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| Farmer Intelligent Helper System (FIHS) |
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Chapter 1: Introduction

* 1. **Overview**

Farmers often face many challenges in their traditional farming practices, including uncertainty in decision-making, limited access to timely and accurate information, poor disease management, and dependency on traditional methods and techniques.

These challenges contribute to decreased agricultural productivity, reduced profitability, suboptimal crop yields, inefficient farming methods, delayed disease management, and overall sustainability issues within the farming community. The need for a solution that provides intelligent, accessible support is crucial to empower farmers, enhance agricultural practices, and improve crop yields.

The Intelligent Farmer Helper System (FIHS) is a cutting-edge agricultural technology designed to address the critical challenges faced by farmers. By leveraging advanced technologies such as artificial intelligence, machine learning, and data analysis, the FIHS aims to provide the famer with intelligent assistance throughout the crop management and decision-making processes to improve overall agricultural productivity.

Beyond its core functionalities, FIHS offers users a user-friendly interface via a mobile app, allowing them to browse, search for various plants, diseases, pests, and access a repository of agricultural articles.

The system targets not only farmers but also researchers and agronomists, providing valuable insights for informed decision-making.

* 1. **Objectives**

The Farmers Intelligent Helper System (FIHS) aims to achieve the following:

* Develop a comprehensive database system for plants, pests, diseases, and articles related to agriculture, ensuring a well-organized and easily accessible repository of information.
* Implement a robust plant identification feature utilizing advanced image recognition technology, allowing users to identify various plant species accurately.
* Integrate a disease detection mechanism within the system, to identify and diagnose plant diseases based the image of the plant.
* Establish a user-friendly chatbot interface capable of providing information on plant care, pest control, disease management, and general agricultural advice.
* Ensure data accuracy and reliability in the database through regular updates and maintenance, Providing a trustworthy source of information for users.
* Enhance user engagement by implementing a feedback mechanism, encouraging users to provide input on the accuracy and helpfulness of the information provided by the system.
  1. **Purpose**

The purpose of this project is to create a comprehensive and user-friendly platform that serves as a unified solution for all individuals interested in agriculture. The primary goals include:

* **Optimize Agricultural Practices:** provide intelligent assistance to the farmer to optimize their crop cultivation process.

* **Enhance Crop Yield:** recommend the most suitable crops based on soil and weather conditions to maximize productivity.

* **Facilitate Diseases Detection:** detect and identify crop diseases and pests to enable timely treatment.
* **Data Provision:** offer a comprehensive database of crops, plants, diseases, pests, fertilizers, pesticides, guides, and articles.
* **Increase Agricultural Productivity:** provide intelligent assistance to the farmer to optimize their crop cultivation process.
* **Support Decision Making:** integrate with chatbot API to enable farmers to receive accurate and timely responses to their farming-related questions.
  1. **Scope**

The scope of the Farmers Intelligent Helper System (FIHS) includes the development and implementation of an intelligent agricultural system designed to assist farmers in optimizing their crop cultivation practices, enhancing crop yield, increasing agricultural productivity, facilitating pest and disease detection, providing farming-related information, and offering a chat interface for answering farming questions.

The system encompasses software development, database management, machine learning model creation, and integration with third-party APIs. It also involves the creation of a user-friendly interface for both farmers and system administrators.

The system will handle plant identification, crop recommendations, disease detection, treatment suggestions, and other features.

* 1. **General Constraints**

The development and implementation of the Farmers Intelligent Helper System (FIHS) operate within certain defined constraints and limitations.

* **Technology Constraints:**
* **Integration Challenges:** Integrating various advanced technologies into a coherent system may present challenges in terms of compatibility and seamless interaction among different components.
* **User Interface Compatibility:** The user interface must be designed to accommodate users with varying levels of technological proficiency. Accessibility features and user-friendly design are essential for widespread adoption.
* **Resources Constraints:**
* **Skilled Workforce:** The availability of skilled personnel proficient in both agricultural and technological domains may pose a constraint in the creation and maintenance of the system.
* **Data Constraints:**
* **Data Accessibility:** The system's effectiveness relies significantly on the availability and accuracy of agricultural data. Access to comprehensive and reliable data may pose a constraint.
* **Time Constraints:**
* **Implementation Schedule:** FIHS will follow a phased implementation approach to deliver essential functionalities in a timely manner. Each phase will have defined milestones and deadlines.

Chapter 2: Project Planning

* 1. **Feasibility Study**

**2.1.1 Technical Feasibility:**

* **Development Tools and Technologies:**
* *Backend (ASP.NET):*ASP.NET is a robust and widely used framework for developing scalable backend systems. Its integration capabilities, security features, and support make it suitable for managing the system's database and functionalities effectively.
* *Frontend (React Native):* React Native provides a flexible and efficient approach for mobile app development. It allows for the creation of cross-platform applications, which aligns well with the requirement for a mobile interface in this system.
* **API Integration:**
* *Plant/Disease Identification API:*we will integrate Plant.id API to enable users to identify plants and detect potential diseases from images. This API provides three highly probable suggestions for plant identification, along with corresponding confidence scores, facilitating accurate identification.
* *Conversional AI Integration:* integrate Google's Gemini API to power a sophisticated chatbot within the application. This chatbot will enable users to ask questions in a natural, conversational way and receive informative, comprehensive answers related to plant care, disease identification, crop recommendations, and other agricultural topics.
* *Scholarly Article Search Integration:* integrate SerpApi to provide users with access to relevant research articles from Google Scholar. This API allows users to enter a topic, and the application will retrieve a curated selection of scholarly articles from Google Scholar based on the search query.
* **Machine Learning Model for Crop Recommendation:**

The FIHS application will utilize a decision tree model, potentially a random forest, to recommend suitable crops for users based on their specific soil and weather conditions. This model will be trained on a comprehensive dataset of agricultural data, enabling it to identify optimal crop choices based on the user environment.

* + 1. **Operational Feasibility:**
* **Data Accessibility:** availability and quality of agricultural data might be a concern, impacting the system's effectiveness. Ensuring comprehensive, accurate, and timely data access will be crucial.
* **Technology Integration:** integrating various technologies seamlessly might present operational challenges. Ensuring compatibility and smooth interaction among different components could be a significant task.
* **Scalability:**
* Employ cloud-based solutions for data storage and backend infrastructure to ensure scalability as the user base and data volume grow.
* Implement modular design principles for the app to facilitate future feature additions and updates.

**2.1.3 Legal Regulatory Compliance:**

* **Legal Compliance:** given the nature of the system dealing with agricultural data, compliance with data protection regulations, and possibly agricultural regulations, would be essential. However, ensuring legal compliance might require constant monitoring and updates.

**2.1.4 Financial Feasibility:**

* **Cost Breakdown:** costs of development, ongoing maintenance, cloud storage, API subscriptions, and potential data acquisition fees.

**2.1.5 Market Analysis:**

* **Market Overview:** the market for intelligent agricultural systems is characterized by a growing awareness of the need for technology-driven solutions in the farming sector. With an increasing focus on sustainable and efficient farming practices, the demand for systems like the Farmers Intelligent Helper System is on the rise.
* **Target Audience:** the primary target audience for FIHS includes individual farmers, agricultural cooperatives, research institutions, and agronomists. The system serves a diverse user base, from small-scale farmers seeking practical advice to researchers looking for data-driven insights.
* **Market Needs:** the FIHS aligns with key market needs, including:
* *Decision Support:* farmers require tools that aid in decision-making for crop management, disease prevention, and resource optimization.
* *Information Accessibility:* the market demands a centralized repository of agricultural information accessible to users with varying levels of technological proficiency.
* *Innovation* *in Agriculture:* there is a growing trend toward incorporating advanced technologies like AI and machine learning in agriculture for improved efficiency and productivity.

The overall feasibility of the Intelligent Farmer Helper System (FIHS) is considered High, where technical and legal aspects indicate high feasibility.

* 1. **Estimated Cost**

The estimated project costs encompass various elements, including the development of a visually engaging user interface, hosting for the database and backend server, and the integration of third-party APIs to enhance app functionalities.

* **Hosting:** To ensure reliable and scalable performance, the app will require hosting for both the database and backend. Hosting costs vary based on factors such as data storage, bandwidth, and the selected hosting provider. We expect the hosting cost in the range of $--- to $---.
* **Third-Party APIs:** The integration of third-party APIs will enhance the app's functionality by providing features such as asking questions to Chat GPT. The cost of third-party APIs depends on the selected services. We expect a cost in the range of $--- to $--- for integrating these APIs into our system.
* **UI Design:** The development of a visually appealing and user-friendly interface is essential for the success of the mobile app. To achieve this, we plan to invest in a professionally designed user interface (UI). Depending on the complexity of the design, the cost for UI design is expected to range between $--- and $---.
  1. **Gantt Chart**

**Chapter 3: Project Analysis**

* 1. **Analysis and Limitation of Existing Systems**

In the current landscape of agricultural technology, several applications aim to assist farmers in various aspects of crop management, such as "Farmers' Companion," "Plantix," and "AgriApp". However, this apps have some limitations in various aspects.

* **Challenges and Limitation**

1. Database Completeness:Many existing agricultural apps lack a comprehensive and up-to-date database encompassing a wide variety of plants, pests, diseases, and treatment methods.
2. User Interface and Accessibility: Some agricultural apps have complex user interfaces, making them less user-friendly, especially for farmers with limited technological proficiency. Additionally, accessibility features may be lacking, preventing widespread adoption among diverse user groups.
3. Integration of Technologies: Integration of advanced technologies, such as machine learning for plant identification and disease detection, is often minimal in existing systems. This results in a missed opportunity to leverage cutting-edge tools for enhanced agricultural productivity.
   1. **Need for the New System**

* **Comprehensive Database:**
* The new system aims to provide farmers with a comprehensive and regularly updated database containing detailed information on a wide range of plants, pests, and diseases. This will empower farmers to make informed decisions regarding crop management and protection.
* **User-Friendly Interface:**
* The new system will prioritize a user-friendly interface, ensuring accessibility for farmers with varying levels of technological expertise. This includes intuitive navigation and features that meet to the diverse needs of the user base.
* **Advanced Technology Integration:**
* Incorporating machine learning algorithms for plant identification will enable farmers to identify various plant species quickly and accurately, facilitating precision agriculture practices.
* Utilizing advanced image recognition and data analytics, the new system will offer real-time disease detection and treatment suggestions. This ensures a targeted and efficient approach to crop health management.
  1. **Analysis of the New System**

**3.3.1 System Requirements:**

* + - **Artificial Intelligence and Machine Learning:**

The system should incorporate advanced AI and machine learning algorithms to analyze data, predict crop diseases, and optimize farming practices.

* + - **Data Analysis:**

The system should be capable of processing and analyzing agricultural data to provide meaningful insights for decision-making.

* + - **User Interface:**

A user-friendly mobile app interface should be developed, enabling farmers, researchers, and agronomists to interact with the system easily.

* + - **Repository:**

The system must have a comprehensive repository containing information on various plants, diseases, pests, and agricultural articles.

* + - **Integration:**

The FIHS should be capable of integrating with other agricultural technologies and data sources to enhance its capabilities.

* + - **Login or Register:**

The system should be accessible to users with varying levels of technological proficiency and available on multiple devices.

**3.3.2 System Requirements:**

* + - **Login or Register:**

When the user uses the system, he can register if it is the first time for him or login if he already has an account.

* + - **Plant Identification:**

The system should be able to identify and provide information about various crops and plants based on images provided by the farmer.

* + - **Crop Recommendation:**

The system should recommend suitable crops or plants to be grown based on the soil type, weather conditions, and other relevant factors.

* + - **Disease Detection:**

The system should be capable of detecting diseases in crops through image analysis.

* + - **Treatment Suggestions:**

Once pests or diseases are identified, the system should provide appropriate treatment recommendations to the farmer.

* + - **Integration with Chatbot API:**

The system should be integrated with a Chatbot API to allow farmers to ask questions related to farming, crop care, and general agricultural practices.

* + - **Database Management:**

The system should maintain a comprehensive database containing information on crops, plants, diseases, pests, articles, and guides.

**3.3.4 Non-functional Requirements:**

* + - **Performance:**

The system should be able to process and analyze images, provide recommendations, and respond to user queries in a timely manner to ensure a smooth user experience.

* + - **Usability:**

The system should have a user-friendly interface that is easy to navigate and understand for farmers.

The system should provide clear instructions and guidance for uploading images, providing input data, and accessing different functionalities.

* + - **Reliability**

The system should be reliable and available to farmers whenever they need assistance, with minimal downtime or system failures.

The system should handle errors gracefully and display appropriate error messages when necessary.

* + - **Security**

The system should encrypt sensitive data to ensure the security and privacy of user data.

The system should implement authentication and authorization mechanisms to ensure that only registered administrators can access database management functionalities.

The system should have robust measures in place to prevent unauthorized access and data breaches.

* + - **Scalability:**

The system should be designed to handle a growing number of users and an increasing amount of data.

**3.3.5 Business Requirements:**

* + - **Accuracy and Reliability:**

The system should provide accurate and reliable recommendations, pest and disease detection, and treatment suggestions to gain the trust of farmers and ensure successful crop cultivation.

* + - **Integration with Third-party APIs:**

The system should be able to integrate with external APIs, such as chatbot and weather APIs, to enrich the functionality and provide comprehensive insights to farmers.

**3.3.6 Domain Requirements:**

* + - **Agricultural Knowledge:**

The system should have a comprehensive understanding of various crops, plants, diseases, pests, and agricultural practices to provide accurate and relevant information.

* + - **Image Processing and Analysis:**

The system should be capable of processing and analyzing images of crops and plants to identify and provide appropriate recommendations and suggestions.

* + - **Data Management:**

The system should efficiently store, retrieve, and update data related to crops, plants, diseases, pests, and guides in the database.

* + - **Machine Learning:**

The system can utilize machine learning algorithms to continuously improve its recommendations, disease detection, and treatment suggestions based on user feedback and new data.

* 1. **Risk and Risk Management**

**3.4.1 Risk Identification:**

1. **Technical Risks**

Machine Learning Performance:Machine learning models for crop identification, recommendation, and disease detection may require extensive training and testing. Poor model performance can lead to unreliable results.

1. **Operational Risks**

Maintenance and Updates:The system will need regular updates to remain effective. Ensuring ongoing maintenance and support is crucial.

1. **Security Risks**

Privacy and Data Security:The system will likely collect and store user data. Ensuring the privacy and security of this data is essential to build trust with users.

1. **User Risks**

User Adoption:Farmers may have varying levels of technological literacy, and their willingness to adopt the system could be a potential barrier.

1. **Data Risks**

Data Accuracy and Quality: The effectiveness of the system's recommendations and disease detection depends on the accuracy and quality of data. Inaccurate data can lead to incorrect suggestions.

**3.4.2 Risk Analysis:**

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| # | Risk Description | Category | Likelihood | Impact | Risk Level |
| 1 | ML Performance: Poor machine learning predictions | Technical | Moderate, depending on the quality and diversity of training data | Poor model performance can result in unreliable crop identification and disease detection | High |
| 2 | Maintenance and Updates: Disruption in service | Operational | Moderate, depending on the frequency and execution of updates | Outdated software may result in reduced system performance and effectiveness | Moderate |
| 3 | Data Accuracy: Inaccurate agricultural data | Data | High, especially if data validation processes are not robust | Incorrect data may lead to inaccurate recommendations, affecting crop health and yield | Critical |
| 4 | Privacy and Data Security: Unauthorized access | Security | Moderate, given the increasing frequency of cyber threats | Compromised privacy can erode user trust and legal consequences | High |
| 5 | User Adaptation: Low user acceptance | User | High, especially if user training and support are not adequately addressed. | Low user adoption may hinder the system's effectiveness and potential benefits for farmers | Moderate |

**3.4.3 Risk Management:**

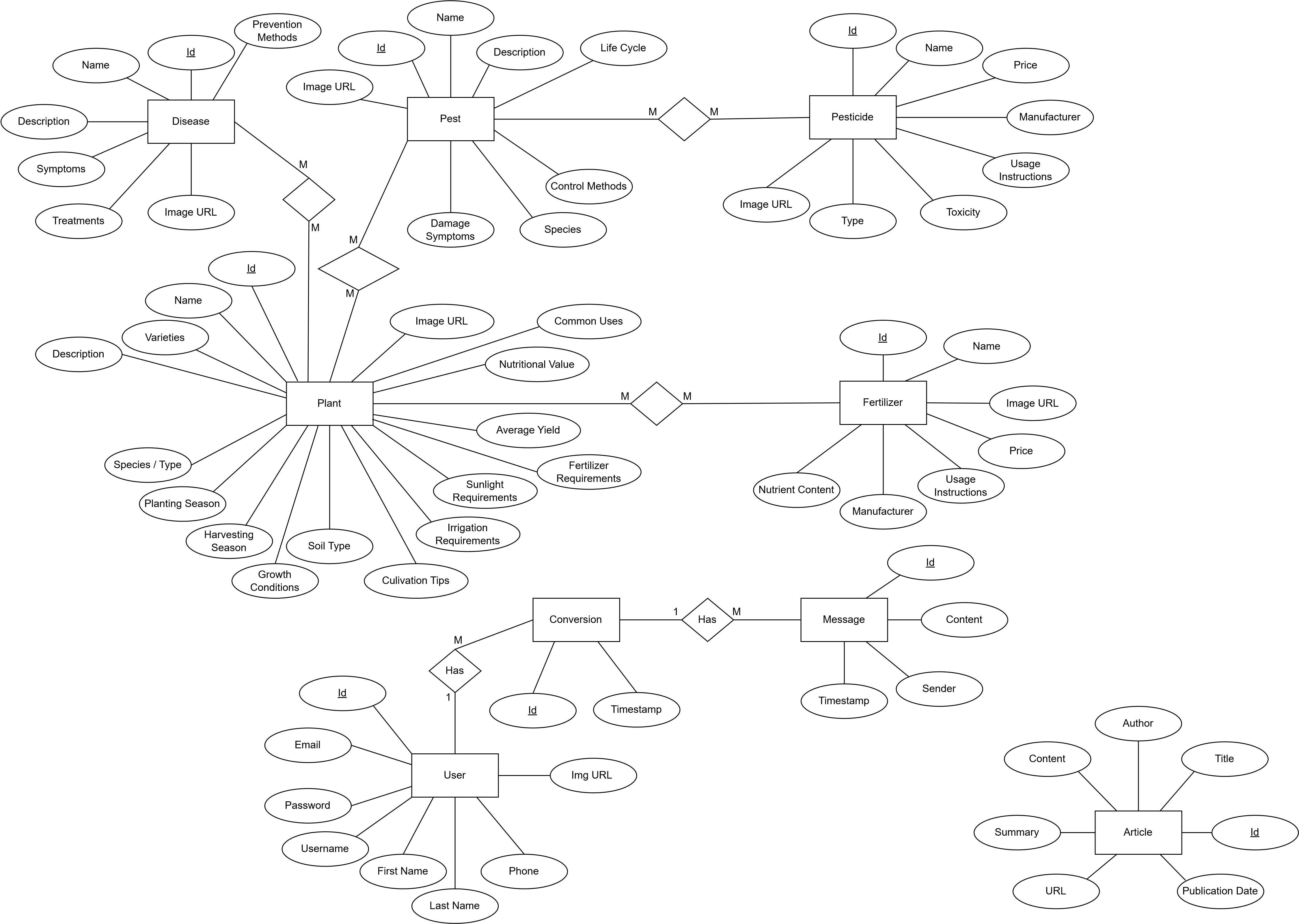
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| --- | --- | --- |
| # | Risk Description | Mitigation Strategy |
| 1 | ML Performance: Poor machine learning predictions | Continuous training of machine learning models.  Monitoring model performance in real-time. |
| 2 | Maintenance and Updates: Disruption in service | Perform regular system backups.  Notify users in advance of scheduled maintenance. |
| 3 | Data Accuracy: Inaccurate agricultural data | Implementing data validation checks.  Regularly update and verify data sources.  Provide clear data quality information to users |
| 4 | Privacy and Data Security: Unauthorized access | Implementing robust access controls.  Regularly audit and monitor system access.  Encrypting sensitive data such as user password. |
| 5 | User Adaptation: Low user acceptance | Involve users in design and development.  Provide extensive user training and support. Iterate based on user feedback. |

**3.4.4 Contingency Plan:**

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| # | Risk Description | Contingency Plan |
| 1 | ML Performance: Poor machine learning predictions | Rapid model updates with improved algorithms. |
| 2 | Maintenance and Updates: Disruption in service | Have a rollback plan for updates.  Perform updates during low-traffic periods. |
| 3 | Data Accuracy: Inaccurate agricultural data | Quick updates for critical inaccuracies.  Open communication about data limitations. |
| 4 | Privacy and Data Security: Unauthorized access | Regularly review and update security protocols. Notify users of any security incidents. |
| 5 | User Adaptation: Low user acceptance | Additional user training and resources.  Analyze user feedback and implement changes Iteratively. |

Chapter 4: Design

* 1. **ERD**



* 1. **Use Case Description**

**System Actors:**

1. **Guest**

A user who has not registered or logged in, typically with limited access to system functionality.

Permissions: Limited access to system features, mainly related to crop and plant information and identification.

Actor Name: Admin

1. **Registered User (non-admin)**

A user who has registered and logged into the system but does not have administrative privileges.

Permissions: Full access to system functionality for features such as asking questions to chatbot.

No access to administrative tasks.

1. **Admin**

A registered user with administrative privileges.

Permissions Admin Full access to system functionality, including administrative tasks such as managing crop and plant data. related to crop and plant information and identification.

1. **Login and Registration:**

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| **Goal** | provide login and registration functionality for both guests and registered admins, allowing them to access the system with the appropriate level of permissions and privileges |
| **Precondition(s)** | The system is operational and accessible.  The guest or admin has a compatible device with an internet connection.  The guest or admin has not already logged in (for guests) or is not already registered (for admins). |
| **Postcondition(s)** | Guests can access limited functionality within the system.  Registered admins can access the full functionality and privileges of the system. |
| **Main Success Scenario** | * The guest or admin accesses the application. * If the user is a guest, they are presented with the option to either log in or register. * If the guest chooses to register, they are prompted to provide the required information, such as name, email, and password. * The system validates the provided information, checks for any duplicate accounts, and creates a new guest account. * The newly registered guest is automatically logged in and gains access to the limited functionality available for guests. * If the user is an admin, they are prompted to provide their login credentials. * The admin enters their registered email and password. * The system verifies the provided credentials against the registered admin accounts. * If the credentials are valid, the admin is granted access to the full functionality and privileges of the system. * The system tracks the user's login status and displays the appropriate interface and features based on their role (guest or admin). |
| **Unsuccessful Scenario(s)** | *Duplicate registration:* If a guest attempts to register with an email address that is already associated with an existing account, the system displays an error message and advises the guest to use a different email or attempt to log in instead. |
| **Initiator** | admin or guest |

* **Plant Identification:**
* **Goal:** The goal of the use case is to accurately identify and provide information about various plants based on images provided by the user.
* **Precondition(s):**
* The user has access to the system.
* The user has provided an image of the plant to be identified.
* **Postcondition(s):**
* The system provides the user with the accurate identification of the plant with detailed information about it.
* **Main Success Scenario:**
* The user initiates the "Plant Identification" use case from the system interface.
* The system prompts the user to upload an image for the desired plant.
* The user uploads an image of the plant.
* The system analyzes the image using machine learning algorithms.
* If the plant is successfully identified, the system will display the name and detailed information about the identified plant.
* **Unsuccessful Scenarios:**
* *An image is not provided:* if the user does not upload an image, the system displays an error message and prompts the user to provide the necessary information.
* *Unrecognized Plant:* if the system fails to accurately identify the crop or plant. In that case, the system displays an error message indicating the failure to identify.
* **Initiator:**
* Registered User.
* **Crop Recommendation:**
* **Goal:** The goal of this use case is to provide users with suitable crops recommendations based on factors such as soil type, weather conditions, and other relevant factors.
* **Precondition(s):**
* The user has access to the system.
* The system has access to relevant data, including soil type information, weather conditions, historical crop performance, and other factors that influence crop selection.
* **Postcondition(s):**
* The system provides the user with a list of recommended crops based on the given parameters.
* **Main Success Scenario:**
* The user initiates the "Crop Recommendation" use case from the system interface.
* The system prompts the user to provide information such as solid type and climate conditions.
* The user enters the required information.
* The system applies algorithms and decision-making models to determine the most suitable crops based on the given parameters.
* The system generates a list of recommended crops.
* **Unsuccessful Scenarios:**
* *Insufficient or inaccurate information:* if the user provides incomplete or incorrect information. In that case, the system displays an error message and prompts the user to provide more accurate or complete information.
* *Unavailable data:* If the system lacks access to necessary data, such as soil type information or accurate weather forecasts, it may not be able to generate reliable recommendations. The system displays an error message indicating the unavailability of suitable crops due to missing or incomplete data.
* **Initiator:**
* Registered User.
* **Disease Detection:**
* **Goal:** The goal of this use case is to detect pests and diseases in crops through image analysis and provide treatment recommendations to the user.
* **Precondition(s):**
* The user has access to the system.
* The user has provided an image of the crop or plant to be analyzed for pests and diseases.
* **Postcondition(s):**
* The system accurately detects any diseases in the crop or plant.
* The system provides the user with appropriate treatment recommendations for the identified pests or diseases.
* **Main Success Scenario:**
* The user initiates the "Pests and Diseases Detection" use case from the system interface.
* The system prompts the user to upload an image for the affected crop or plant.
* The user uploads an image of the crop or plant.
* The model processes the images and extracts features to determine the presence and type of diseases.
* The system accurately identifies the pests or diseases affecting the crops.
* Once the pests or diseases are identified, the system generates appropriate treatment recommendations based on the specific diseases found.
* The system displays the treatment recommendations to the user, including suggested pesticides, organic methods, or other measures to mitigate the diseases.
* **Unsuccessful Scenarios:**
* *An image is not provided:* if the user does not upload an image, the system displays an error message and prompts the user to provide the necessary information.
* *Unrecognized pests or diseases:* If the trained model encounters diseases that are not part of its learned knowledge, it may not be able to accurately identify them. In that case, the system displays a message indicating that the pests or diseases could not be recognized.
* **Initiator:**
* Registered User.
* **Crop/Plant Management:**
* **Goal:** The goal of this use case is to allow the admin to add, update, and delete information related to crops and plants section in the system. The admin can perform these actions to maintain and keep the data up-to-date.
* **Precondition(s):**
* The admin has the necessary permissions and credentials to manage the database.
* The system is properly configured and operational.
* **Postcondition(s):**
* The data about crops and plants has been successfully managed by the system through adding, updating, or deleting records.
* **Main Success Scenario:**
* The admin selects the “Manage Crops and Plants” option from the system’s admin panel.
* The system presents a list of available actions, including Add, Update, or Delete Crop/Plant.
* The admin chooses the desired action, such as “Add Crop/Plant”.
* The system prompts the admin to enter the relevant information, such as crop/plant name, description, cultivation tips, images, and other related details.
* The admin submits the new crop/plant information, and the system validates and stores the data.
* The admin can continue managing other categories or perform additional actions within the “Crop/Plant Category”.
* **Unsuccessful Scenarios:**
* *Unauthorized access:* If an unauthorized user attempts to access the crop management functionality, the system denies access and displays an error message.
* *Validation errors:* If the admin provides incorrect or incomplete information for a new record, the system displays an error message and prompts for the correct information.
* *Database update failure:* If there are technical issues with the database management process, such as connectivity problems or data corruption, the system displays an error message.
* **Initiator:**
* Registered Admin.
* **Searching/Filtering Crops:**
* **Goal:** The goal of this use case is to enable users, both guests and registered, to search for specific crops or plants within the system's database based on various criteria.
* **Precondition(s):**
* The user has access to the system.
* The system contains a database of crops and plants with relevant information.
* **Postcondition(s):**
* The system provides the user with a list of crops or plants that match the search query, including detailed information about each matching crop or plant.
* **Main Success Scenario:**
* The system presents a search interface with various search criteria, such as crop name, type, or specific characteristics.
* The user enters their search criteria.
* The system processes the search request and queries the database for matching crops or plants.
* The system displays a list of crops or plants that meet the search criteria, along with detailed information about each matching entry.
* **Unsuccessful Scenarios:**
* *No matching results:* If the search query does not yield any results, the system informs the user that no matching crops or plants were found and suggests refining the search criteria.
* *Technical issues:* the system displays an error message and advises the user to try the search again later.
* **Initiator:**
* User (Guest or Registered).
* **Ask Questions to Chatbot:**
* **Goal:** The goal of this use case is to allow users to ask farming-related questions to a chatbot integrated into the system and receive informative.
* **Precondition(s):**
* The user has access to the system.
* The chatbot feature is available and functional within the system.
* **Postcondition(s):**
* The system provides the user with relevant and informative answer to his question.
* **Main Success Scenario:**
* The user accesses the "Ask a Farming Question" feature.
* The system presents a chatbot interface where the user can type their question.
* The user enters their question or query.
* The chatbot processes the question using relevant data sources.
* The chatbot provides an informative response to the user's question, which may include advice, recommendations, or explanations related to crop cultivation, plant care, pest management, or other farming topics.
* **Unsuccessful Scenarios:**
* *Technical issues:* If the chatbot or the data sources encounter technical problems, such as service unavailability or data retrieval errors, the system informs the user of the issue and advises them to try again later. 
* *Unrecognized query:* If the chatbot cannot understand the user's query.
* **Initiator:**
* Registered User.
  1. **UML Diagrams**

1. **Use Case Diagram**

صورة تحتوي على رسم بياني, رسم, نص, خط

تم إنشاء الوصف تلقائياً

1. **Activity Diagrams**

صورة تحتوي على نص, لقطة شاشة, رسم بياني, خط

تم إنشاء الوصف تلقائياً

صورة تحتوي على نص, لقطة شاشة, رسم بياني, خط

تم إنشاء الوصف تلقائياً

صورة تحتوي على نص, لقطة شاشة, رسم بياني, خط

تم إنشاء الوصف تلقائياً

صورة تحتوي على نص, لقطة شاشة, رسم بياني, خط

تم إنشاء الوصف تلقائياً

1. **Sequence Diagrams**

صورة تحتوي على نص, رسم بياني, خط, موازِ

تم إنشاء الوصف تلقائياً

صورة تحتوي على نص, رسم بياني, خط, موازِ

تم إنشاء الوصف تلقائياً

صورة تحتوي على نص, رسم بياني, موازِ, خط

تم إنشاء الوصف تلقائياً

صورة تحتوي على نص, موازِ, رسم بياني, رقم

تم إنشاء الوصف تلقائياً

**Chapter 4: Implementation**

* 1. **Software Architecture**

The application is built with *client-server architecture*, which offers a clear separation between the user interface (client) and data storage and processing (server).

* **Client-Side (Mobile Application):**

Built with React Native, a framework enabling the creation of mobile applications using JavaScript and React This choice empowers cross-platform development, allowing the application to run on both iOS and Android devices.

* **Server-Side:**

Leverages ASP.NET, a robust web application framework offers a comprehensive set of tools and libraries for building web applications, APIs, and services. It excels in handling database interactions, security, and scalability.

* **Database:**

SQL Server database to manage application data and stores information such as user accounts and profile, plants, disease, pests, and many other agricultural related data.

* **Object-Relational Mapping (ORM)**

Bridge between the object-oriented world of the application code and the relational model of the database, we used Entity Framework Core (EFCore) offering many benefits:

* Reduced Development Time: ORMs simplify data access code, minimizing the need for manual SQL queries and database interaction logic.
* Improved Maintainability: By centralizing data access logic, ORMs make code easier to understand, modify, and test.
* Strong Typing and Data Validation: ORMs enforce data type checks and validations at compile time, enhancing application robustness.
* **Client/Server Communication:**

The client and server communicate via RESTful APIs, adhering to a well-defined request-response pattern:

* Client Initiates Request: The user interacts with the mobile application, triggering a request to the server-side API. This request typically carries data (e.g., user query, image for identification) in the request body, following the chosen HTTP method (e.g., GET, POST, PUT, DELETE).
* Server Processes Request: The server receives the request, parses its contents, and routes it to the appropriate API endpoint. This endpoint typically interacts with the database to perform operations like data retrieval, insertion, or updates.
* Server Sends Response: Based on the request processing outcome, the server constructs a response message containing the requested data or a status code indicating success or failure. The response may also include additional information, such as error messages.
* Client Receives Response: The client's mobile application receives the server's response, parses its contents, and updates the user interface accordingly. The application might display retrieved information, present identification results, or inform the user of any errors encountered.
* **Security and Authentication:**

The architecture incorporates security measures, such as encryption, secure communication protocols and authentication mechanisms to protect sensitive data and ensure secure user access.

The application leverages JWT and Refresh Tokens to handle authentication:

* JWT: compact, self-contained tokens used to securely transmit user information between the client and server. They contain claims about the user (e.g., user ID, roles) and a signature to ensure authenticity.
* Refresh Token: token used to obtain new JWTs without requiring a full login. This improves user experience by automatically obtaining new JWTs before the current one expires.
* **Hosting and Deployment:**

**The backend is** uploaded and hosted on a cloud-based hosting provider server, The server handles incoming requests, runs the backend code, and connects to the SQL database.

* **External APIs Integration:**

FIHS leverages external APIs to provide enhanced functionalities to the user. These APIs act as external data sources or services, extending the capabilities of the core application.

* Plant.Id:
* **API Integration:**
* *Conversional AI Integration:* integrate Google's Gemini API to power a sophisticated chatbot within the application. This chatbot will enable users to ask questions in a natural, conversational way and receive informative, comprehensive answers related to plant care, disease identification, crop recommendations, and other agricultural topics.
* *Scholarly Article Search Integration:* integrate SerpApi to provide users with access to relevant research articles from Google Scholar. This API allows users to enter a topic, and the application will retrieve a curated selection of scholarly articles from Google Scholar based on the search query.
* **Machine Learning Model for Crop Recommendation:**

The FIHS application will utilize a decision tree model, potentially a random forest, to recommend suitable crops for users based on their specific soil and weather conditions. This model will be trained on a comprehensive dataset of agricultural data, enabling it to identify optimal crop choices based on the user environment.

* 1. **External APIs Integration**

1. **Plant.Id API:**

**We utilized the Plant.Id API, a machine learning-based service for plant identification and disease detection. This API provided a convenient and efficient way to incorporate these functionalities into our project.**

**By leveraging the API, we were able to focus development efforts on the core functionalities of our project while still benefiting from a pre-trained and accurate plant identification model. This significantly reduced development time and ensured access to a comprehensive plant database and disease detection capabilities.**

The API response provided the top 3 suggested plant classifications along with their corresponding probabilities. Additionally, details like common names and Wikipedia links, and taxonomy were included in the response. This information was then presented to the user within the application interface.

The Plant.Id API leverages a powerful Convolutional Neural Network (CNN) with EfficientNet architecture, boasting a claimed accuracy of 90% in plant identification. It supports an extensive database of over 33,250 plant classes including houseplants, wild plants, garden ornamentals, trees, shrubs, herbs, etc. and can detect over 80 distinct plant diseases. it allows specifying the desired response language, including Arabic.