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1. Introduction

1.1. Stakeholder purpose

Digital Health Inc. is looking to expand into the energy intake monitoring market so they can sell a complete energy intake/expenditure system to third parties in the health industry. Like most businesses, the primary objective of Digital Health Inc. is to increase revenue and selling a complete energy monitoring system will give them a much greater share of the market.

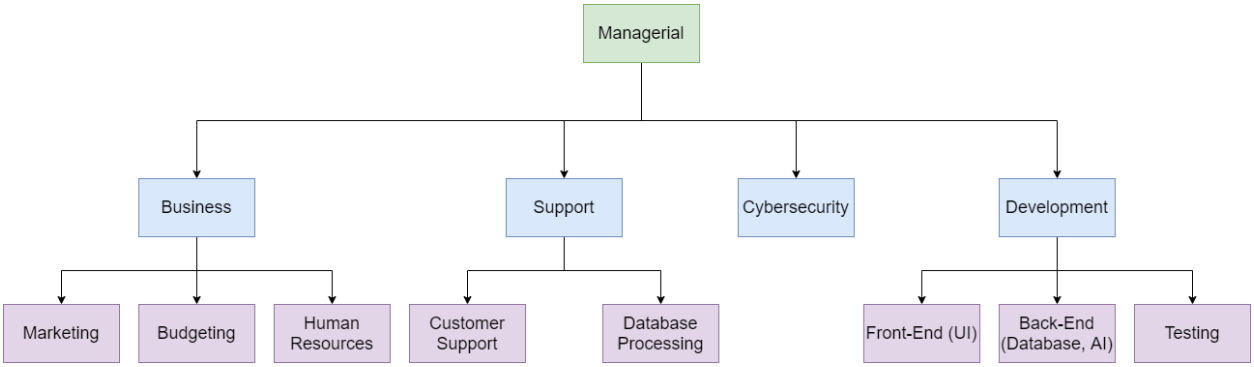
1.2. Stakeholder scope

Digital Health Inc. is a personal health monitoring company that is primarily involved with providing devices and services that allow individuals to measure their energy intake and view changes in their health. Developing this application will require the involvement of many divisions, including:

- Managerial: responsible for overseeing the progress of all other divisions and ensuring the project is advancing as expected, ordering for necessary changes should they be necessary.
- Business: responsible for establishing a budget and managing it throughout the development and deployment processes, marketing, and hiring necessary employees to develop the system.
- Developers: responsible for creating the application itself. This system will require both front-end and back-end developers. One team will create the front-end system that users will interact with, while another team will develop the functionality that powers the user interface (UI) that the user sees. This includes creating and training an artificial intelligence (AI) to accurately detect foods and estimate their amounts and managing multiple databases that will contain information on foods and users. Testers will also be responsible for ensuring there are no bugs before features are deployed to users.

- Support: responsible for ensuring users' feedback and issues are properly handled once the product is deployed. Support staff will process user submitted food entries that are not already in the database and add entries that will provide merit to the AI after they are validated. They will also handle any questions and complaints that users have and lead users to a solution.
- Cybersecurity: responsible for keeping track of those who are accessing the database, reporting and defending against malicious accesses.

1.3. Overview



The above diagram depicts the major internal divisions and how they are related to each other. The managerial department will oversee all of the departments. Some of the departments will also have sub-teams who will work closely together.

1.4. Definitions

- User Interface (UI): the view of the application that an end user will see and interact with.

1.5. Stakeholders

- Customers: this product is aimed to be convenient for both general and specialized consumers.
    - General users: people that will use this application to monitor their caloric intake due to overweightness or a want to stay fit.

    - Institutions and Doctors: people or entities in the health care sector that will purchase the application to have a comprehensive view of their patients' eating habits so they may better assist their patients.
    - Competitive Athletes and Trainers: people that will use this application to closely monitor an athlete's intake of calories as well as relevant nutrients, and then either maintain or adjust their eating habits to stay at peak competitive form.
- Employees: refer to the people who work at Digital Health Inc. or will be hired once the development process begins to help the company meet its business and technical goals. Employees in the company can be divided into different departments, as discussed in previous sections.

2. Business management requirements

2.1. Business environment

Digital Health Inc. has a very high standard for their products and services because they seek an accuracy of almost 95% for their energy intake monitoring system. This shows that the company would require a solution that is of high quality. The lack of useful alternatives on the markets means that the company would need to be able to provide in-depth details of how they would want the final product to look like. This can be an issue if the people contributing to the requirements of the project are not well-versed in technology or are unable to come to conclusive decisions.

2.2. Mission, goals, and objectives

The goal of developing an energy intake monitoring system is for Digital Health Inc. to capture a large market share of the energy intake market. Due to there being no products on the market that have high amounts of accuracy when estimating a meal's weight, Digital Health Inc. has decided it will be the first of its kind and develop a highly accurate system that will precisely estimate the amount of food in a photo and generate an equally precise report displaying nutritional information of the food(s) in question. Having the most

accurate application in the field of energy intake monitoring systems will ensure that Digital Health Inc. is a leader in the industry.

By creating an application that is better than its competitors in accuracy and feature set, it will also incentivize customers to exclusively use the Digital Health Inc. ecosystem of applications. The goal of developing this application is to not only to develop a strong standalone application, but also to introduce customers to applications also developed by the company. Customers will be more inclined to invest in exclusively using the entire suite of Digital Health Inc. products to have a more streamlined, user-friendly experience, and will lead to an increased number of users in all other previously existing applications.

2.3. Business model

The product that will be offered is an application to calculate the energy intake depending on different meals. The services offered by the product will be the ability to take a photo of different meals and analyze all the types and amounts of the ingredients included, as well as calculate different nutritional and caloric information of all the ingredients combined.

The product will be available globally with no geographical restrictions and will be available across all common mobile platforms such as Android and iOS with no platform restrictions. As this will be the leading application of its kind, it is expected that a majority of users who are interested in keeping records of their nutritional intake will use this application over its competitors.

The revenue model will be based on a subscription system. The product will be available for free for the basic functionalities of taking a photo, analyzing ingredients and a basic report of the caloric content. Basic users will be presented with advertisements after they have made several actions, and these advertisements will contribute to the revenue of this application. In order to avoid advertisements, view more advanced reports containing information such as macronutrients and micronutrients of the meals, save reports locally on their device, and use a faster backend system to calculate the report, the user will

need to pay a subscription fee monthly. These monthly subscription fees will be the majority source of revenue for the system.

2.4. Information environment

Each of the databases will have multiple permission levels to prevent unwanted access or misuse by employees who are not privy to such information.

As the food database has the least confidential information, there will only be 3 types of permissions. Employees who are not directly working with the database will be given no access to either read from or write to the database, junior employees working on the system will be given ability to read but not write to the database, and senior employees will be given full access to the database.

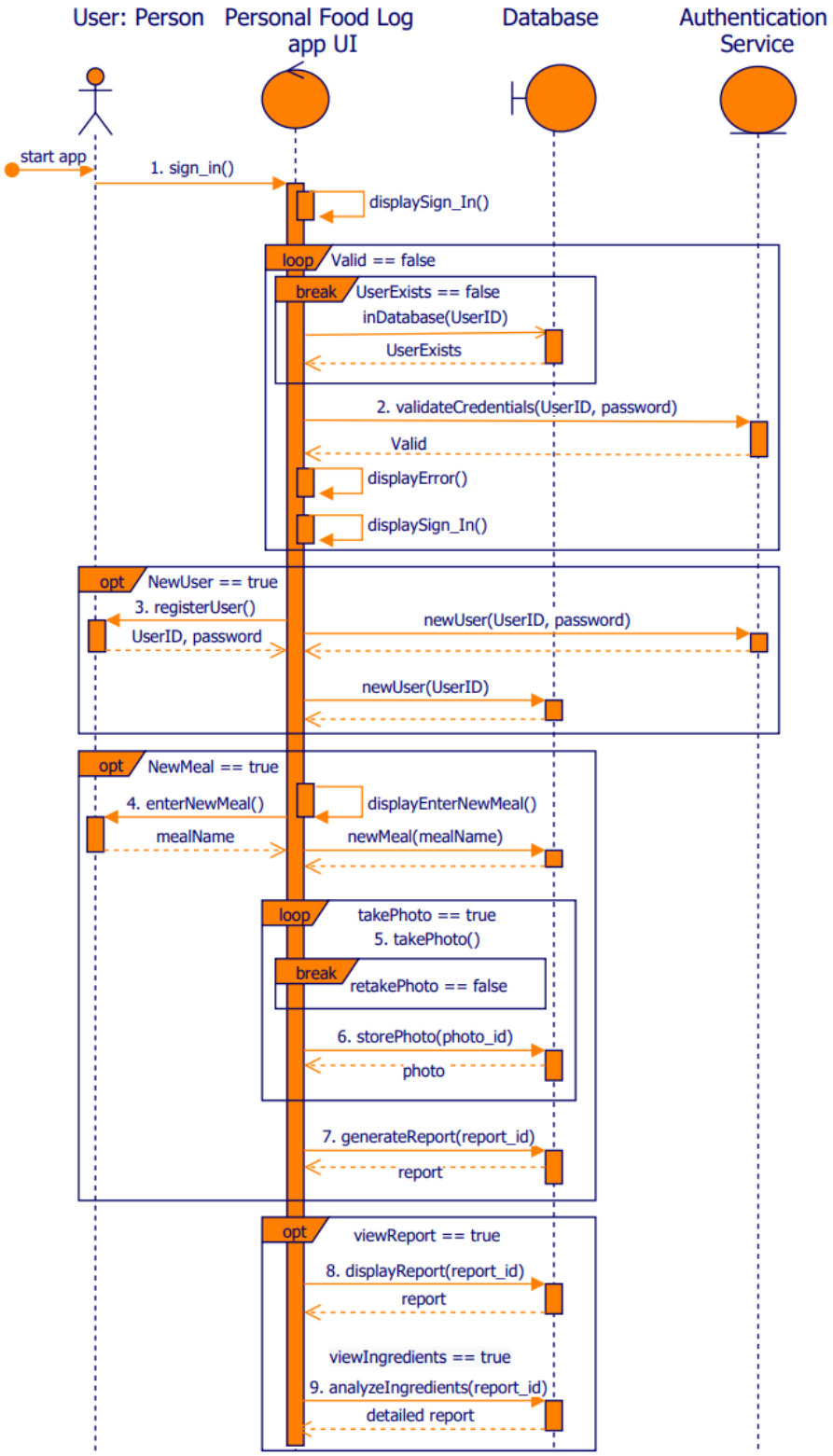
The logs of database access and any information related to users will be much more protected. Only cybersecurity staff and executives will have any access to logs, to ensure information that could lead to attacks on the database is not leaked. Lastly, statistics on revenue, total user base, etc. will be distributed only amongst shareholders of Digital Health Inc.

3. System operational requirements

3.1. System processes

The UML sequence diagram below will establish a high-level overview of the system processes in the context of the user. From the diagram we can see that the system plays a major role in this application by involving a database and authentication service. Both of these major system components are involved in numerous business activities. For example, logging in or registering an account invokes the database where the userID is stored/retrieved, and then that data is then validated against the authentication service to see if the userID currently exists in the system. The system is also responsible for handling action triggers when the user clicks on a UI component on the application. For

example, the system should transfer the user to a different page when the user selects the ‘view reports’ prompt from the home screen.



3.2. System operational policies and rules

1. Sign in:
    1.1. System conditions: Loop this process until the break condition is met, i.e. inDatabase(UserID) evaluates as True. Call displaySign_In() if (2.4) evaluates as True, otherwise call displayError().
2. Validate credentials:
    2.1. System conditions: Return True if validateCredentials(UserID, password) evaluates as True else return False.
3. Register user:
    3.1. System conditions: Call registerUser() only if NewUser evaluates to True. The system shall then authenticate the UserID and password to verify if the registered combination already exists. After validation as a newly registered user, the credentials will be stored in the database.
4. Enter new meal:
    4.1. System conditions: Call enterNewMeal() only if NewMeal evaluates to True from the user's confirmation following the UI prompt. The system will then display a prompt for the user to type in a new meal name. The entered meal name will then be stored in the database.
5. Take photo:
    5.1. System conditions: Call takePhoto() only if takePhoto evaluates to True from the user's confirmation following the UI prompt. Loop this process until the break condition is met, i.e., the user does not select the 'retake photo' prompt.
6. Store photo:
    6.1. System conditions: Begin process only after (5) is terminated. After the photo and its photo_id is stored in the database, return the photo.
7. Generate report:
    7.1. System conditions: Begin process only after (6) is terminated. After the report and its report_id is stored in the database, return the report.

8. Display report:
    8.1. System conditions: Call enterNewMeal() only if viewReport evaluates to True from the user's confirmation following the UI prompt. The system will search for the report with matching report_id in the database and then display the selected report.
9. Analyze ingredients:
    9.1. System conditions: Call analyzeIngredients() only if viewReport evaluates to True from the user's confirmation following the UI prompt. The system will then analyze the ingredients within the report with matching report_id and then return a detailed report with the analyzed ingredients.

3.3. System operational constraints

Sign in:

- Signing in shall successfully bring the user to the homepage of the app or display an error message for entering incorrect credentials in <= 1 second.

Validate credentials:

- Validating credentials against the system shall provide accurate results <= 99.9% of the time.
- Failures shall be frequently monitored to determine false negatives.

Register user:

- Registering an account shall sign the user into their new account and bring them to the homepage of the app in <= 2 seconds.

Enter new meal:

- Every stage of entering a new meal when selecting prompts shall bring the user forward or back to a different page in <= 1 second.

Take photo:

- The app shall send a notification to the user that it requires private access to their mobile camera to take a photo.
- This process will be infrequently monitored to ensure that only the user's camera can be accessed and nothing else.

Store photo:

- The loading icon associated with this process shall take <= 1 second.

Generate report:

- The report shall be generated following the process trigger in <= 2 seconds.
- This process shall be frequently monitored to ensure the accuracy of results.

Display report:

- Reports shall be displayed to the user within <= 0.1 seconds of selecting the ‘display report’ prompt or upon generating a new report.

Analyze ingredients:

- The ingredients shall be classified correctly with an average accuracy of >= 90% and it should take <= 5 seconds for the image processing to complete.
- This process shall be frequently monitored to improve accuracy and performance.

3.4. System operational modes and states

Default mode

In this operational mode, the system will operate normally for regular registered users with all the default features mentioned above.

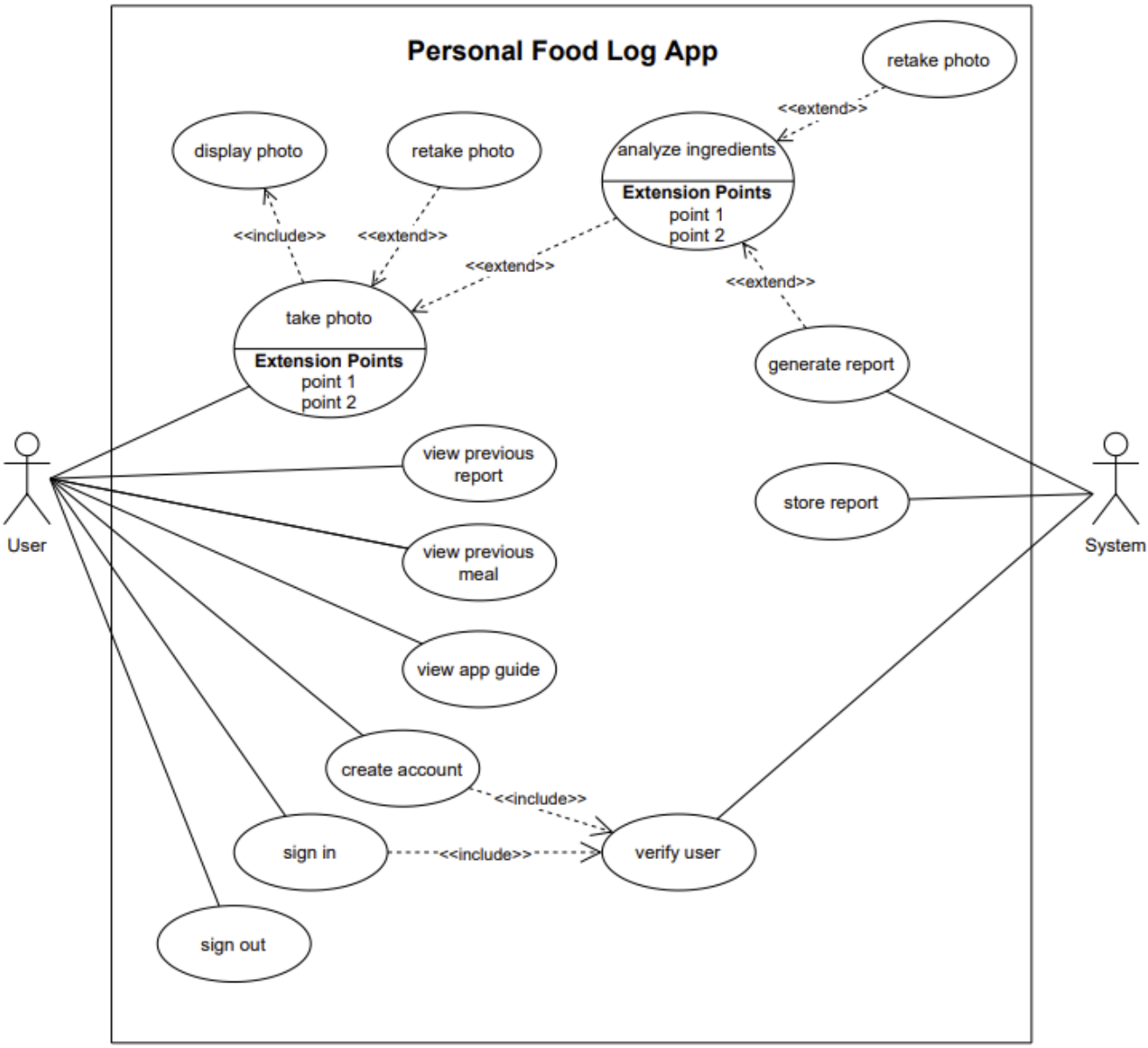
Premium mode

In this operational mode, the system will operate at a faster speed for premium registered users who are paying a monthly/yearly subscription to the application. Additional system features include locally storing data, more specific/detailed reports, report customizability, etc.

Manual mode

In the event of an unexpected server error, the system will operate in manual mode which means it will not be capable of image processing or storing any user/photo/report data to the server’s database. However, premium users will be capable of storing the following data to their local devices. These data objects will be first in the queue for the system to process when the server is back online.

4. User requirements



The following use case diagram provides a high-level overview of how the user will interact with the system for this application. From this diagram, we can extract the following user requirements:

- Users shall receive a report of a meal that the user has captured within a photo.
- The aforementioned report shall display detailed information like calories and percentage of RDA for carbohydrates, fats, protein, vitamins, and minerals.

- Users shall be able to retake a photo as many times as they want before deciding if they want the ingredients within the selected photo processed.
- Users shall be able to view previous reports and meals that were captured in the past.
- Users shall be able to view a guide on how to use the application from the home screen.
- Users shall be able to create an account, sign in to an account, or sign out of an account.
- Users shall be able to take a photo of a meal and have a report generated with minimal delay from the system.
- Users shall have different viewing options for generated reports e.g., simple, detailed, etc.
- Reports that are generated from the user shall be stored in the application's database by the system.
- Users shall have their credentials (UserID, password) validated against the authentication system when logging in/registering to ensure data security.
- Users shall have an optional feature pay a monthly/yearly subscription to the application to receive privileged benefits.
- Users shall be able to manually change the weights of ingredients that were processed by the system if they wish.
- Users shall be able to provide feedback to the application if they feel that the report is inaccurate.
- Users shall be able to manually enter information for a food item that the system cannot classify, and then the next time they scan said item, the application shall process it correctly.
- When a user manually enters in a food item and its ingredient information, the user can decide if they want the data to be local only to the user, or if they want to make it global for all users to see (at the request and verification by an admin).

5. Detailed life-cycle concepts of proposed system

5.1. Operational concept

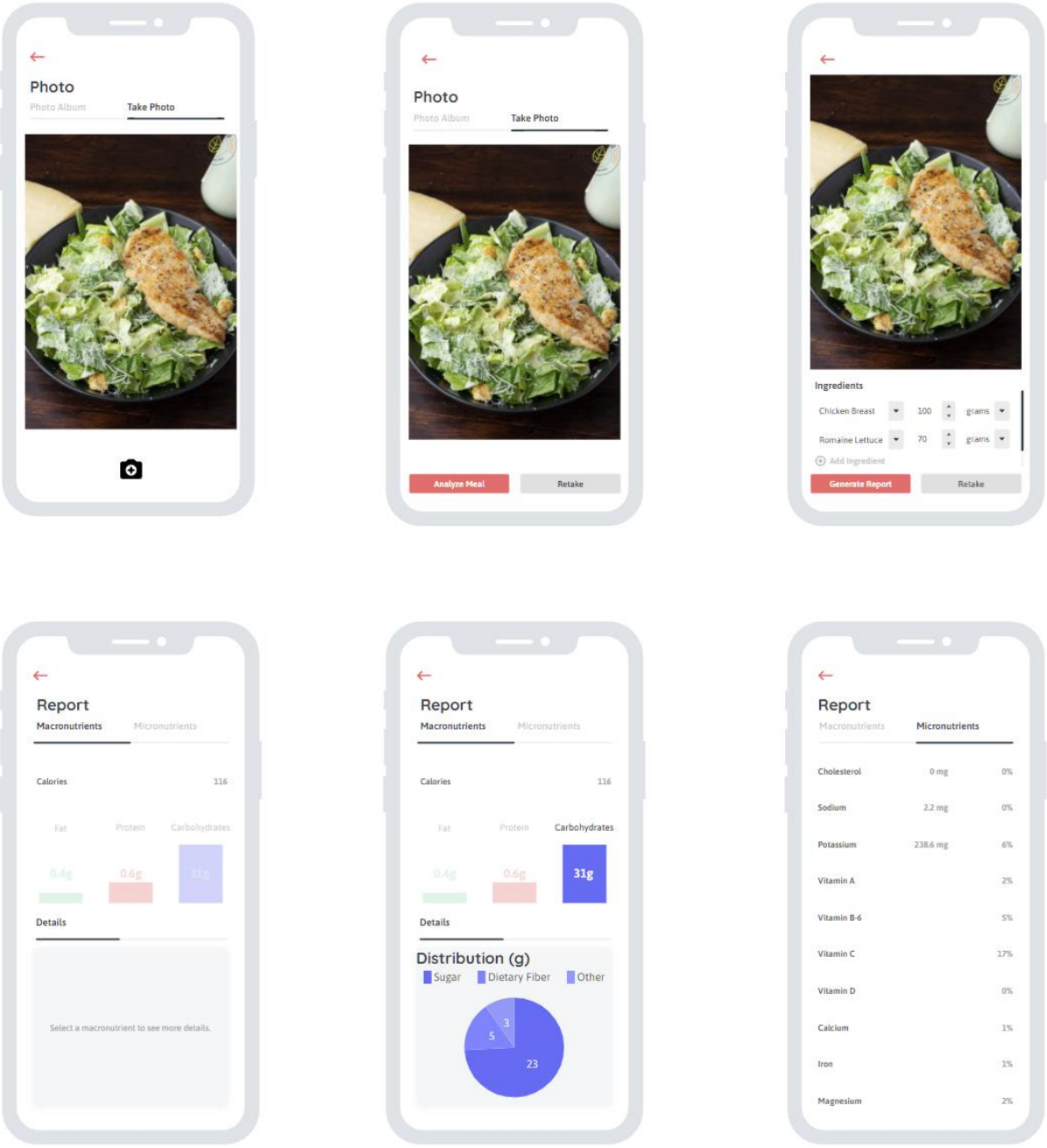
Operational policies and constraints

The project has two main operational policies that will dictate decision making. For one, this application will require a highly scalable database to store food information, with the database being linked to Amazon Cloud Services. Secondly, the project must use AI for its food detection system. By using existing food libraries to train the AI while also allowing users to submit their own foods, it will be able to learn from multiple sources to establish an extremely large database of nutritional information.

Descriptions of the proposed system

The proposed system will be a mobile application that will be available in both iOS and Android operating systems, whose function is to scan pictures of foods and then display accurate estimates of the food's nutritional value. It does so by extrapolating the non-visible portion's amount of food based on the visible portion's volume and density. The user will be able to either take photos with their mobile device's camera or choose a photo that already exists on the device. After selecting an image, the user will be given chances to confirm whether the photo is the one they want to use, as well as whether the estimates of food amounts are correct. If so, the system will analyze the combined nutritional value of the ingredients that have been scanned and present a report.

The report will feature varying amounts of information based on the subscription plan that the user is under. Should they be a regular user, the system will only present basic nutritional information such as caloric content. If they are subscribed to a more premium option, they will have the ability to take a look at macronutrient and micronutrient distributions, as well as daily consumption percentages of these nutrients.



Above are some basic mock-ups of what the UI could potentially look like for a premium user should they generate a report. Basic plan users will see a more simplified report that will only display distribution of ingredients and number of calories.

User classes and other involved personnel

- Basic user: will be given barebones functionality, allowing for food visual detection and a general report to be generated, which will only show the number of calories and amount of each ingredient.
- Premium user: will have more advanced functionality when compared to the basic user. In addition to all the functionality that a basic user has, being a premium user will also allow for complex reports to be generated which will display detailed distribution of macronutrients and micronutrients. Additionally, they will be able to save these reports locally for later use.
- Developer/Administrator: will have the ability to access the backend implementation of the system and make changes to the application. Basic developers will only be able to make developmental changes to the application, whereas administrative users will have the ability to modify user account information and account type. Both developers and administrators will also be able to access a testing environment to make changes before these are shown to users on the live deployment environment.
- Tester: will use a separate, testing environment to analyze bugs or pending changes. They will not have access to user account information.
- Database support: will be given access to user submitted food reports in order to filter through inaccurate submissions that may negatively affect the AI's performance. They will also be given access to the database's entries so they may either add new validated data or remove erroneous data.

Support environment

The system will be supported by the development team to fix bugs, increase performance, and add additional features later in the deployment cycle. Additionally, the system will have a dedicated support team that will develop a system to either manually or automatically analyze the validity of user submitted food nutritional information and add said information to the database if it is not already existing, and the information is accurate. They will also be responsible for removing invalid entries should users submit reports on an entry.

5.2. Operational scenarios

1. Enter new meal:
    1.1. Start condition: The user must be registered and signed in to their account and then select the ‘enter new meal prompt’ to trigger this process
    1.2. Branch conditions: If the user selects the ‘cancel’ prompt, they will be sent back to the home screen. If the user selects take photo (5), they will have the option to take a photo from their mobile phone of the food item.
    1.3. End condition: After entering the meal name and photo, a report will be generated (4).
2. Take photo:
    2.1. Start condition: Following from (1.1) the user must then select the ‘take photo’ prompt after they have entered the meal name.
    2.2. Branch conditions: If the user selects the ‘retake photo’ prompt, this process will be repeated from the start.
    2.3. End condition: After the user confirms that they are satisfied with the photo they took, this process will end.

3. Store photo:
    3.1. Start condition: Following from termination of (2), this process will then be triggered.
    3.2. End condition: After (2.3) a loading icon will appear which indicates processing and storage of the user’s selected photo. After the loading icon disappears, the process is completed.
4. Generate report:
    4.1. Start condition: Following from termination of (3), this process will then be triggered.
    4.2. Branch condition: The user can select the ‘retake photo’ prompt again to return to (2) if they wish.
    4.3. End condition: After the user selects the ‘generate report’ prompt, a message will appear indicating that report was generated and then the process will end.

5. Display report:
    5.1. Start condition: The user must be logged in and either select the ‘view previous reports’ prompt or just finished generating a new report following (4) to trigger this process.
    5.2. End condition: Once the start condition is met, the report is displayed to the user and the process is finished.
6. Analyze ingredients:
    6.1. Start condition: Following termination of (5), this process will be triggered if the user selects the ‘view ingredients’ prompt.
    6.2. End condition: Once the start condition is met, the detailed report is displayed to the user and the process is finished.

5.3. Acquisition concept

The system acquisition will begin with the hiring of a development team, who will work alongside the business team to determine specifics of the requirements. This will be followed by interviews with relevant stakeholders about the vision of the system to further narrow down the specifications. Digital Health Inc. will have a major part in this preliminary discussion, and the software will begin development once agreements have been made.

The software system will feature a robust AI image processing module that can accurately determine weight and density of various ingredients based on an image provided by the user. This will then be translated through real-time conversion to a report that contains nutritional information such as caloric content and macro and micronutrient specifics. The information on individual ingredients will be stored using Amazon Cloud Services to line up with Digital Health Inc.’s pre-existing infrastructure.

Prototypes will be unveiled to Digital Health Inc. in regular intervals to ensure the product is being developed in accordance with the requirement specifications.

5.4. Deployment concept

The system will be deployed once all major development has been completed to the satisfaction of major stakeholders and will be released on both Android and Apple iOS platforms through the Google Play Store and Apple App Store, respectively. Varying subscription models will be offered to users that will provide varying levels of speed and functionality. Users will be able to use the application for free but will be offered the option to upgrade their plan to have access to more detailed reports and the ability to save reports locally.

5.5. Support concept

The system will be supported after deployment by constant updates to further improve functionality and fix bugs. This will require further development and testing work to be done. Additionally, user submissions may need to be scanned for correctness before it is added to the image recognition database, so a team will need to be assembled to ensure the database is using accurate nutrition and volume measurements. They will be responsible for reviewing user submissions and reports and adding or removing database entries respectively as necessary.

5.6. Retirement concept

When the system is retired, any user information that is unrelated to user submissions will be safely deleted to avoid the leak of any sensitive information. This will include payment methods, emails, passwords, and other personal data. The database of food nutritional information may be compiled and sold for commercial use to other companies after the retirement of the application.

6. Project constraints

Time and cost constraints are present for this project. Deadlines will be established at the beginning of the project development phase once requirements and a timeline have been established. Deliverables will be presented to stakeholders at the end of each phase’s

deadline for review, and changes will be made according to feedback for review in the next iteration deadline. This is closely linked to the cost constraints of the project, as the size of the development team will be proportional to the budget given to the development team after initial planning.

A major functional constraint that this project will face is the visual detection of foods. To have an effective detection system, robust image processing and machine learning modules must be developed so that the application is able to find distinct foods, and correctly identify their volume and weight based on an AI that is trained on existing databases as well as user submissions. Should development of the image processing and detection module not go smoothly, it is unlikely that the project as a whole will be able to be completed within cost and schedule.

7. Appendix

7.1. Acronyms and abbreviations

- StRS: Stakeholder Requirements Specification
- UI: User Interface
- AI: Artificial Intelligence
- RDA: Recommended Dietary Allowance