply with relevant agricultural and environmental regulations in Pakistan, ensuring that recommendations align with established safety standards.

5.3. Security Requirements

Data Protection:

The system must employ encryption mechanisms to protect sensitive data, both during transmission and storage.

User Authentication:

Access to the system should be restricted, requiring user authentication to prevent unauthorized access.

Privacy:

User data, including uploaded images and recommendation history, must be treated with strict

confidentiality, adhering to privacy regulations.

Integrity:

The system should ensure the integrity of recommendations and prevent tampering or manipulation of output results.

5.4. User Documentation

User Manuals:

Comprehensive user manuals describing system functionalities, input requirements, and interpretation of results will be provided in both print and digital formats.

Tutorials:

Tutorial materials, including video guides and step-by-step tutorials, will be provided to facilitate user onboarding and maximize the effective use of the system.

Contextual Help:

Features will be integrated into the user interface, providing relevant assistance based on the user's interaction with the system.

6. References

[1] A. Holzinger et al., "Current Advances, Trends and Challenges of Machine Learning and Knowledge Extraction: From Machine Learning to Explainable AI," in Machine Learning and Knowledge Extraction, Springer, Cham, 2018, pp. 1, DOI: 10.1007/978-3-319-99740-7_1.

[2] M. Hassaballah and K. M. Hosny (Eds.), "Recent Advances in Computer Vision: Theories and Applications," Studies in Computational Intelligence, Springer Cham, 2019, pp. XV, 425, DOI:10.1007/978-3-030-03000-1.

[3] A. A. Khan, A. A. Laghari, S. A. Awan, "Machine Learning in Computer Vision: A Review," SIS EAI,2021, DOI: 10.4108/eai.21-4-2021.169418.

[4] Government of Pakistan, Ministry of Finance, "Pakistan Economic Survey 2020-21," 2021. [Online]. Available: https://www.finance.gov.pk/survey/chapters_21/02-Agriculture.pdf.

[5] M. A. Khan and M. Ahmed, "Review of Available Knowledge on Land Degradation in Pakistan," ICARDA, March 2012.

[6] "The Impact of Fertilizers on the Environment: Inorganic vs. Organic," Farmerline, June 23, 2023. Available: https://farmerline.co/

[7] Nation, "Unsustainable farming," The Nation, Jul. 4, 2023. [Online]. Available: https://www.nation.com.pk/04-Jul-2023/unsustainable-farming

[8] IIPS. (2023). "Sustainable Agriculture and Food Security: Boosting Pakistan's Economy." [Online]. Available: https://iips.com.pk/sustainable-agriculture-and-food-security-boosting-pakistans-economy/#:~:text=Soil%20erosion%2C%20salinity%2C%20and%20declining,its%20ability%20to%20support%20crops

[9] H. N. Pahalvi, L. Rafiya, S. Rashid, B. Nisar, and A. N. Kamili, "Chemical Fertilizers and Their Impact on Soil Health," in: First Online: 01 April 2021. DOI: 10.1007/978-3-030-61010-4_1. Available: https://link.springer.com/chapter/10.1007/978-3-030-61010-4_1

[10] M. A. Khaskheli, "Fertilizers and Environmental Pollution," Agriculture Officer Sanghar. [Online]. Available: https://www.pakissan.com/english/issues/fertilizers.and.environmental.pollution.shtml

[11] M. A. Khaskheli, "Fertilizers and Environmental Pollution," Agriculture Officer Sanghar. [Online]. Available: https://www.pakissan.com/english/issues/fertilizers.and.environmental.pollution.shtml

[12] S. Z. H. Shah, H. T. Rauf, M. I. Ullah, M. S. Khalid, M. Farooq, M. Fatima, S. A. C. Bukhari, "Fish-Pak: Fish species dataset from Pakistan for visual features based classification," Department of Zoology,University of Gujrat, Pakistan; Department of Computer Science, University of Gujrat, Pakistan; Department of Fisheries and Aquaculture, University of Veterinary and Animal Sciences, Lahore, Pakistan; Division of Computer Science, Mathematics and Science, Collins College of Professional Studies, St. John's University, New York, USA.

[13] G. Wright, "AI is becoming an 'integral part' of fisheries management and seafood processing," Mar. 20, 2023.

[14] M. M. U. Rehman, "Advancements in Fish Farming is a Sustainable Solution for Future Fish Demand," Jun. 22.

[15] M. Y. Laghari, "Aquaculture in Pakistan: Challenges and opportunities," Int. J. Fisheries Aquat. Stud., vol. 6, no. 2, pp. 56-59, 2018.

[16] S. Abbas, S. Fatima, and M. S. Khattak, "The role of aquaculture in the sustainable development of irrigated farming systems in Punjab, Pakistan," Published online: June 28, 2008. DOI: 10.1046/j.1365-2109.1997.00912.x.

[17] I. Ahuja, E. Dauksas, J. F. Remme, R. Richardsen, and A.-K. Løes, "Fish and fish waste-based

fertilizers in organic farming – With status in Norway: A review," Norwegian Centre for Organic Agriculture (NORSØK), Tingvoll, Norway; Department of Biological Sciences, Norwegian University of Science and Technology (NTNU), Ålesund, Norway; SINTEF Ocean, Ålesund, Norway; SINTEF Ocean, Tromsø, Norway, Received May 22, 2020, Revised July 8, 2020, Accepted July 28, 2020, Available online July 28, 2020. DOI: 10.1016/j.wasman.2020.07.025.

[18] "AnchoisFert: A New Organic Fertilizer from Fish Processing Waste for Sustainable Agriculture," Published online: March 2, 2022. DOI: 10.1002/gch2.202100141.

[19] M. Radziemska, M. D. Vaverková, D. Adamcová, M. Brtnický, and Z. Mazur, "Valorization of Fish Waste Compost as a Fertilizer for Agricultural Use," Original Paper, Published: April 16, 2018, vol. 10, pp. 2537-2545, 2019.

[20] M. Khan and C. A. Damalas, "Farmers' knowledge about common pests and pesticide safety in conventional cotton production in Pakistan," Published online: July 14, 2015. DOI: 10.1016/j.cropro.2015.07.014.

[21] F. Aldosari, M. Mubushar, and M. B. Baig, "Assessment of farmers knowledge on pesticides and trainings on pesticide waste management in Central Punjab – Pakistan," Journal of Experimental Biology and Agricultural Sciences, vol. 6, no. 1, pp. 168-175, February 2018. DOI: 10.18006/2018.6(1).168.175.

[22] M. F. Ali, M. Ashfaq, S. Hassan, and R. Ullah, "Assessing Indigenous Knowledge through Farmers' Perception and Adaptation to Climate Change in Pakistan," Institute of Agricultural and Resource Economics, University of Agriculture, Faisalabad, Pakistan. Received: August 3, 2017; Accepted: February 10, 2018.

[23] S. Fahad, T. Inayat, J. Wang, L. Dong, G. Hu, S. Khan, and A. Khan, "Farmers' awareness level and their perceptions of climate change: A case of Khyber Pakhtunkhwa province, Pakistan," Published online: 2020. DOI: 10.1016/j.landusepol.2020.104669.

[24] A. Memon, "Agriculture: The need to increase farmers' knowledge," Published: March 20, 2023.

7. Appendices

[Refer To LR Document]