REVOLUTIONIZING REMOTE HEALTH MONITORING: AUTONOMOUS DETECTION OF CARDIAC ABNORMALITIES WITH CUSTOMIZED DIETARY PLANNING

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REMOTE HEALTH MONITORING: A REVOLUTIONARY SOFTWARE FOR AUTONOMOUS DETECTION OF PULMONARY AND CARDIAC ABNORMALITIES

Final Report

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DECLARATION

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ABSTRACT

This research components targets provide a customized dietary advice to its users considering factors such as Age, gender, Body Mass index, heart condition, blood glucose level and blood cholesterol level. The system leverages a dataset, curated in collaboration with professional dietitians, which encompasses 291 possible combinations to deliver highly customized dietary recommendations. WS Textract to extract text from tabular medical reports, enabling the analysis of the patient's medical condition and the extraction of critical data such as blood glucose and cholesterol levels. This information is integrated into the dietary recommendation process. An added feature of the system includes the ability to scan and analyze patients' medication prescriptions using the GPT-4 API, which facilitates setting up automated reminders for pill intake.

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LIST OF ABBREVIATIONS

Abbreviation	Description
ECG	Electrocardiogram
NCD	Non-Communicable diseases
GDP	Gross Domestic Production
US	United States
BMI	Body Mass Index
AI	Artificial Intelligence
SDK	Software Development Kit
OCR	Optical Character Recognition
AWS	Amazon Web Services
ML	Machine Learning
API	Application Programming Interface

1. INTRODUCTION

Maintaining a healthy lifestyle is nearly impossible due to intensely scheduled lifestyles that many people lead. Despite this, the rapid increase in mortality due to non-communicable diseases has made health an important critical component in daily life. As technology continues to evolve, specifically in the fitness segment, a significant portion of the younger population demonstrate their interests in wearable devices and other associated health apps to manage and improve their well-being. However, the effectiveness of these modern strategies in truly promoting a healthy lifestyle remains a topic to debate.

Diet cannot be treated as one size fit for all components of health. It is a inconsistent element which depends on factors such as activity level, age, physiological status and gender. Many health and diet plan applications tend to provide premade diet menu promising individuals to achieve their targeted health goal. However, a critical question arises, do these proposed menus accurately align the calories burned by an individual with the calories they are instructed to consume?

According to the Sri Lanka Nutrition Division of the Ministry of Health, the recommended daily caloric intake ranges from 1,600 kcal for a sedentary woman to 2,600 kcal for a very active man, with specific serving sizes defined for individual consumption. However, these general guidelines may not suffice for everyone. For instance, a pregnant woman may require more calories than an average woman, a young growing girl may need specific nutrients that differ from others, and an elderly person may require a different set of nutrients, such as multivitamins. This discrepancy between generic diet plans and individual needs raises concerns about the effectiveness of such dietary recommendations.

The need for such a solution arises from the limitations of current dietary approaches, which often overlook the diverse factors that influence nutrition. Many existing strategies fail to account for critical variables such as age, gender, body composition, metabolic needs, and underlying health conditions. As a result, individuals may find themselves making dietary choices that fall short of supporting their health goals.

Our proposed system seeks to overcome these challenges by harnessing technology to gather and analyze a comprehensive range of health metrics, which include demographic data (such as age and gender), anthropometric measurements (including weight and height), and physiological indicators (like glucose and cholesterol levels). Based on these metrics the system provides personalized dietary advice, guiding individuals on how to plan their diet effectively.

Additionally, the software will feature a convenient medicine reminder function, allowing users to upload a photo of their prescription for easy tracking. This feature, along with the ability to analyze patients' medical reports and scan medicine prescriptions, will help reduce the need for frequent doctor visits for minor issues.

By offering personalized dietary advice based on a holistic view of an individual's health, this innovative software solution aims to empower users to make informed choices and ultimately achieve their wellness objectives.

1.1 Background & Literature Survey

Consuming a healthy diet throughout the life-course helps to prevent malnutrition in all its forms as well as a range of noncommunicable diseases (NCDs) and conditions. However, increased production of processed foods, rapid urbanization and changing lifestyles have led to a shift in dietary patterns. People are now consuming more foods high in energy, fats, free sugars and salt/sodium, and many people do not eat enough fruit, vegetables, and other dietary fiber such as whole grains [1].

The increasing focus on health in the modern era has led to a growing trend of individuals seeking to improve their dietary habits. This often involves adopting healthier practices like reducing sugar and fat intake or increasing physical activity. However, adhering to rigid, unguided dietary changes can be detrimental to an individual's well-being. For instance, while reducing sugar consumption is generally beneficial, eliminating it can disrupt metabolic processes. Therefore, individualized, and well-informed approaches to healthy eating are crucial [2].

According to the food based dietary guidelines provided by nutrition division ministry of health Sri Lanaka recommended calorie intake that a person should consume depends on the activity level, age, physiological status and gender of the person. Further studies have proved that an individual attempting a healthy weight loss should have flexibility in choosing the plan that fits their personal preferences [3].

The current landscape of dietary solutions is fraught with its own limitations, particularly when it comes to accessibility and customization. Consulting with a diet expert is often prohibitive expensive, which places personalized nutritional guidelines out of reach for many. Compounding this issue is the increasingly hectic lifestyles that many people drive today, leaving adequate time for frequent visits to health professionals for something perceived as minor, like creating a personalized diet plan. As a result, many individuals turn to commercially available diet applications that offer appealing user interfaces, exercise tutorials and premade diet plans. However, the accuracy and effectiveness of these solutions are highly questionable.

Most off the shelf diet applications which is available fail to consider critical variables such as an individuals calorie intake, body composition, health conditions, age, gender and daily calorie expenditure. Without these personalized inputs, the dietary recommendations provided by these apps are often generic and can lead to suboptimal, or even harmful dietary practices. For instance, a diet plan that does not account for a person's specific metabolic needs or underlying health conditions may inadvertently promote an imbalanced diet, potentially leading to nutrient deficiencies or other health issues.

Moreover, the existing dietary applications like Noom and MyFitnessPal have shown some success in weight loss for certain users, they often rely on calorie counting and basic activity tracking which may not be suitable for everyone, specially for individuals who are undergoing specific health requirements. A study conducted by Mauro Lambardo et al investigated the interplay between body composition, dietary patterns and physical activity across genders focusing on the gender specific differences in food preferences and eating behaviors concluded highlighting the limitation of one-size-fits-all approaches and suggest the value of more tailored recommendations considering combined contribution of gender and body composition [4].

The combination of the Keto diet with intermittent fasting, despite its rising popularity, is particularly concerning. This dietary approach lacks robust long-term evidence and may pose risks, especially for individuals with underlying health conditions such as diabetes. Potential adverse effects include elevated LDL cholesterol and an increased risk of kidney stones, which are particularly concerning when these diets are not tailored to the individual's specific health conditions [5].

The ideal diet application should be capable of integrating comprehensive data—beyond just calorie intake—to include more sophisticated metrics such as body composition, metabolic health, and lifestyle factors. This would allow for more accurate and personalized dietary recommendations. However, most existing diet apps fall short in this regard, often leading users towards unhealthy dietary practices due to the lack of individualized data integration.

Table 1- Modern diet applications and their limitations

Diet Application	**Key Features**	**Limitations**
MyFitnessPal	Calorie tracking exercise logging large food database	Relies heavily on user input, potential inaccuracies in calorie estimation, lacks personalized advice tailored to metabolic health or specific dietary needs
Noom	Behavioral change focus, psychology-driven weight loss	Expensive, limited integration of detailed biometric data, generic recommendations may not suit specific health conditions.
WW (Weight Watchers)	Point-based system, group support	Points system can oversimplify nutrition, expensive subscription, may not account for individual metabolic differences
Lose It!	Simple interface, barcode scanner for food tracking	Limited in-depth nutritional guidance, primarily focused on calorie counting, does not consider metabolic health or individual conditions

Keto Diet App	Focus on low-carb, high-fat diets, macronutrient tracking	Lacks long-term evidence for safety, may increase LDL cholesterol, risk of kidney stones, not suitable for individuals with certain health conditions like diabetes

The limitations of existing dietary applications necessitate a shift towards more personalized and data-driven approaches. By addressing these concerns and leveraging advancements in technology, we can develop effective and evidence-based tools that empower individuals to make informed dietary choices and achieve their health and wellness goals. A more personalized approach to diet and nutrition could help mitigate the risks associated with generic diet applications, leading to better health outcomes and more sustainable dietary practices

1.2 Research Gap

The landscape of fitness applications has seen significant growth improving their products adapting to the modern technology, with many platforms offering exercise tutorials and diet plans aimed at helping users achieve their fitness goals and maintain a healthy lifestyle. However, a notable gap exists in these applications' approach to dietary guidance. Most fitness apps currently available in the market focus on providing predefined diet plans that do not account for the individual's unique physiological characteristics or ongoing health metrics. These static diet plans fail to adapt to the dynamic nature of human metabolism and health, which vary significantly based on factors such as age, gender, BMI, heart condition, blood glucose levels, and cholesterol levels.

Predefined diet plans can often lead to suboptimal health outcomes because they do not consider the user's real-time health data. These plans typically ignore critical metrics such as blood glucose and cholesterol levels, which are vital for creating personalized dietary recommendations [6]. Furthermore, studies have shown that diet plans that do not adapt to individual health conditions, such as heart disease or diabetes, can sometimes exacerbate these conditions rather than help manage them [7].

The proposed solution addresses this gap by offering customized dietary advice rather than a one-size-fits-all diet plan. This dietary advice is tailored based on the user's age, gender, BMI, heart condition, blood glucose levels, and cholesterol levels. Unlike existing applications, which generally require extensive user input and still fail to provide truly personalized advice, the proposed solution minimizes user input to essential factors such as age, gender, height, and weight. More critical health indicators, such as blood glucose and cholesterol levels, are obtained through scanning the patient's medical reports, and heart conditions are assessed through ECG readings.

Studies by Thomas et al. and Johnston et al. suggest that personalized dietary recommendations that consider a range of health metrics are more effective in promoting long-term health and preventing chronic diseases [8-9]. For instance, the inclusion of blood glucose levels in dietary advice is crucial for individuals at risk of or managing diabetes, as highlighted by the research of Evert et al [10]. Similarly, tailoring dietary recommendations based on cholesterol levels can help in managing cardiovascular risk, as supported by the findings of Lichtenstein et al [11].

The proposed solution thus fills a significant gap in the current market by moving beyond static diet plans. It provides dynamic, evidence-based dietary advice that is closely aligned with the user's current health status. This approach not only enhances the relevance and effectiveness of the dietary advice provided but also aligns with the latest research advocating for personalized nutrition. This solution's focus on integrating multiple health indicators into a cohesive dietary advice model is in line with the growing recognition in the scientific community that effective dietary interventions must be tailored to the individual's specific health needs [12].

Table 2: Summary of Research Gaps

Current Approaches	**Identified Research Gaps**	**Proposed Solution**
Static Diet Plans	Do not account for real-time health data and individual variability	Provide dynamic dietary advice based on personalized health metrics
Limited Health Metrics Consideration	Ignore critical factors like blood glucose, cholesterol levels, and heart condition	Include age, gender, BMI, heart condition, blood glucose, and cholesterol levels
Extensive User Input Required	Requires user to input a large amount of data manually	Minimize user input by automating data collection through medical reports and ECG
Lack of Real-Time Adaptability	Static plans fail to adapt to changes in the user's health status	Continuous updating of dietary advice as health metrics change

While existing fitness applications offer general diet plans that may not cater to individual health needs, the proposed solution fills this gap by providing tailored dietary advice based on a thorough consideration of various health metrics. This innovation in dietary recommendation stands on the cutting edge of personalized nutrition, making it a potentially more effective tool for users seeking to manage their health through diet. By addressing the gaps identified in current approaches, the proposed solution enhances the relevance, personalization, and effectiveness of dietary advice in fitness applications.

1.3 Research Problem

Eating and Food provides a crucial impact when it comes to a person`s health. Even thinking about food and longing for food plays a key role in our lives with people making more than 200 food decisions daily [13]. During the modern era, most people have come to state that eating is essential for survival and consume that is only required for it. A person's food consumption has an impact from external factors such cultural behaviors, geographical variations, and various personal targets.

However, food is not the only source of pleasure and enjoyment of manhood today. But due to its rapid increase in concern because of its substantial consequences of ill health. The growing epidemic of overweight resulting from obesogenic environment with plenty of cheap high caloric non hygienic food available at any plenty of time had made a vital importance as to why we food should be a key concern [14]. A substantial proportion of the world population, which includes both children and adolescents, are at the risk of being overweight with consequences in terms of increased risk of chronic illness [15]. The overweight epidemic has spurred research into the health consequences of overeating and overweight, and information about this has found its way to the public that now tends to associate eating with health, especially in the US.[14]

When it comes to food intake analysis of Asian region both overweight and underweight aspects need to be considered. Specially in countries like Sri Lanka the malnutrition rate increased to 15.3 per cent in 2022 from 12.2 per cent in 2021 [18]. Key major factors that cause unhealthy food intake patterns in Asian countries are mainly because of its demographical and socio-economic factors of nutrition transition. In Sri Lanka the income level, female labor force participation rate, urbanization and prevalence of processed food coupled with low quality cheap unhealthy fruits and vegetables available in market are in favor of a nutrition transition [16]. During the 1963 to 2016 period, there has been a marked increase in the income levels of people. Per capita GDP has increased from 147 US$ to 3,835 US$. More women have entered the workforce (the female labor force participation rate has improved from 14.2% to 35.9%) [17].

Food Category	1961	1970	1980	1990	2000	2010	2011	2012	2013
Alcoholic beverages	1.18	1.06	1.03	0.84	1.96	3.64	5.17	6.75	6.51
Sugar crops	7.90	5.46	7.95	17.01	25.31	29.52	18.93	16.88	30.10
Cereals	121.44	139.43	129.5	140.84	137.18	148.08	149.83	152.35	152.26
Eggs	0.92	1.40	1.86	2.45	2.38	2.61	2.72	2.75	4.57
Vegetables	19.70	16.44	25.72	31.28	32.83	38.46	40.34	41.59	46.24
Milk	17.49	20.9	27.72	28.22	32.61	36.07	40.61	39.98	34.98
Pulses	7.17	5.91	4.01	4.88	6.92	8.94	10.03	8.02	9.29
Vegetable oil	3.23	3.94	3.92	2.80	2.66	2.98	2.87	3.46	3.17
Animal fats	0.45	0.37	0.21	0.25	0.24	0.13	0.13	0.13	0.13
Fish	16.43	14.11	14.71	15.16	22.34	24.14	26.08	25.86	25.65
Fruits	38.40	38.21	121.48	37.16	39.54	35.15	36.70	36.61	36.15
Meat	3.97	4.46	3.53	3.17	5.38	6.60	6.34	6.45	6.48
Oil crops	67.07	76.52	67.31	66.67	66.9	63.87	66.95	70.43	72.44
Spices	5.15	3.62	3.25	2.53	3.65	4.65	5.21	4.72	4.61
Starchy roots	30.73	26.27	32.38	22.07	19.03	18.11	19.13	18.52	19.87
Sugar (raw equivalent)	17.60	24.65	17.29	18.47	30.68	28.49	27.03	26.71	26.34

Figure 1: Changes in Food Supply in Sri Lanka by selected years (kg/capita/year)

Source: [16]

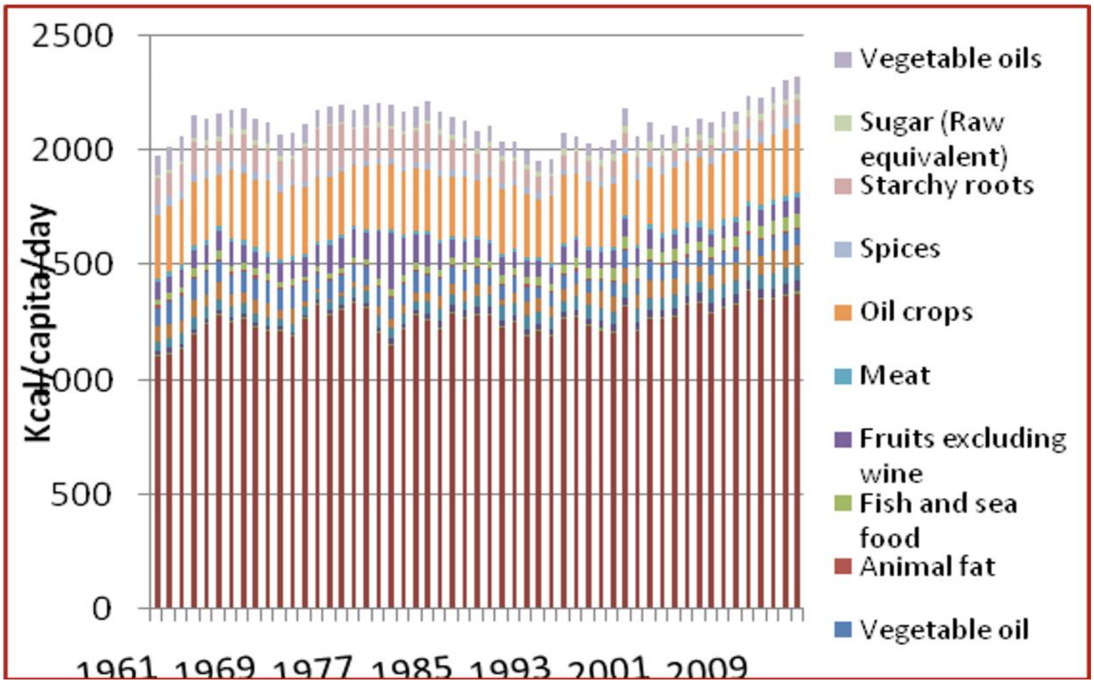

Figure 2: Changes in Total Energy Supply (Kcal/capita/day) from selected aggregated food items.

Source: [16]

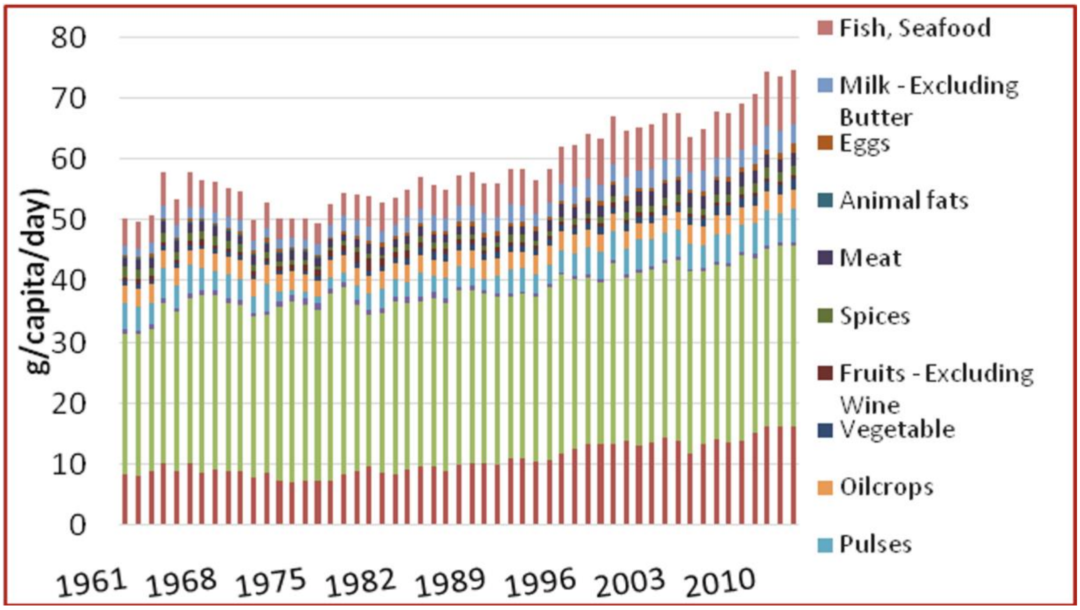

Figure 3: Changes in Protein Supply (g/capita/day) from selected aggregated food items.

Source: [16]

The above images represent the consumption patterns of the citizens in Sri Lanka, due to its economic and social status with the competitive and hectic human lifestyle in modern era.

With the rapid growth of non-communicable diseases and interest in maintaining healthy diet, a variety of dietary plans are followed by people to battle the impacts triggered by the ill effects caused by harmful consumption. Out of all the methodologies followed many tend to use mobile apps which guide them to consume healthy diet by suggesting food items matching to the persons demographics entered such as age, height, weight, and gender. The main limitation behind these approaches is its inefficiency in proposing an accurate diet plan matching the person's physiological factors such as pulse rate, Spo2, blood glucose level, cholesterol level and ECG readings. Due to this reason, there is a tendency that a person who consumes a proposed diet plan from an application which only focuses on demographic data leads to surge in non-communicable disease even when they believe they consume healthy diet. This provides the importance of building an application which could predict a personalized diet plan to people considering not just demographic data (age, gender) and anthropometric data (weight, height) but also physiological data (SpO2, glucose, cholesterol levels), and additional data points (potentially ECG readings and pulse rate).

The significance of personalized dietary advice cannot be overstated. Proper diet recommendations should be tailored to an individual's special needs, considering factors such as age, gender, BMI, heart condition, blood cholesterol condition and blood glucose conditions. A personalized nutrition plan will ensure that a person intake the necessary nutrition to maintain their health while avoiding practices that could lead to detrimental outcomes.

For an instance a person with high cholesterol may need to consume a diet with low saturated fats and high in fiber, whereas someone with low blood glucose may need to consume a diet rich in complex carbohydrates to maintain stable glucose levels. Similarly, age and gender play a significant role in determining nutritional needs, as metabolic rates, hormonal changes and the risk of certain diseases vary across different demographics. Most diet plan apps which are available overlook these critical factors leading to the persistence of unhealthy practices.

Moreover, a personalized diet plan is crucial for managing and preventing chronic conditions such as cardiovascular diseases, diabetes and obesity. These conditions are often influenced by diet and improper dietary practices can exacerbate them. Evidence based individualized nutrition advice can help mitigate these risks by aligning dietary practices with the specific health needs. The growing trend of unhealthy dietary practices highlights the urgent need for personalized diet advice tailored to an individual's unique health profile. Adopting a personalized approach to nutrition can prevent the adverse effects associated with generalized diets and promote long-term health and well-being.

2. OBJECTIVES

2.1 Main Objectives

Provide personalized diet advice for users by considering collection of factors for accurate healthy lifestyle.

2.2 Specific Objectives

1. Collect dataset which contain demographic data (age, gender), anthropometric data (weight, height), physiological data (Glucose, cholesterol levels)
2. Explore how to map the generated diagnosis results with accurate diet advice using suitable analytical learning algorithm.
3. Conduct pilot studies to test the accuracy of the software.
4. Analyze patient medical report and provide its results.
5. Build a mechanism which allows a patient to upload medical prescriptions and set medicine reminders based on the information provided in the prescription.

3. PROJECT REQUIREMENTS

3.1 Functional Requirements

1. Predict accurate dietary advice matching the person's diagnosis.
2. Store user demographics such as age, gender, weight, and height effectively.
3. Build a user-friendly mobile application which has smooth navigation and high usability.
4. Ensure personal details of users are secure.
5. Users should be allowed to upload and analyze medical reports to extract data from personalized dietary advice.
6. Users should be allowed to upload medicine prescriptions and set up pill reminders automatically.
7. Users should have the flexibility to set up medicine reminders manually.

3.2 Non-functional Requirements

1. Performance - Responsive and fast loading, even on various devices and internet speeds.
2. Scalability - Ability to handle a growing user base without compromising performance.
3. Usability - Intuitive and easy to navigate for users with varying technological expertise.
4. Availability - Highly available with minimal downtime to ensure user access.
5. Maintainability - Well-documented and easy to maintain and update.

3.3 System Requirements

1. The mobile application is expected to be built using flutter technology. Therefore, the machine learning libraries should support flutter farmwork, the mobile devices used by the user should have minimum SDK version 21 to 34 in android.
2. Reliable network connection, for seamless data creation, retrieval, update and deleting.

3.4 User Requirements

1. Users should be able to capture access to the internet connection to their devices.
2. Users need to have a smart watch.
3. Users are expected to have a basic technical literacy on how to use a smart phone and a smartphone.
4. Willingness to provide accurate data.

3.5 Use Case Diagram

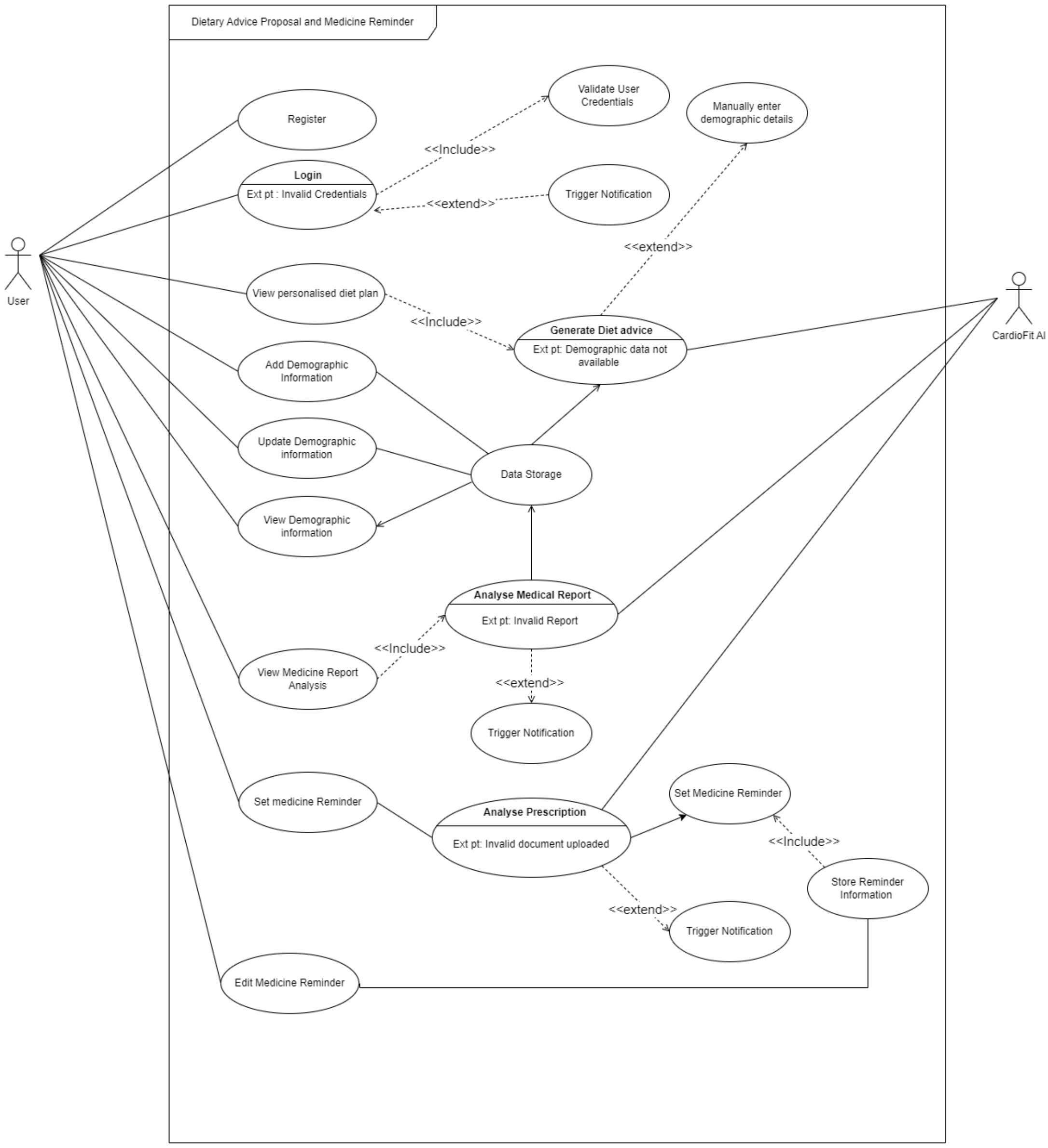

Figure 4: Use Case Diagram for personalized Dietary plan component.

Figure 4 denotes the Use case diagram for personalized dietary plan component which represents the interaction between a user and the "CardioFit AI" system, which is designed to offer dietary advice and manage medicine reminders. The diagram outlines how a user engages with the system through various functionalities, highlighting the steps involved in registration, login, and accessing personalized services.

The system begins with basic user management features where a user must either registrar or login. During registration, the system ensures that user credentials are validated to maintain security. Upon logging in, the user may view or update their demographic information, which includes vital details like age, gender, height, and weight. This demographic data is important as it serves as the foundation for generating personalized diet advice tailored to the user's specific needs.

A key feature of the system is its ability to produce dietary advice based on the collected demographic and health data. The system processes this information and, if required data is missing, prompts the user to input the necessary details. The generated diet advice is then presented to the user, providing them with a personalized advice aimed at improving or maintaining their health.

The system includes a medical report analysis function, where users can upload their medical reports, such as blood test results. The system analyzes these reports using advanced algorithms and OCR Technology, extracting critical health metrics like glucose and cholesterol levels. The results of this analysis are stored within the user's profile and can be viewed at any time. In cases where the report is invalid or unreadable, the system triggers a notification to inform the user of the issue.

Additionally, the system supports prescription analysis allowing users to upload images of their medication prescriptions. The system reads and extracts the necessary information, such as medication names, dosages, and schedules, which are then used to set up automated medicine reminders. These reminders are crucial in ensuring that users adhere to their medication regimens, thereby improving treatment outcomes. Users have the flexibility to edit these reminders, adapting to changes in their medication schedule.

This comprehensive system architecture facilitates a seamless user experience, allowing individuals to effectively manage their health through personalized dietary advice and precise medication management, all within a user-friendly interface.

3.6 Test Cases

Table 3: Test Cases

Id	Name	Scenario	Expected Output
1.	User Login Test	Enter invalid credentials and login to the system	The system should trigger an error message
2.	New User sign up Test	Enter credentials of an existing user and click sign in	The system should trigger an error message, "Stating that the user already found"
3.	Sign up form Validation test	Enter incorrect email format and numbers in the name field	System should show inline validations and should not allow the user to submit the sign-up form.
4.	Check Form Validations in demographic data enter form	Enter inappropriate values in the text input fields like type a word in the age field where numbers are expected	The system should trigger error messages and should not allow the use to submit the demographic data
5.	Generate diet plan when demographic data not entered	If the user request to generate a diet plan when demographic data are blank	Notify the user with a warning message stating that the generated diet plan may not be accurate due to lack of demographic data.

3.7 Wireframes

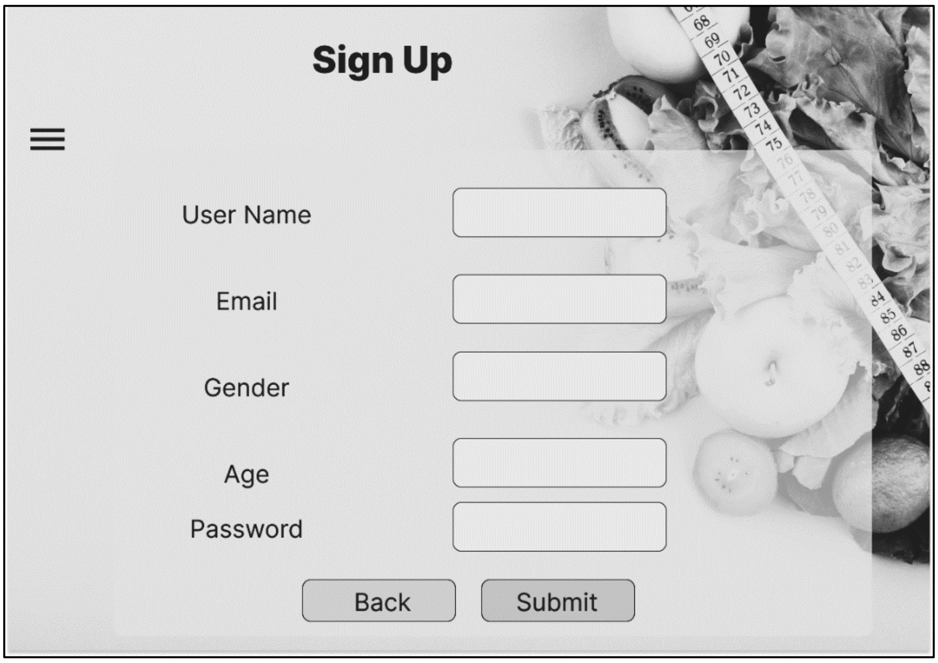

Figure 5: High Fidelity Wireframe - Sign up page.

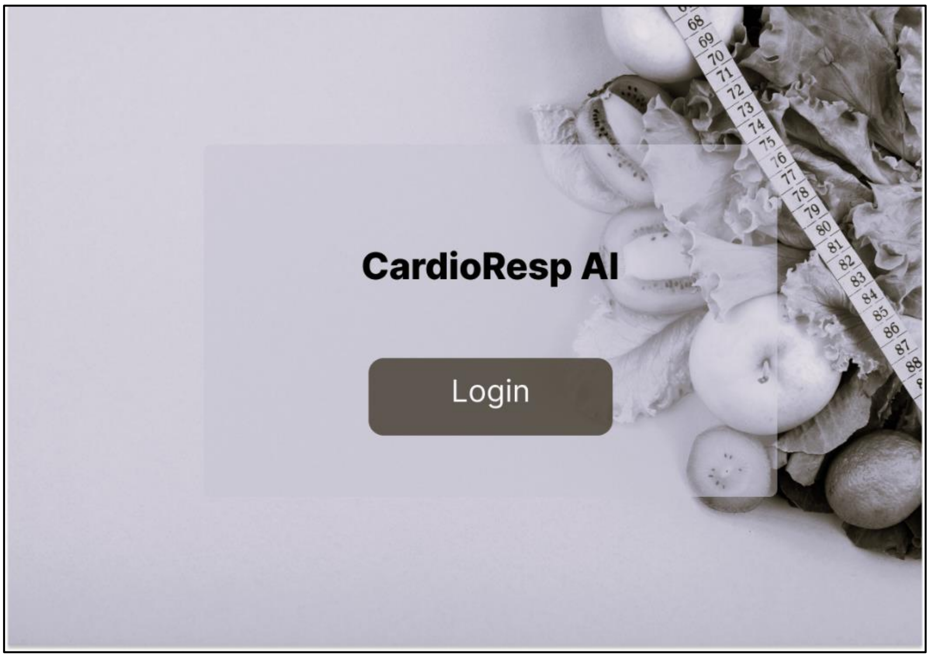

Figure 6: High Fidelity Wireframe - Login Screen

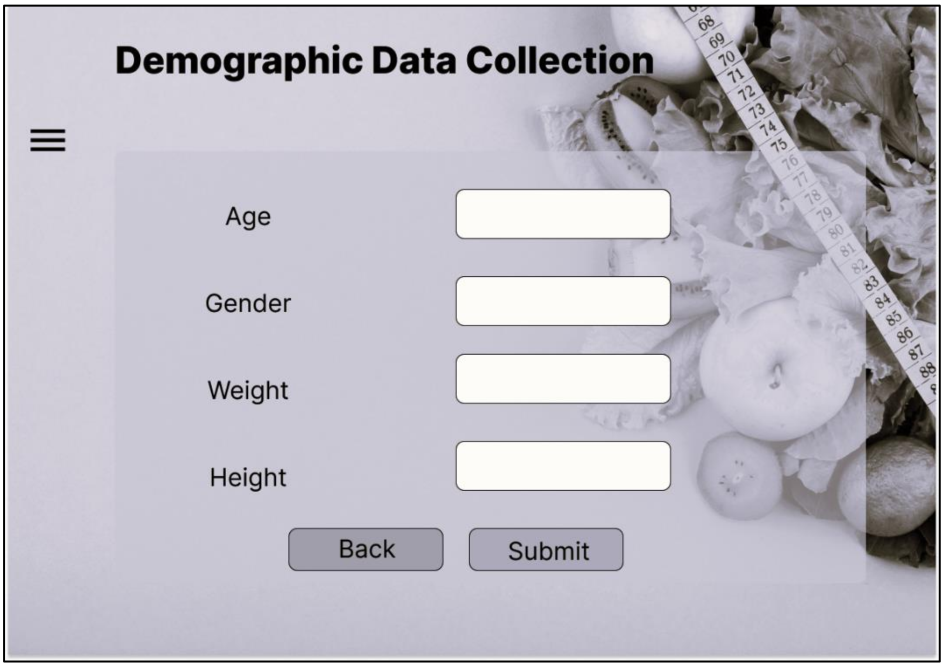

Figure 7: High Fidelity Wireframe - Collecting Demographic Data

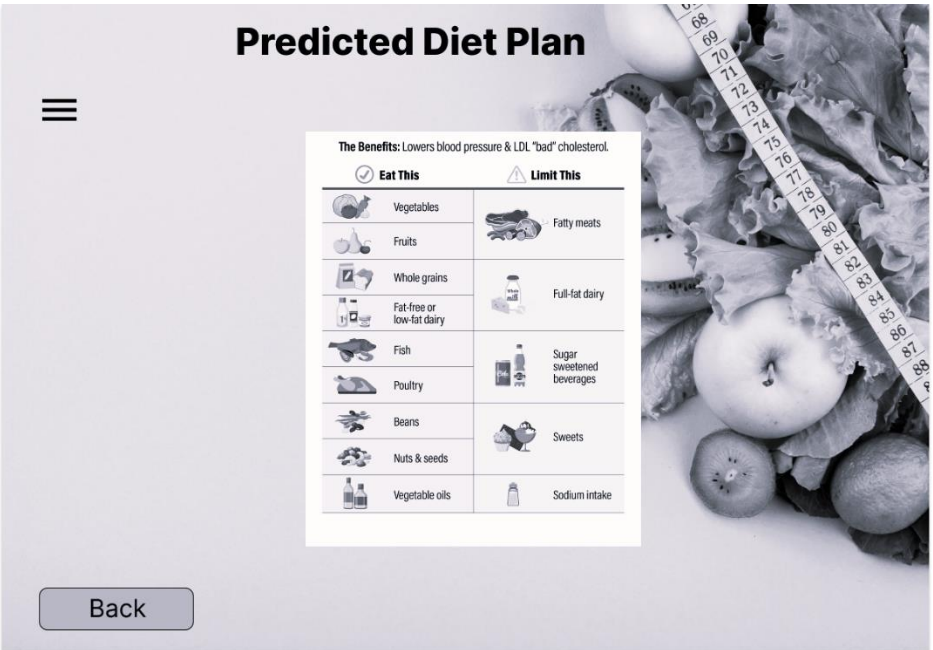

Figure 8 : High Fidelity Wireframe - Proposed Diet Plan

Figure 9 : High Fidelity Wireframe - Diet Progress Report

4. METHODOLOGY

The success of developing a reliable and effective dietary advice system hinge on a thorough and systematic approach to requirement gathering. This process is crucial as it forms the foundation for creating a robust dataset that can deliver personalized dietary recommendations.

4.1 Requirement Gathering

The initial phrase of the project was focused on gathering the comprehensive requirements necessary for developing an accurate and effective dietary advice system. The requirement gathering process involved the following steps,

1. Expert consultations: To ensure that the dietary advice system is grounded in expert knowledge, consultations were held with several experts in the domain. I engaged with experienced nutritionists and dietitians who provided valuable insights into the factors that must be considered when creating personalized recommendations. It was with their guidance and advice that a dietary advice section was selected instead of following the tradition of proposing a diet plan.

2. Collaboration with Colombo Research Institute: The initial milestone of the requirement gathering originated at the nutrition department of Colombo Research Institute. This collaboration was instrumental in understanding the scientific and clinical aspects of the nutrition domain that are crucial for developing a credible dietary advice system. The nutritionists at the department provided the latest research trends, nutrition requirements that a healthy person must consume, the right quantity of food that needs to be consumed and steps on how a diet should be prepared.

3. Diet dataset preparation: To further refine the requirements, I collaborated with dietitians at Hemas hospital Wattala. This conjunction helped me in gathering practical insights from a clinical setting, ensuring that dataset is relevant and applicable to real world scenarios. The domain expertise of the dietitian was valuable in understanding and preparation of the dataset matching the scenarios chosen.

4.2 Dataset Development

Based on the requirement gathering and insights collected a comprehensive dataset was developed. The dataset was designed to incorporate critical and important factors that influence dietary needs and recommendations. The factors considered are as follows,

1. Age: Different age groups have different nutritional requirements. Therefore, it is important to consider age as a factor when providing dietary advice. For the ease of dataset creation age is classified for three categories as,
   a. Age 01 - Age 19
   b. Age 20 – Age 64
   c. Age 64+

2. Gender: Gender differentiates in nutritional and metabolism, thereby it is considered as an important factor.

3. Body Mass Index (BMI): BMI is a key indicator of an individual's health status and was included to provide recommendations that align with an individual's weight category. People are grouped into four categories considering the BMI obtained,

Table 4: BMI Categorization

BMI	Category
BMI less than 18.5 kg/m^2	Underweight
BMI >= 18.5 kg/m^2 && BMI < 24.9 kg/m^2	Normal
BMI >= 25.0 kg/m^2 && BMI < 29.9 kg/m^2	Overweight
BMI >=30.0 kg/m^2	Obese

4. Heart Condition: Individuals with existing heart conditions require specialized dietary advice. The dataset includes parameters for tailoring recommendations to support cardiovascular health.

5. Blood Glucose Levels: Managing blood glucose levels is crucial for individuals with diabetes or prediabetes. The dataset includes guidelines for diets that help maintain stable glucose levels.

6. Blood Cholesterol Levels: The dataset also considers cholesterol management, providing dietary advice that supports healthy cholesterol levels and reduces the risk of cardiovascular disease.

4.3 Method of obtaining the essential factors

To provide effective dietary advice the following methods were employed to obtain the necessary factors,

Table 5: Method of obtaining essential factors

Factor	**Method**	**Description**
Age	User input	Obtained by asking the users to enter their age in their user profile, which is then categorized into relevant categories when proposing the dietary advice
Gender	User input	Gender information is obtained through user inputs, allowing the system to provide dietary recommendations in a customized manner.
Height	User input	Obtained by asking the users to enter their height in their user profile, which is then used for BMI calculation. Height is obtained in centimeters (cm).
Weight	User input	Obtained by asking the users to enter their height in their user profile, which is then used for BMI calculation. Weight is obtained in kilogram (kg).
BMI	System calculation	When the user enters the height and weight the BMI of the person is calculated based on the following equation, $$BMI = \frac{Weight\ (kg)}{Height\ (m)^2}$$
Heart condition	ECG reading analysis	The heart condition is derived from ECG (Electrocardiogram) analysis. If any cardiac arrhythmia (irregular heartbeat) is

		detected in the ECG readings, the system records this condition as a Boolean value, “Yes” if arrhythmia is present, and “No” if no arrhythmia is observed. This information is crucial for tailoring dietary advice to support cardiovascular health, particularly in individuals with identified cardiac conditions.
Blood glucose condition	Medical report analysis	Blood glucose levels are obtained from the analysis of medical reports. This data is critical for creating dietary recommendations for individuals with diabetes or those at risk of developing diabetes.
Blood cholesterol condition	Medical report analysis	Obtained from the analysis of medical reports. This data is critical for creating dietary recommendations for individuals with diabetes or those at risk of developing cholesterol.

BMI Calculation

To calculate the Body Mass Index, it is necessary to convert the user's height from centimeters to meters before applying the BMI formula. The user inputs their height in centimeters (cm) and weight in kilograms (kg), and the system performs the necessary conversion and calculation to provide the BMI value in kilograms per square meter (kg/m^2).

```
//Function to calculate BMI
void calculateBMI(String weight, String height) {
  if (weight != "" && height != "") {
    double bmi = double.parse(weight) /
        (double.parse(height) / 100 * double.parse(height) / 100);
    double roundedBMI = double.parse((bmi).toStringAsFixed(2));

    _caluclateBMIController.text = roundedBMI.toString();
  } else {
    _caluclateBMIController.text = "";
  }
}
```

Figure 10 : BMI Calculation

As mentioned in the above snapshot since the height provided by the user is initially input in centimeters. This height is then converted to meters by dividing the value by 100, as BMI requires height in meters for accurate calculation. Once the height is converted, the BMI is calculated using the standard formula: BMI = Weight (kg) / Height $(m)^2$. This calculation is performed by parsing the input values, which are initially provided as strings, into double data types to ensure precise mathematical operations.

After the BMI is computed, the result is rounded to two decimal places to enhance clarity and readability. Finally, the calculated BMI value is displayed to the user via the `_calculateBMIController`, with the output being shown only when valid inputs for both weight and height are provided. This process ensures that the BMI calculation is accurate and user-friendly, delivering essential data for subsequent health assessments or dietary recommendations.

Medicine Report Analysis

The medicine report analysis involves a systematic process to extract and analyze data from uploaded medical reports. The process is designed to be efficient, accurate, and user-friendly, ensuring that users can easily upload reports and receive meaningful analyses.

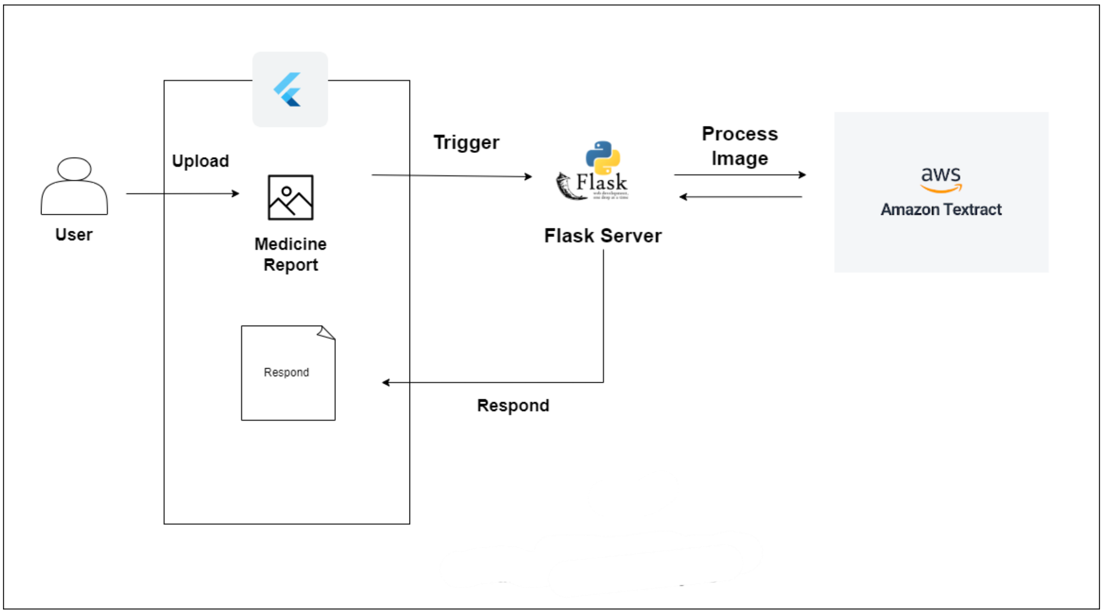

Figure 11: Medical Report Analysis

The following are the steps on how report analysis feature is executed,

1. User Interaction and Report Upload

The process begins with the user interacting with the application through a Flutter-based interface. The user is prompted to upload their medical reports using the app's file picker. The application supports multiple report types, including Fasting Blood Sugar, Urine Full Report, Lipid Profile, and Full Blood Count Report. Once the user selects a report type and uploads the corresponding image file(s), the application prepares the data for analysis.

2. Image Handling and Preprocessing

Upon image upload, the selected images are stored temporarily within the application. The app uses the `ImagePicker` package to facilitate the selection and uploading of images from the user's gallery. The uploaded images are then displayed in a table format within the app, allowing the user to review their selections. If the user decides to remove an image, they can do so easily through the app's interface.

3. Triggering the Analysis Process

After the user has uploaded the necessary reports, they can trigger the analysis process by clicking the "Analyse" button. This action initiates the image processing workflow. The app sends the images to a backend server implemented using Flask, which interfaces with Amazon Textract, a service provided by AWS for document text extraction.

4. Backend Processing and Image Analysis

The Flask server receives the images and processes them using Amazon Textract. Textract analyzes the images, extracting textual data, including medical values such as glucose levels, lipid profiles, and other relevant metrics. The server then structures this extracted data into a JSON format, which is returned to the Flutter app for further processing.

5. Data Parsing and Result Compilation

Once the data is returned to the app, it is parsed and organized into a tabular format. Each report type has specific components, such as "Fasting Blood Sugar," "Cholesterol-Total," "HDL-C," etc., which are matched against the extracted data. The app dynamically generates rows in a data table for each component, displaying the measured values and corresponding units.

6. Diagnosis and User Feedback

Based on the extracted and parsed data, the app performs a comparative analysis to determine potential diagnoses. For instance, if certain glucose or cholesterol levels are detected, the app will classify the results into categories such as "Diabetes Mellitus," "Pre-Diabetes," or "High Cholesterol." The application then updates the user profile with these new data points and provides an overall diagnosis. This diagnosis is presented to the user along with the detailed report data.

7.User Interface and Navigation

The user can navigate back to the report selection screen or proceed to view the analysis results. The interface is designed to be intuitive, with clear prompts and actions, ensuring that users can efficiently manage and review their health data.

Throughout the process, the app ensures that user data is handled securely. All communication with the backend server is encrypted, and sensitive data is stored and processed in compliance with relevant privacy regulations. The app uses secure methods to handle image uploads, API requests, and data storage, ensuring the confidentiality and integrity of user information.

The medicine report analysis methodology is a multi-step process that leverages modern technologies like Flutter, Flask, and Amazon Textract to provide users with insightful health data analysis. By combining a user-friendly interface with powerful backend processing, the application aims to make health data management accessible and meaningful for users.

4.4 Additional System Features

Medicine Prescription Reading and Pill Reminder

This feature is designed to enhance the medication management process by leveraging modern technology. The system simplifies the process of reading prescriptions, setting up medication reminders, and managing alarms, ensuring users can maintain their medication schedules accurately and efficiently.

Prescription Reading

The system incorporates an AI-powered prescription reading feature that allows users to upload an image of their prescription. The uploaded image is processed using a backend service, which extracts relevant information such as medicine names, dosages, frequencies, and durations. This data is then presented to the user, allowing them to review and confirm the details before setting up reminders.

Users can upload a prescription image via device camera or gallery. The uploaded image is analyzed by an GPT 4o service, which extracts key details and presents them in user friendly format. The extracted data is then populated into appropriate fields for setting up reminders. If by any chance the extracted data has any errors, the users have the flexibility to edit the relevant fields.

Additionally, the system provides flexibility to the users to set up their medicine reminders manually as well. Here the users could manually enter the medicine name, dosage, frequency, duration and any additional instructions if there is and set up pill reminders.

Setting up Alarm Reminders

Once the prescription details are confirmed or manually entered, the system sets up reminders using the `Alarm` package. These reminders are crucial in helping users take their medications on time. The system provides an intuitive interface for managing these reminders. Here the users could view, edit or delete their reminders from the list of scheduled alarms. The alarms are displayed with key details like dosage, time and additional notes (if any). Also, the users could enable or disable individual alarms without deleting them allowing for temporary changes in the schedule without looking the reminder settings.

By integrating prescription reading with an advanced pill reminder system, this solution significantly enhances medication adherence, providing a reliable tool for users to manage their health effectively. The combination of AI-driven automation and manual customization ensures that users have full control over their medication schedules, tailored to their specific needs.

4.5 Component Diagram

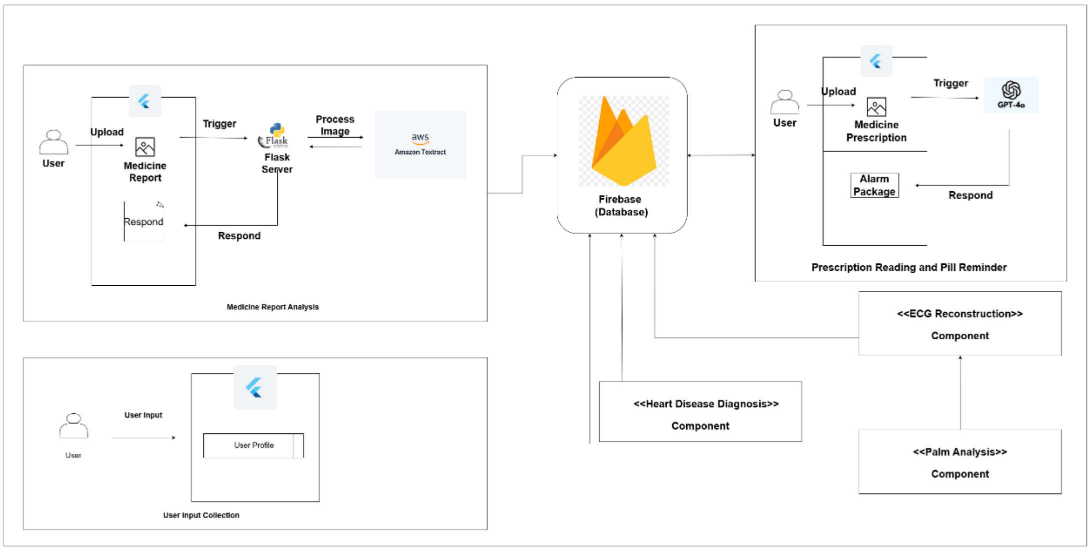

Figure 12: Component Diagram

The above component diagram outlines the architecture of the system designed for analyzing medical reports, reading prescriptions, managing medication reminders, and providing dietary advice in a customized manner. This system integrates several technologies and methodologies to ensure a comprehensive and user-friendly experience.

Medical Report analysis component

This component handles the analysis of medical reports uploaded by users. The process begins with the user uploading their medical report through a Flutter-based interface. The uploaded report is processed by a Flask server, which triggers the analysis using Amazon Textract—a service from AWS that extracts text and data from scanned documents. The extracted data is then structured into a format that can be used to provide insights and factors to produce dietary advice to the user. The processed results are sent back to the Flutter application, where the user can view the analysis.

Collection of User inputs

This component is responsible for gathering user inputs necessary for composing dietary advice. Users enter details such as age, gender, height, weight into their user profile. This information is used for calculating BMI and other health metrics that is then used for personalized dietary advice.

Prescription Reading and Pill Reminder

This component is designed to assist users in managing their medication schedules. Users can upload their prescription images, which are processed using an AI service that extracts critical details like medicine names, dosages, frequencies, and durations. These details are then used to set up alarms and reminders using the Alarm package. The system allows users to view, edit, or delete these reminders, ensuring they maintain their medication schedule accurately.

Firebase

The system uses Firebase as its backend infrastructure. Firebase is used to store and manage all user data, including profiles, medical reports, prescription details, and reminders.

This system provides a comprehensive solution for medication schedules, and dietary advice. By integrating various technologies like Amazon Textract, Flask, and AI services, the system offers an intuitive and effective platform for users to monitor and manage their health. The combination of prescription reading, pill reminders, and dietary advice ensures that users receive timely and personalized advice, enhancing their overall health management and decline the growing trend in non-communicable diseases and limit people from following unhealthy diet plans.

5. RESULTS AND DISCUSSION

The most important component of this research component is requirement gathering and system data collection. These inputs were essential in building the accurate dietary advice. The process involved extensive collaboration with healthcare professionals and domain experts to ensure that the system's outputs were accurate, reliable, and aligned with real-world medical practices.

5.1 Requirement Gathering

Requirement gathering process required meticulous collaboration with domain experts who have a in depth knowledge of nutrition and medical domain. This process could be breakdown into following phrases,

Consultation of health professionals

- ❖ Nutrition Experts: To accurately validate the system design idea and kick off the initial requirements gathering I consulted nutrition experts at Nutrition department of Colombo Research Institute. Their expertise provided critical insights into the nutritional needs of different demographic groups, as well as specific health conditions that could influence dietary requirements. These visits helped me understand the scientific underpinnings of dietary recommendations and ensured that the system's dietary advice component was grounded in up-to-date nutritional research.

- ❖ Medical Practitioners: For the report analysis component, I engaged with doctors practicing at Colombo chest clinic. Their feedback was instrumental in refining the system’s ability to analyze medical reports accurately. Their guidance and insights were incorporated into the system, ensuring that the analysis algorithms were robust and capable of interpreting various health indictors such as glucose and cholesterol level.

  The extracted medical report data was classified as follows based on their guidelines,

Table 6: Medical Report Analysis Data

Report Type	Component considered	Reference Range and units	Results
Fasting Blood Sugar (FBS)	Fasting blood glucose	<100 mg/dL	Normal
		>126 mg/dL	Diabetes Mellitus
		100-125 mg/dL	Prediabetes
Random Blood Sugar (RBS)	Random blood glucose	<140 mg/dL	Normal
		>200	Diabetes Mellitus
		140-199	Prediabetes
Lipid Profile	Total Cholesterol	<200	Desirable
		200-300	Border Line high
		240	High
	Triglycerides	<150	Normal
		150-199	Borderline high
		200-499	High
		500	Very High
	HDL-C	<40	Low
		60	High
	LDL-C	<100	Optimal
		100-129	Near Optimal
		130-159	Borderline High
		190	High

5.2 Dataset development and validation

Development of the dataset was another vital aspect of the project, as it forms the foundation of the dietary advice system, and its accuracy was ensured through collaboration with healthcare professionals. Even though there are plenty of datasets available in internet for diet plans it was difficult to find a dataset which includes dietary advice considering the factors such as age, gender, BMI, heart condition, blood glucose levels and blood cholesterol levels. Therefore, I had to create a dataset by myself.

For this endeavor collaboration of Dr. Timathi Wickramasekra and his team at Colombo Research Institute nutrition department and Dr. Disna Kumari of Hemas hospital Wattala was immensely helpful.

Dr.Disna Kumari provided her expertise in making the datasets for the dietary advice considering the all required factors. The dataset composed contained 251 customized dietary scenarios when all factors were been considered.

Table 7:Factors Considered

Age	Gender	BMI	ECG changes	Level of blood sugar	Level of cholesterol
1-19 yrs	Male	underweight	Yes	High blood sugar	High
20-65 yrs	Female	Normal	No	Low blood sugar	Low
65+		Overweight		Normal	Normal
		Obese			

Age	Gender	BMI	ECG changes	Level of blood sugar	Level of cholestrol	Diet Advice given
0-19 yrs	Female	Underweight	No	Normal	Normal	Get a balanced diet
0-19 yrs	Female	Underweight	No	High	Normal	Get a balanced diet, Limit high sugary foods.
0-19 yrs	Female	Underweight	No	low	Normal	Get a balanced diet,
0-19 yrs	Female	Underweight	yes	Normal	Normal	Be aware of salt and fat intake
0-19 yrs	Female	Underweight	yes	High	Normal	Be aware of salt and fat intake, Limit high sugary foods
0-19 yrs	Female	Underweight	yes	Low	Normal	Meet a dietitian
0-19 yrs	Female	Underweight	No	Normal	Normal	Get a balanced diet
0-19 yrs	Female	Underweight	No	High	High	Get a balanced diet, Limit high sugary foods, Limit deep fried foods
0-19 yrs	Female	Underweight	No	low	Low	Meet a dietitian
0-19 yrs	Female	Underweight	yes	Normal	Normal	Be aware of salt and fat intake.
0-19 yrs	Female	Underweight	yes	High	High	Be aware of salt intake, Limit high sugary foods, Limit deep fried foods
0-19 yrs	Female	Underweight	yes	Low	Low	Meet a dietitian
0-19 yrs	Female	Overweight	No	Normal	Normal	Get a balanced diet
0-19 yrs	Female	Overweight	No	High	Normal	Get a balanced diet, Limit high sugary foods.
0-19 yrs	Female	Overweight	No	low	Normal	Get a balanced diet
0-19 yrs	Female	Overweight	yes	Normal	Normal	Be aware of salt and fat intake
0-19 yrs	Female	Overweight	yes	High	Normal	Be aware of salt and fat intake, Limit high sugary foods
0-19 yrs	Female	Overweight	yes	Low	Normal	Meet a dietitian
0-19 yrs	Female	Overweight	No	Normal	Normal	Get a balanced diet
0-19 yrs	Female	Overweight	No	High	High	Get a balanced diet, Limit high sugary foods, Limit deep fried foods
0-19 yrs	Female	Overweight	No	low	Low	Meet a dietitian
0-19 yrs	Female	Overweight	yes	Normal	Normal	Be aware of salt and fat intake
0-19 yrs	Female	Overweight	yes	High	High	Be aware of salt intake, Limit high sugary foods, Limit deep fried foods
0-19 yrs	Female	Overweight	yes	Low	Low	Meet a dietitian
0-19 yrs	Female	Obese	No	Normal	Normal	Get a balanced diet

Figure 13 : Snapshot of the dataset created

5.3 System Implementation

The system uses advanced technologies to ensure efficient functionality and user experience. The system is built using Flutter, which is a powerful framework that enables the development of high performance, cross platform mobile applications. Flutter is chosen for its ability to provide a seamless and visually appealing user interface, while also allowing the integration of complex functionalities. Firebase is employed as the database solution due to its real-time data synchronization capabilities and ease of integration with Flutter, ensuring that user data is stored securely and accessible instantly across devices.

For report analysis, the system utilizes Amazon Textract, an OCR (Optical Character Recognition) service from AWS that excels in extracting text from scanned documents, such as medical reports. This choice allows the system to efficiently process and analyze complex medical data, such as blood glucose and cholesterol levels, which are crucial for providing personalized dietary advice.

The prescription reading feature is powered by the GPT-4 API, a cutting-edge AI model known for its natural language processing capabilities. This API allows the system to accurately interpret and digitize prescription data, enabling the creation of automated medication reminders. The combination of these technologies ensures that the system is not only robust and scalable but also capable of delivering highly personalized healthcare solutions to its users.

Parameter collection for dietary advice

The system requires key parameters to generate accurate dietary advice. These parameters as whole could be obtained from user via user inputs. But to add in some value and for efficiency purposes, user inputs are limited in the system. Age, gender, height and weight were collected directly from user inputs. However, obtaining blood glucose and cholesterol levels were done by analyzing patient medical reports.

Medicine Report Analysis

For the medical report analysis component, I initially experimented with various OCR technologies, to extract the components in the uploaded report to text from Image. For this I followed multiple approaches,

Table 8 Report Analysis Tools used

Technology	Description
Firebase OCR Scanner	Firebase OCR provides basic capabilities that are easy to integrate with mobile apps. *Limitations:* ❖ Struggles with complex and inconsistent layouts found in medical reports ❖ Limited customization for handling different text formats or special characters in reports.
Google ML Kit text recognition	Google ML kit package is designed for mobile applications offering on device text recognition *Limitations:* ❖ Optimized for simple, structured texts.

	❖ Lacks advanced features needed for parsing the carried and complex structures of medical reports.
Flutter Scalable OCR	Flutter package which is designed to scale well within different text recognition needs. *Limitations:* ❖ General purpose OCR not specialized for diverse and intricate formats of medicine reports ❖ Difficult to handle special characters and inconsistent data formatting
OCR Space API	Provide features to read OCR of different formats, documents, tables etc. And available in various packages. *Limitations:* Failed to read specific characters such as % marks and confuses numbers and letters, example 0 with o or 1 with letter l

Out of all the OCR tools followed, finally a few custom adapters in AWS Textract were built to ensure accurate results are fetched during optical character recognition process. Further, the decision to use Amazon Textract with Custom Adapters for scanning and analyzing medical reports is a significant choice due to its flexibility and precision.

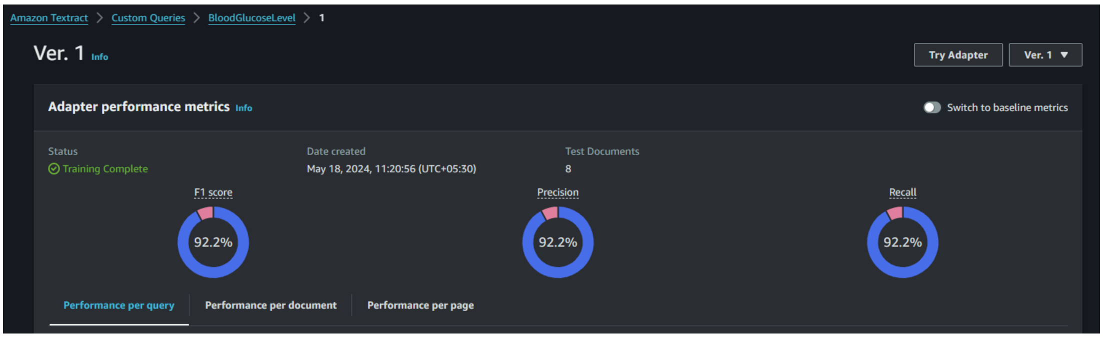

Figure 14: Final Evaluation Random and Fasting blood glucose report adapter

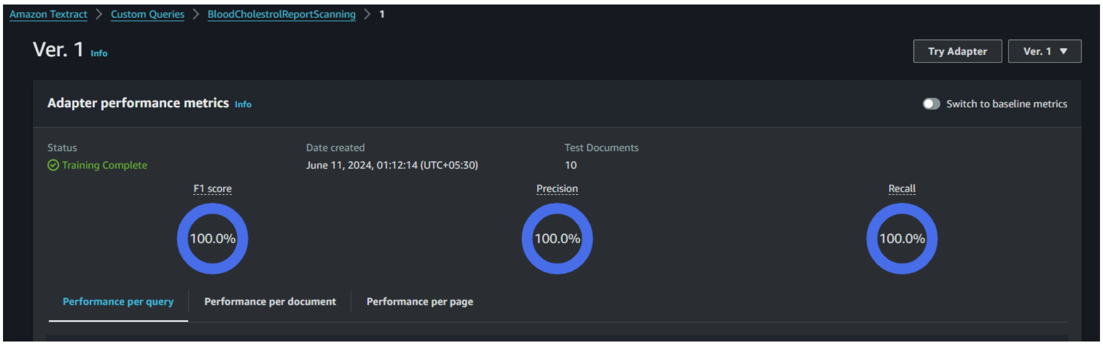

Figure 15: Final Evaluation Lipid Profile Report adapter

As shown in figure 14 and figure 15 evaluations of the models for blood glucose levels (including both random and fasting blood sugar reports) and lipid profile reports, Amazon Textract's Custom Adapters have demonstrated exceptional performance, with the lipid profile adapter achieving a perfect F1 score of 100%, while the blood glucose level adapter achieved an impressive F1 score of 92.2%. These results highlight the capability of Amazon Textract to handle the complex and inconsistent structures typical of medical reports. Custom Adapters allow for the fine-tuning of the model to specific document types, ensuring that even with the variability in report formats, critical data such as glucose levels and cholesterol markers are accurately extracted and analyzed. This adaptability and high accuracy make Amazon Textract an ideal solution for applications that require detailed and reliable extraction of health data from diverse and intricate medical documents.

Prescription Reading and Alarm Setting

For the prescription reading feature, Handwritten medicine prescriptions were difficult to analyze, therefore it was required to train a model which could read prescriptions accurately. Since training a model which was capable to reading prescription information accurately with a comprehensive dataset with updated drugs will consume a comparable amount of time, I choose artificial intelligence to read medicine prescription information and set medicine reminder.

GPT-4o was chosen for its efficiency and effectiveness in quickly extracting prescription details, such as medication names, dosages, and frequencies. This approach allowed for a rapid development cycle, enabling the system to accurately interpret and digitize prescriptions with minimal setup.

However, while GPT-4o provided a satisfactory solution, it is recognized that building a custom model specifically tailored for prescription reading would be a more robust and scalable long-term solution. A custom model could be trained to handle the unique formatting and terminology specific to medical prescriptions, improving accuracy and reliability over time. Such a model would be better equipped to handle variations in handwriting, medical abbreviations, and other complexities commonly found in prescription documents.

Since AI nor any machine learning approach is bound to make mistakes, I designed the system interfaces which provided flexibility for the users to edit the populated information.

Medicine Reminder

For medicine reminder feature I implemented an alarm setting feature within the Flutter application to help users manage their medication schedules effectively. This feature utilizes the Alarm package, which integrates with the device's native alarm app, allowing users to set reminders for taking their medications. The integration with the native alarm app ensures that reminders are presented in a familiar and reliable manner, directly through the device’s standard alarm interface.

To ensure that the best reliability and user-friendly reminder system is built, I explored various notification methods. Such as, flutter local notifications, which was considered for its ability to schedule and display notifications locally on the device. It supports both Android and iOS, making it a versatile choice for cross-platform applications. However, its complexity in setting up and the potential issues with background execution prompted the use of a more straightforward approach for this phase of the project.

The Alarm package was chosen for its simplicity and integration with the native alarm system, ensuring that alarms are consistent and reliable. This package is specially useful and chosen for managing recurring reminders and for cases where users may need to adjust their schedules manually.

The combination of GPT-4o for prescription reading and the Alarm package for setting medication reminders provided an effective and efficient solution within the constraints of the project timeline. However, recognizing the potential for future enhancements, building a custom prescription reading model and further refining the alarm and notification systems will be critical for improving the robustness and user experience of the application in the long term. This approach ensures that users receive timely and accurate reminders, helping them adhere to their medication schedules more effectively.

5.4 Integration Challenges

Integrating AWS Textract, particularly with custom adapters, into a Flutter application presented several challenges due to the inherent limitations in establishing direct communication between Flutter and AWS services. Initially, I explored multiple approaches, including the use of Amazon API Gateway in conjunction with Lambda functions. This method was intended to create a secure and scalable API endpoint that the Flutter application could interact with. However, despite careful configuration, this approach did not achieve the desired outcome. The complexities involved in managing state, handling asynchronous data processing, and ensuring seamless integration with the Flutter environment made this solution impractical for the project at hand.

To overcome these challenges, I opted for a more traditional, yet robust solution by leveraging the Amazon SDK within a Python environment. This involved writing a Python script that directly communicates with AWS Textract, utilizing the custom adapters I had trained to process specific types of medical documents. These custom adapters were critical for accurately handling the varied and often complex formats found in medical reports, ensuring precise data extraction essential for the application's functionality.

Given the need to interface this Python-based solution with the Flutter application, I implemented a Flask server as an intermediary. The Flask server manages the interactions with AWS Textract, effectively serving as the backend for the Flutter application. It exposes RESTful APIs that the Flutter app can easily call, abstracting the complexity of the AWS operations from the client-side environment. This design not only simplifies the communication process but also enhances security by keeping AWS credentials and processing logic on the server side, away from the mobile client.

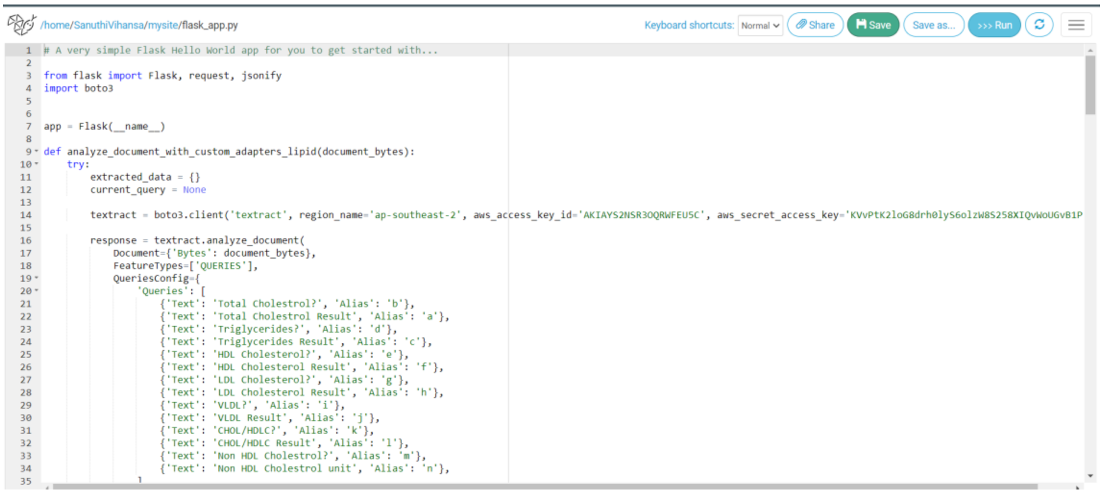

Figure 16: Flask Server Acts as a Middleware Between AWS and Flutter App

This approach proved to be both scalable and maintainable. By using the Flask server as a bridge, I ensured that the integration between Flutter and AWS Textract was reliable and secure, with the flexibility to accommodate future expansions or modifications. The Python environment further allows for continued customization and optimization of the AWS interactions, providing a solid foundation for the ongoing development and enhancement of the application.

The approach of integrating AWS Textract with a Flutter application through a Flask server and Python script effectively addressed the initial challenges. This architecture not only resolved the immediate connectivity issues but also laid the groundwork for a scalable and secure system capable of evolving with the application's needs.

5.5 Tools and Technologies Used in Development

Table 9 : Tools and Technologies Used

Tool	Justification
Flutter Technology	Flutter was chosen for its ability to create high performance, cross platform mobile applications. This ensures a consistent user experience across both android and IOS platforms reducing development time and cost.
Firebase	Firebase is used for its real time database capability which allows seamless synchronization between the mobile app and the cloud. It is trusted to provide secure authentication and scalable

	storage solutions, essential for managing user data and health records efficiently.
GitHub	GitHub was used as the version controlling tool which allowed integrating with other components and tracking the changes done during development.
AWS	AWS is critical for hosting and managing cloud-based services, particularly Amazon Textract for OCR processing of medical reports. AWS provides scalable infrastructure, ensuring that the application can handle varying loads and maintain high availability.
Python Flask Server	Used as the middleware between the flutter app and AWS services, handling API requests and responses. It enables the integration of AWS Textract into the app ensuring secure and efficient communication.
Dio	Dio is a powerful HTTP client for Flutter, used for making network requests to the Flask server and other external APIs. It supports advanced features like request cancellation, interceptors, and error handling, making it ideal for managing API interactions.
Alarm Package	Google Analytics can be integrated to monitor user engagement and app performance. This data helps in refining the user experience and making data-driven decisions for future update.
GPT 4o	GPT-4o is utilized for its natural language processing capabilities to accurately read and interpret medical prescriptions. It provides a quick solution for extracting complex data, which is essential for setting up medication reminders in the app.
Figma	Figma was used as the primary tool for designing the user interface and creating wireframes for the application.
draw. io	Draw.io was used for creating system architecture and use case diagrams, which were essential for planning and documenting the application's structure.

5.6 Snapshots of System

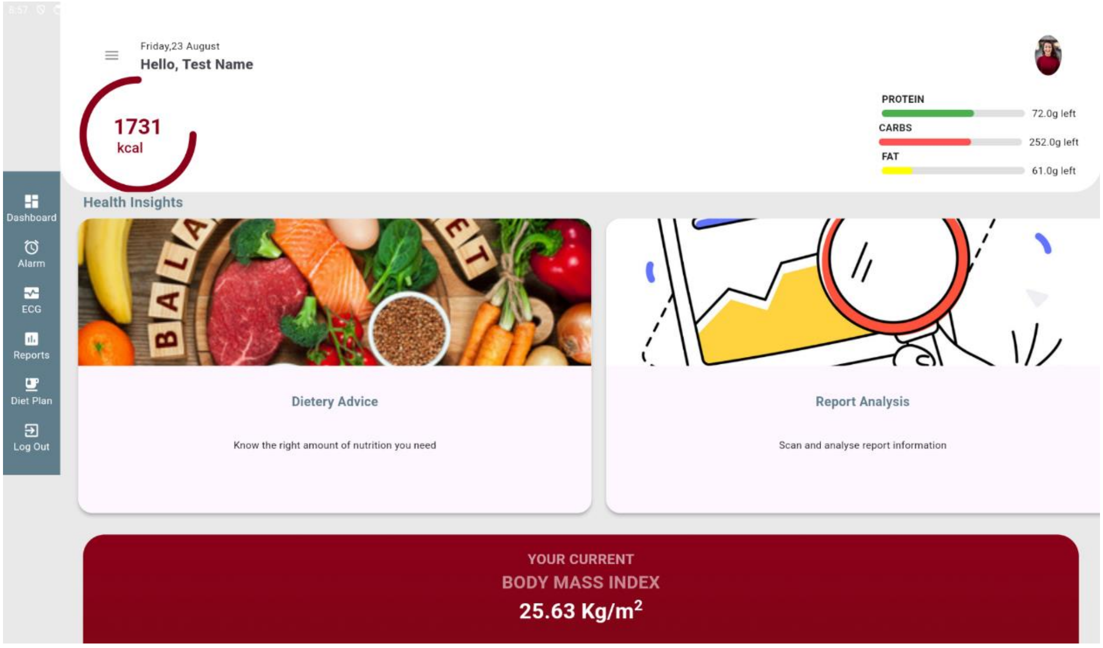

Figure 17: Diet Home Page

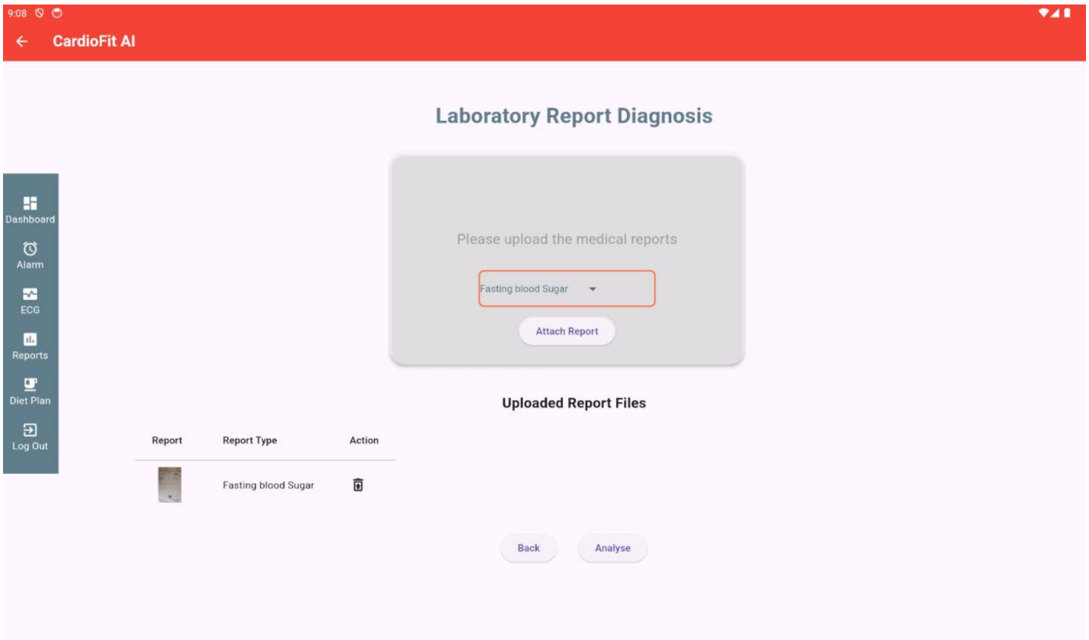

Figure 18: Medicine Report Upload Screen

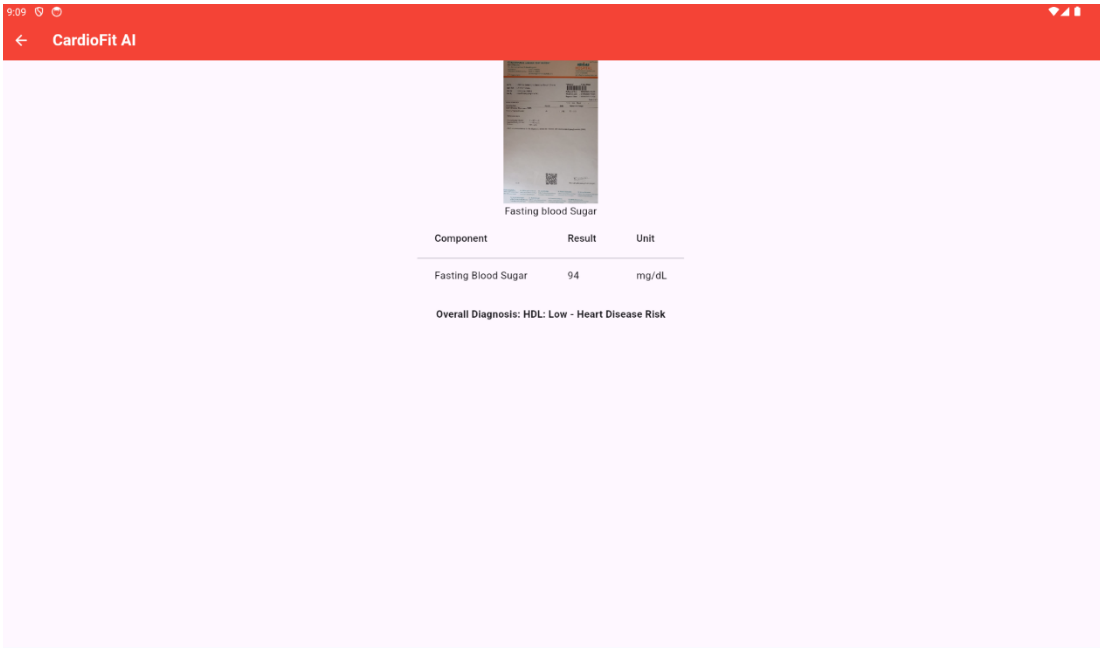

Figure 19: Medicine Report Analysis Screen

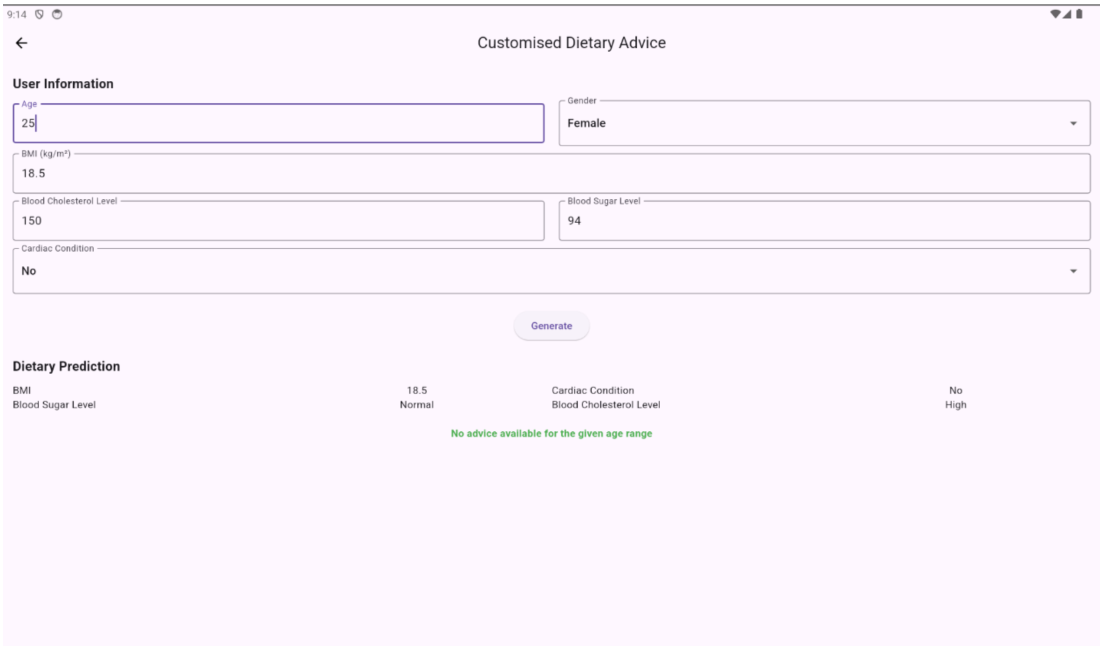

Figure 20: Dietary Advice Proposing Screen

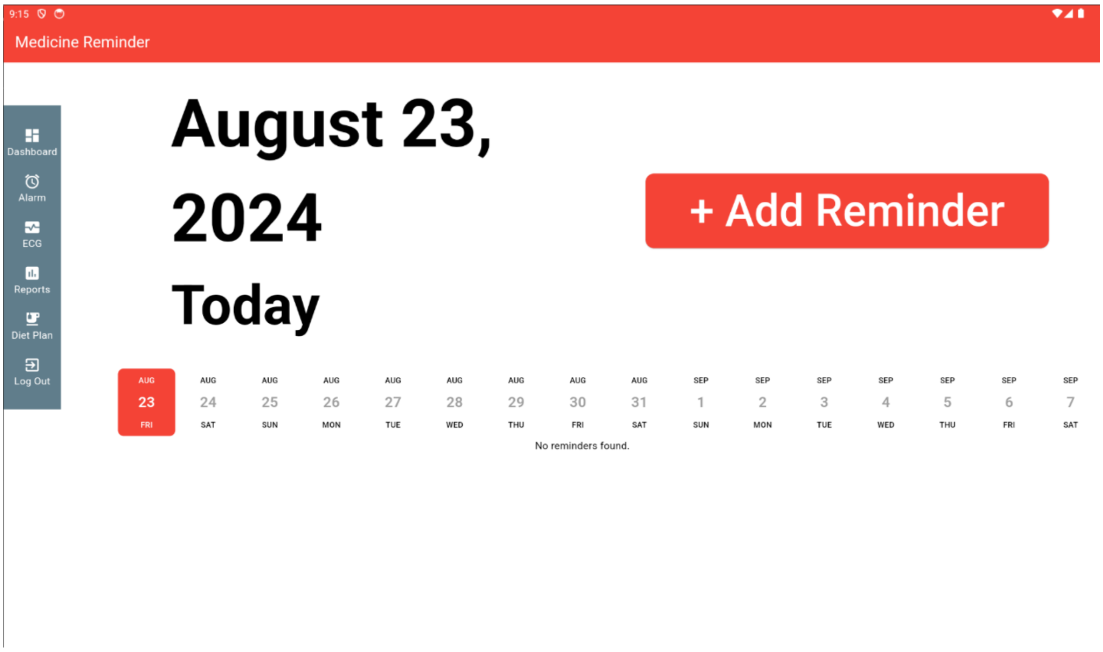

Figure 21: Medicine Reminder Home Page

5.7 Social and Ethical Aspects

In the development and implementation of the "Remote Health Monitoring" system, addressing social security and ethical considerations is critical, given the sensitive nature of the data involved. The system interacts with and processes sensitive health-related data, including medical reports, prescription details, and personalized health metrics, which necessitates stringent measures to ensure data protection and ethical handling.

Informed consent

A crucial aspect of ethical data handling is obtaining informed consent from users before collecting and using their data. The system provides users with clear information on how their data will be used, ensuring transparency. Users are informed of their rights, including the ability to withdraw consent at any time, allowing them to maintain control over their personal information. This approach aligns with ethical standards, ensuring that users are fully aware of how their data is being utilized.

Ethical use of AI in the application

The system's use of AI, particularly in analyzing medical reports and prescriptions, brings up important ethical considerations, such as the accuracy and bias of AI models. To mitigate these concerns, the AI algorithms used in the system are trained on diverse datasets and are regularly updated to ensure accuracy. Additionally, the system provides users with the ability to review and verify AI-generated outputs, such as dietary recommendations and medication reminders. This human in loop approach (human decision making) ensures that AI complements, rather than replaces, human decision-making, thereby maintaining ethical standards in healthcare recommendations.

5.8 Future Directions

As the application continues to evolve, several key areas have been identified for future development to enhance its functionality and expand its impact on user health and wellness.

One significant enhancement is the development of a practical and accurate method for tracking calories consumed and burned by individuals. This system would integrate with wearable devices, utilize AI-driven food recognition technology, and tap into extensive nutrition databases. By automatically tracking dietary intake and physical activity, the system can provide personalized dietary advice tailored to the user's specific needs, helping them maintain a balanced diet. Additionally, the system could offer customized workout recommendations that align with the user's calorie intake, ensuring a comprehensive approach to health management that considers both nutrition and physical activity.

Another critical area for future improvement is the creation of a custom machine learning adapter specifically designed for reading medical prescriptions with high accuracy. This custom adapter would be trained on a diverse range of prescription formats, including handwritten notes, to ensure precise extraction of medication details such as dosage, frequency, and duration. By enhancing the prescription reading capability, the application could automatically set up pill reminders, minimizing user errors and improving adherence to prescribed medication schedules. Furthermore, the data collected from user medication usage could be analyzed (with user consent) to provide valuable business insights for the pharmaceutical industry, identifying trends and improving patient outcomes.

Expanding the integration of health data is also a crucial step forward. The application could incorporate additional health metrics, such as blood pressure, heart rate variability, and sleep patterns, either through integration with advanced sensors or by allowing users to manually input data from other health apps or devices. This expanded data set would enable the application to offer more personalized and precise health recommendations, tailored to the user's comprehensive health profile.

To further support users in managing their health, the development of a feature that tracks and analyzes emotional well-being could be considered. This feature could use data from wearable devices, such as heart rate variability and sleep patterns, combined with user input on mood and stress levels, to provide insights into how emotional health impacts physical well-being. Based on this data, the application could offer suggestions for stress management techniques, mental health resources, or lifestyle adjustments that could improve overall health.

Additionally, enhancing user engagement through gamification could be explored. Features such as rewards for reaching health goals, challenges that promote healthy habits, and social sharing options could increase user motivation and long-term adherence to health plans. This could lead to better health outcomes and increased user satisfaction with the application.

Finally, incorporating AI-driven predictive analytics could allow the application to anticipate potential health issues based on trends in the user's data. For example, the system could analyze patterns in diet, exercise, and vital signs to provide early warnings of potential health risks, such as the onset of cardiovascular disease or diabetes. This proactive approach could empower users to take preventive actions and seek medical advice before issues become serious.

These future development suggestions aim to make the application a more comprehensive and proactive health management tool, offering users personalized, data-driven insights that support their long-term well-being. By continually evolving and integrating advanced technologies, the application can remain at the forefront of personalized healthcare solutions.

6. Conclusion

The "Revolutionizing Remote Health Monitoring: Autonomous Detection of Cardiac Abnormalities with Customized Dietary Planning " project embodies a significant step forward in personalized healthcare management. This project addresses the pressing need for individualized dietary and health monitoring solutions in the face of rising non-communicable diseases and lifestyle-related health issues.

With the use of advanced technologies such as Amazon Textract for medical report analysis, GPT-4o for prescription reading, and Flutter for a cross-platform mobile application, the project successfully integrates critical health data into a user-friendly interface. The integration of these technologies allows for the accurate extraction and interpretation of medical data, which is then used to generate tailored dietary advice and medication reminders. The project not only demonstrates the feasibility of creating a personalized health management tool but also highlights the potential for future enhancements, including more sophisticated health monitoring capabilities and further integration of AI-driven insights.

Despite the challenges encountered, particularly in integrating AWS Textract with a Flutter application, the solutions developed—such as the Python Flask server acting as an intermediary—showcase the project's innovative approach to overcoming technical barriers. This adaptable and scalable architecture lays the groundwork for ongoing improvements and expansions.

Looking forward, the project identifies key areas for future development, including the enhancement of calorie tracking and workout recommendations, the creation of a custom prescription reading model, and the incorporation of additional health metrics such as emotional well-being and predictive analytics. These advancements will further refine the application, making it a more comprehensive tool for users seeking to manage their health proactively.

In conclusion, this project sets a foundation for future innovations in personalized healthcare, offering a robust solution that addresses current gaps in the market. By continuing to evolve and integrate cutting-edge technologies, the "Remote Health Monitoring" system has the potential to significantly improve health outcomes for its users, making it an asset in the fight against non-communicable diseases and the promotion of healthier lifestyles.

7. Commercialization

The "Remote Health Monitoring" system has a significant opportunity to revolutionize the healthcare market by offering a unique blend of personalized dietary advice and advanced remote health monitoring. With the global rise in non-communicable diseases such as diabetes, cardiovascular diseases, and obesity, there is a growing demand for tools that help manage these conditions more effectively. This system stands out by integrating critical health metrics like age, gender, BMI, blood glucose, and cholesterol levels into a cohesive platform, providing users with tailored health insights that address the limitations of generic diet and health apps. The market potential is vast, especially with the increasing adoption of wearable devices and the emphasis on preventive healthcare.

To ensure sustainability and growth, the commercialization strategy will involve multiple revenue streams, including a subscription-based model that offers different tiers of access to the system’s features. This approach will cater to a wide range of users, from those seeking basic health monitoring to those requiring more advanced features like AI-driven predictive health analytics. Additionally, the system will explore B2B partnerships with healthcare providers, insurance companies, and corporate wellness programs, offering these organizations an opportunity to enhance their services while managing chronic disease more effectively. Licensing and white-labeling the system's technology to other healthcare companies and generating data-driven insights for research and development also present lucrative opportunities.

The go-to-market strategy will be phased, targeting regions with high smartphone penetration and growing demand for digital health solutions. This strategy will leverage digital marketing, influencer partnerships, and a freemium model to drive user adoption and build brand awareness. Ensuring regulatory compliance, particularly regarding data privacy and security, will be crucial in establishing trust with users and partners. By executing this comprehensive commercialization plan, the "Remote Health Monitoring" system is well-positioned to achieve widespread adoption and become a leading solution in the remote health monitoring and personalized healthcare sectors.

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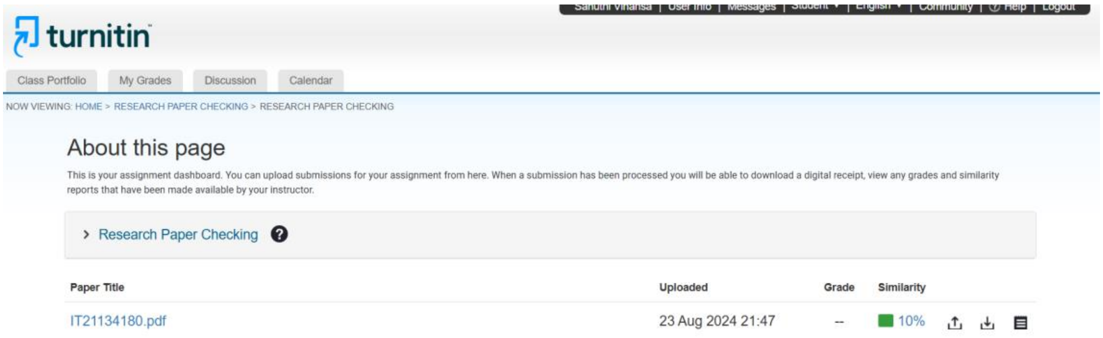
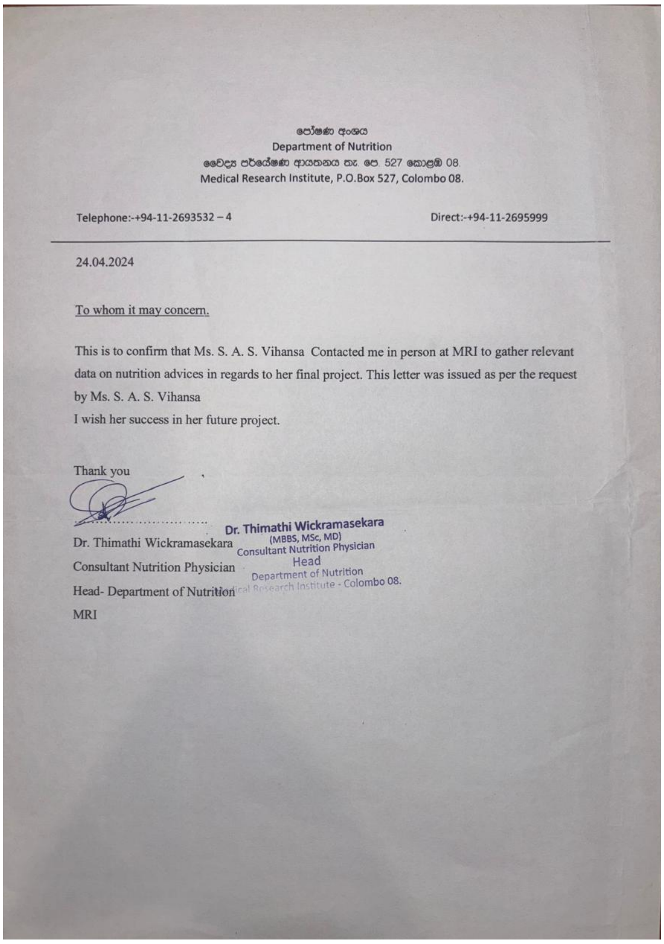
APPENDICES

Appendix A: Turnitin Plagiarism Check



Appendix B: Requirement Gathering



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24.04.2024

To whom it may concern.

This is to confirm that Ms. S. A. S. Vihansa Contacted me in person at MRI to gather relevant data on nutrition advices in regards to her final project. This letter was issued as per the request by Ms. S. A. S. Vihansa
I wish her success in her future project.

Thank you

……………………………

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