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Foodsnap: A Deep Learning Based Dietary Management and Food Analysis Application

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ABSTRACT

Dietary health and nutrition have become increasingly significant concerns in contemporary society. Amidst rising rates of diet-related diseases, there is a pressing need for innovative solutions to assist individuals in managing their dietary intake effectively.The research presents an innovative and comprehensive app, termed FOODSNAP, which aims to revolutionize dietary management through the seamless integration of cutting-edge technologies such as Deep Learning and Natural Language Processing (NLP). At its core, FOODSNAP leverages a sophisticated Machine Learning-based Sentence Classifier, coupled with a custom-trained Deep Learning Model for food detection. This dual approach ensures precise classification of food image and textual descriptions, enabling users to effortlessly record and monitor their dietary intake with more accuracy and ease. One of the key features of FOODSNAP lies in its extensive and diverse database, which provides detailed nutritional information for a wide array of foods. From essential metrics like calories, carbohydrates, fats, and proteins to specialized dietary requirements, the app offers users comprehensive insights into their food choices. This wealth of information empowers users to make informed decisions about their dietary habits, fostering a deeper understanding of nutritional content and its impact on overall health. It also offers personalized dietary recommendations tailored to individual body constitutions. By analyzing user data and health profiles, the app delivers targeted suggestions for optimal nutrition, guiding users towards healthier eating habits and improved well-being. It is equipped with features such as Food Allergen Alerts, notifying users when a particular food is not recommended based on their allergies or dietary restrictions, thereby ensuring safety and peace of mind. FOODSNAP also facilitates goal setting for weight management, with intuitive tools for both weight gain and weight loss objectives. Through efficient tracking capabilities and insightful analytics, users can monitor their progress in real-time, empowering them to stay on course towards their desired goals. Additionally, the app offers dynamic Diet Report Generation, allowing users to review their dietary patterns and trends over weekly, monthly, and yearly intervals. This holistic approach to dietary management enables users to gain deeper insights into their eating habits and progress towards long-term health objectives. In essence, FOODSNAP represents a paradigm shift in dietary management, offering a comprehensive solution that combines advanced technology with user-centric design principles. By empowering users with actionable insights, personalized recommendations, and intuitive tools, FOODSNAP aims to promote healthier eating behaviors and enhance overall well-being in the digital age.

Keywords: AI-based Smart food analyzer, Dietary tracking, Personalized Dietary Recommendations, Smart Food Analyzer.

INTRODUCTION

In today's fast-paced world, maintaining optimal health can be a challenge, especially when it comes to managing our dietary habits. Traditional methods of food tracking often fall short, plagued by tedious manual recording, limited accessibility, and a lack of personalized insights. This is where the "FOODSNAP-A Deep Learning Based Dietary Management and Food Analysis Application" emerges as a groundbreaking solution, leveraging the power of Deep Learning and Natural Language Processing (NLP) to revolutionize dietary management. Imagine a world where recording your meals is as effortless as taking a picture, where personalized dietary recommendations cater to your unique needs and body constitution, and where health-conscious alerts guide you towards informed choices. By utilizing Deep Learning algorithms, users can simply take a picture of their meals, and the application automatically recognizes and records the

nutritional content using a streamlined approach to eliminate the tedious task of manual data entry, making dietary management more accessible and user-friendly.

Traditional calorie trackers have their limitations. Manual data entry is time-consuming and error-prone, while the lack of support for regional languages and unnamed foods creates barriers for diverse user groups. Furthermore, the project acknowledges the importance of user feedback and continuous improvement. Regular updates and enhancements based on user input ensure that the application evolves in tandem with user needs, reinforcing its commitment to being a dynamic and user-centric dietary management tool.

In envisioning a future where maintaining a healthy lifestyle is seamlessly integrated into daily routines, the "FOODSNAP" introduces a novel approach to food tracking. Imagine capturing the essence of your meals effortlessly, receiving instant nutritional insights, and having a virtual dietary assistant who understands and caters to your unique preferences. This project aspires to be more than just a conventional food diary; it strives to be a personalized companion on the journey towards improved health, providing users with the knowledge and tools they need to make informed decisions about their well-being.

Moreover, the project emphasizes inclusivity by supporting regional languages and accounting for unnamed foods. Recognizing the diverse dietary habits across different cultures, the application ensures that users from various backgrounds can easily incorporate the tool into their daily lives. This inclusivity aligns with the project's goal of reaching a broad user base and promoting healthier dietary choices on a global scale. The limitations of traditional calorie trackers extend beyond the realm of practicality. The arduous process of manual data entry discourages consistent usage, and the lack of support for regional languages and unnamed foods excludes diverse user groups. By addressing these challenges, our project not only embraces technological advancements but also embraces inclusivity and a holistic understanding of nutrition, promising a more effective and user-friendly dietary management solution for individuals from all walks of life.

LITERATURE SURVEY

In recent years, there has been a surge of interest in leveraging deep learning techniques to address the pressing issue of obesity and promote healthier living through dietary management and food recognition systems.

Nadeem et al. (2019) introduced the "Smart Diet Diary," [1] a smartphone application designed to aid obese individuals and patients in monitoring their dietary intake. Utilizing a pre-trained faster R-CNN model, the application identifies food items and computes their nutritional value. The study underscores the limitations of traditional dietary assessment methods and advocates for image-based recognition systems as a more convenient and potentially more accurate alternative.

Similarly, Mansouri et al. (2020) proposed a comprehensive system for food image recognition and dietary assessment [2]. Employing deep learning models such as Inception v3, v4, and ResNet, the system achieves notable accuracy. However, the study acknowledges the challenge of incorporating individual factors like BMI and health issues into calorie estimation, which could impact the accuracy of nutritional assessments.

In contrast, Alfaro, and Allende-Cid (2018) introduced a novel approach for text classification. Their study, titled "Evaluation of a New Weighting Function for Text Representation in Multilabel Classification," [3] explores the use of a weighting function called relevance frequency for a label (rf1) to modify text representation during multilabel classification. While their approach shows promise, it lacks the advanced contextual understanding and semantic representation capabilities of models like GPT.

These studies collectively underscore the potential of deep learning techniques in revolutionizing dietary management and food recognition. However, they also highlight the need for further research to address challenges such as incorporating individual factors into dietary assessment models and exploring advanced techniques for text representation and classification.

Proposed system

The envisioned system,"FOODSNAP: A Deep Learning Based Dietary Management and Food Analysis Application" is a cutting-edge mobile application developed on the React Native framework with a robust backend supported by Node.js and MongoDB. The system integrates state-of-the-art technologies to redefine dietary management, providing users with an intuitive, secure, and feature-rich experience.

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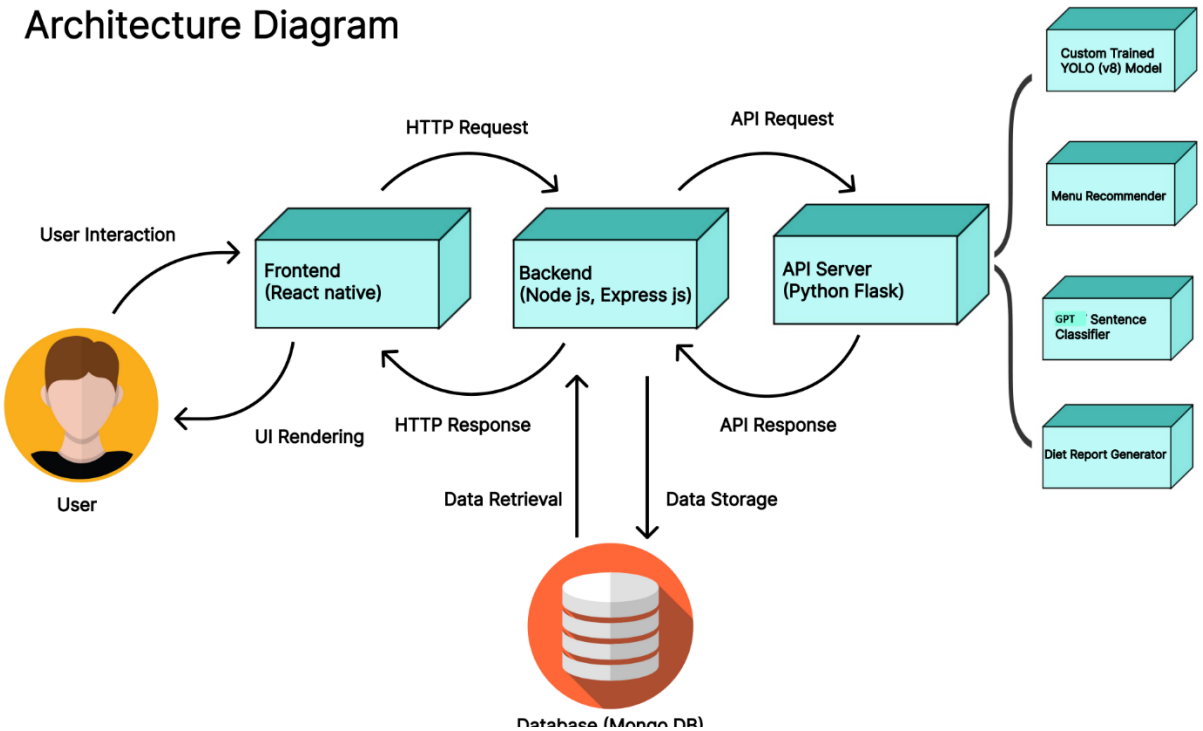
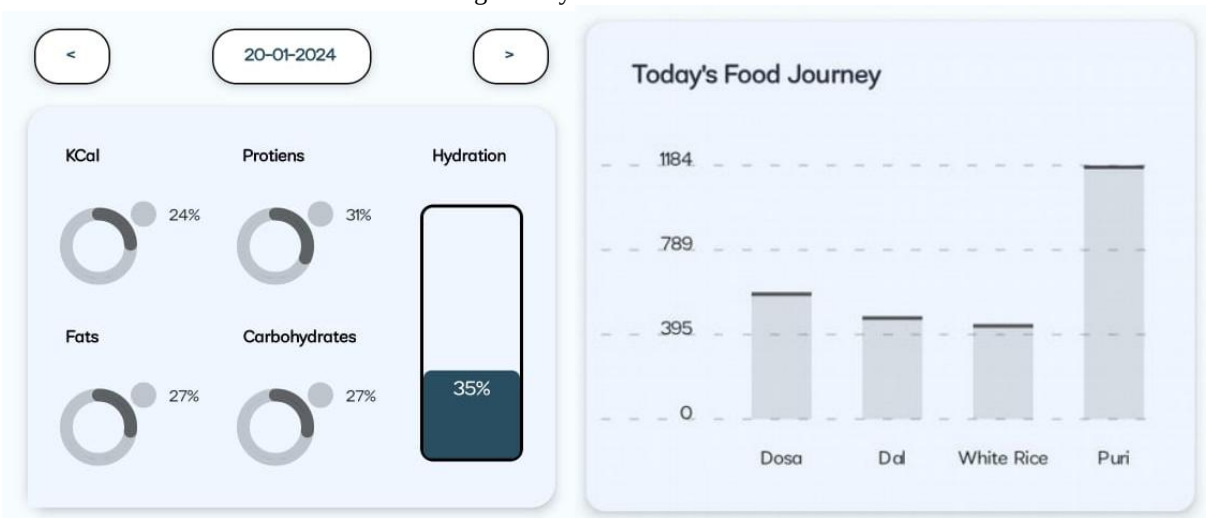


Methodology: Development and Implementation of FOODSNAP Features
This section outlines the methodology employed in developing and integrating key features within the FOODSNAP application, aimed at enhancing dietary management and user experience.

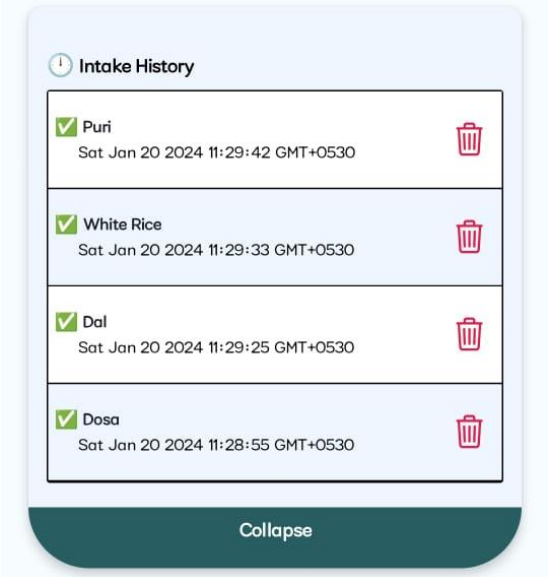
User-Friendly Dashboard: The proposed system integrates a user-friendly dashboard tailored for efficient dietary management. This dashboard will offer an intuitive snapshot, providing users with comprehensive insights into their nutritional journey. Elements shown as follows

a. A central donut chart elegantly displays the proportional breakdown of calories, proteins, fats, carbohydrates, and water consumed throughout the day. Each segment of the donut represents the percentage contribution of these nutritional elements, providing users with a quick and easy-tounderstand overview of their dietary intake.
b. A bar chart complements the donut chart by presenting a graphical representation of the quantity of food consumed at different times during the day.



Meal History and Tracking: The Intake History feature in the FOODSNAP application seamlessly integrates with MongoDB to record and organize user-generated data. As users input their dietary information through the application's frontend, this data is efficiently stored in the MongoDB database. The Intake History is a dynamic and real-time reflection of the user's dietary journey.

1. User-generated data, including food item names, quantities, date, and time of consumption, are stored in MongoDB. The NoSQL structure of MongoDB facilitates efficient storage and retrieval of this diverse and dynamic dietary information.
2. The intake history serves as a detailed log, presenting a list of consumed food items along with the respective day, date, and time.
3. Users can effortlessly review and analyze their past food entries, gaining valuable insights into their eating patterns.

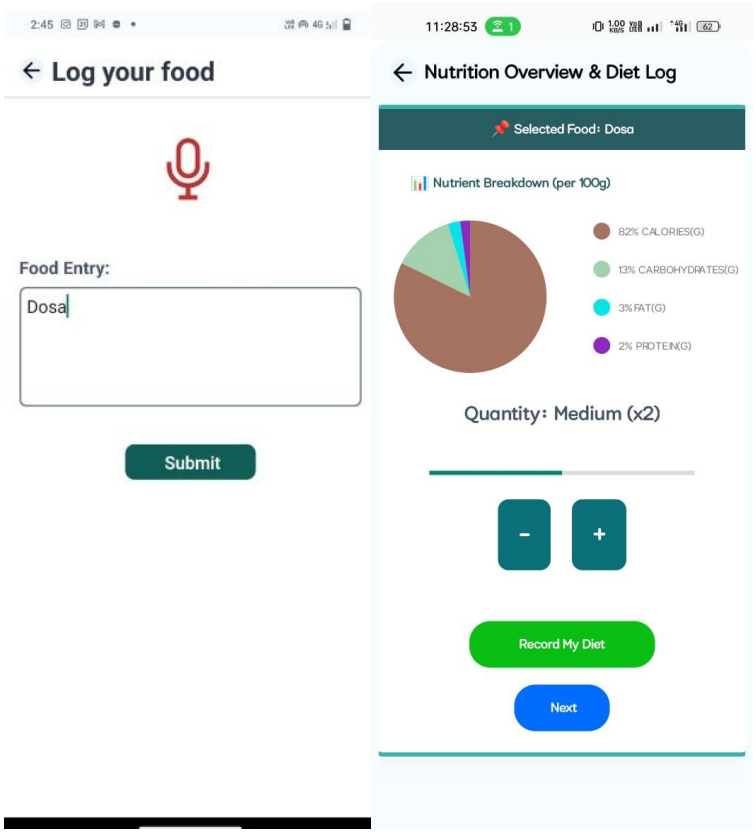


Food Entry Options: The FOODSNAP application introduces versatile methods for users to record their dietary intake seamlessly. Users can choose from two intuitive options such as manual entry via search and image recognition using YOLOv8 [6]. These flexible recording methods cater to different user preferences and enhance the overall user experience.

Manual Entry via Search: Empowering users with control, the manual entry option allows them to search for and add food items directly. Leveraging a user-friendly interface, individuals can effortlessly input the names, quantities, and other details of the consumed items. This method is ideal for users who prefer a hands-on and precise approach to recording their meals.

GPT Based Sentence Classification MODEL: It involves predicting the class label of dietary-related text inputs. Our model, based on the 'GPT architecture, is used to classify texts into one of 138 relevant categories of food we have selected. The model can predict a specific number of labels. A crucial aspect of our methodology is the integration of the GPT tokenizer. The tokenizer preprocesses input texts, converting them into a format suitable for the GPT model and predicts the final output variable among all the different variables using the users input sentence or description.

Image Recognition with YOLOv8:FOODSNAP utilizes YOLOv8 [6], an advanced image recognition model, to automate the process efficiently. With a simple snap/photo of their meal, users can have food items identified and categorized without manual data entry. This streamlines meal logging, particularly useful for users on-the-go. YOLOv8 [6] offers significant advancements in object detection and recognition, ensuring both speed and accuracy in identifying food items within images. During the development of FOODSNAP's image recognition system, a comprehensive dataset of up to 657 images was used to train the model, capturing diverse food items, and ensuring robustness in real-world scenarios. This dataset encompasses variations in shapes, sizes, colors, and contextual settings, enhancing the model's effectiveness.



Gamification Feature: Incentivizing users to maintain consistent and accurate dietary records, FOODSNAP introduces a gamified system where users earn 5 points for each food entry. This point-based reward system serves as a motivational tool, encouraging users to actively engage with the application and diligently document their meals. Accumulated points not only reflect the user's commitment to their dietary journey but also unlock potential benefits and recognition within the gamified ecosystem. Recognizing the significance of sustained commitment to healthy habits, FOODSNAP incorporates streaks as a gamification feature. Users are rewarded for maintaining consistent engagement with the application over consecutive days. Whether it is logging meals, achieving specific dietary goals, or adhering to recommended nutritional guidelines, users can build and extend their streaks. This element adds an element of challenge, fostering a sense of accomplishment and reinforcing positive behavior patterns.

Personalized Diet Recommendations: In the realm of modern nutritional science, personalized meal recommendations have emerged as a pivotal aspect of promoting individual well-being. Recognizing the inherent diversity among individuals, especially in terms of age, weight, height, and gender, the FOODSNAP application employs a sophisticated approach to tailor dietary guidance for each user. FOODSNAP's personalized meal recommendations begin with user-entered details like age, weight, height, and gender, building a comprehensive picture of their physiology.
BMI, a key metric derived from weight and height, categorizes users into specific ranges like underweight or overweight, guiding tailored meal plans to align with individual health goals. Recognizing gender differences, FOODSNAP incorporates gender-specific considerations in its calculations, ensuring recommended meals are attuned to the unique metabolic rates and nutritional needs of each user.

BMI = weight / (height / 100) **2

Caloric Intake Calculation: The heart of personalized meal recommendations lies in the precise calculation of daily caloric intake. Leveraging renowned Harris-Benedict equations [5], the system computes the Basal Metabolic Rate (BMR) for both males and females. The formulas for calculating BMR are as follows:

- For males: BMR_{male} = 88.362+ (13.397 x weight) + (4.799x height) (5.677 x age)
- For females: BMR_{female} = 447.593 + (9.247 × weight) + (3.098 x height) (4.330 x age)

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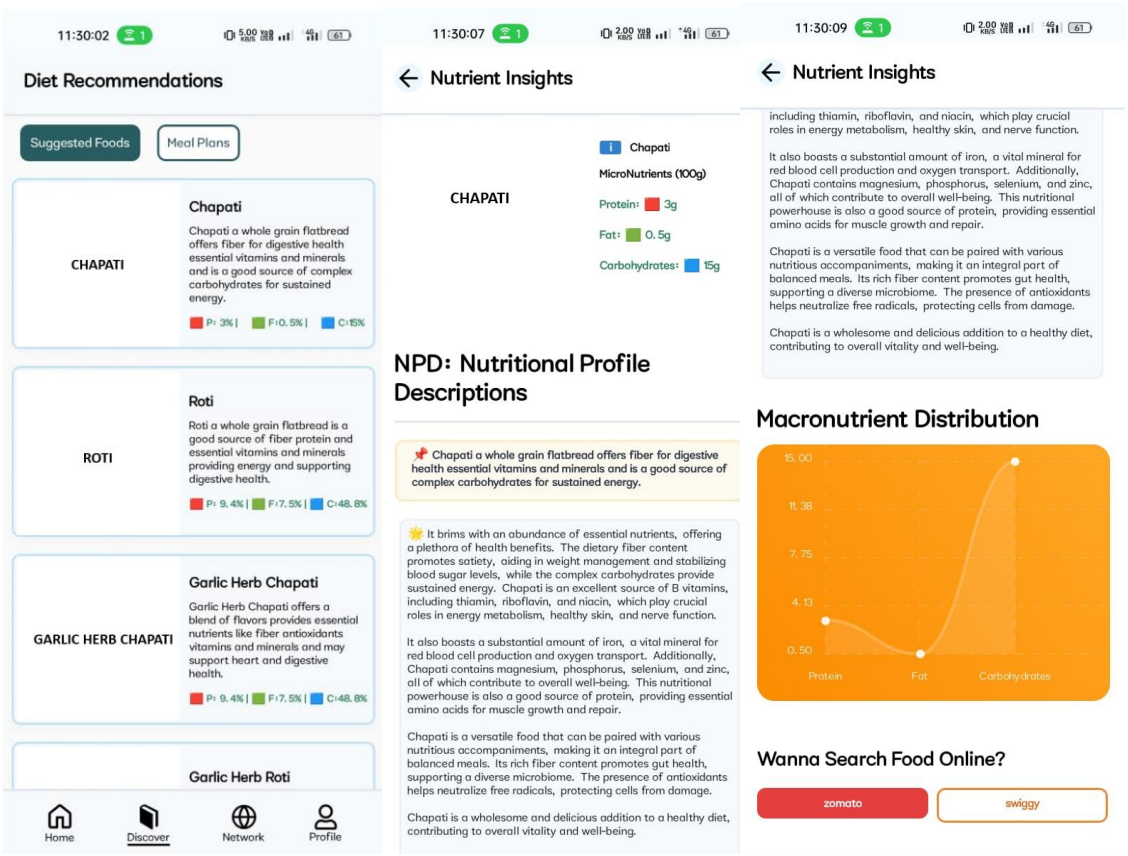
These formulas form the basis for determining the user's BMR, which is then multiplied by an activity factor to provide a personalized estimation of the calories they should consume daily. The activity factor, representing different activity levels, is a crucial component in tailoring recommendations to individual lifestyles

- Total Calories = BMR × Activity Factor
- The activity level multipliers include:

1. Sedentary: 1.2
2. Lightly Active: 1.375
3. Moderately Active: 1.55
4. Very Active: 1.725
5. Extremely Active: 1.9

- Food is suggested from different filtering criteria based on the user's BMI category:

a. **Underweight:** Suggests foods with high protein (>10g), high carbohydrates (>10g), or high calories (>200).
b. **Normal Weight:** Suggests foods with high protein (>10g), high carbohydrates (>10g), low fat (10), moderate calories (>10)
c. **Overweight or Obese**: Suggests foods with high protein (>10g), low carbohydrates (<10g), low fat (<10g) or low calories (<200).

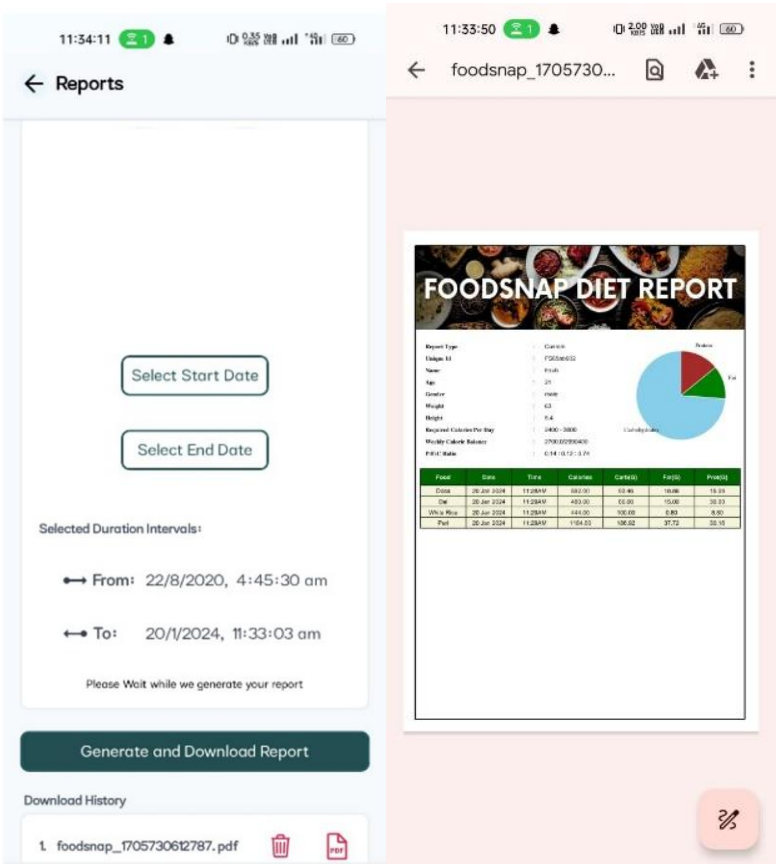


Report Generation: Customized Insights and Nutritional Analysis FOODSNAP's report generation feature introduces a tailored and detailed approach to providing users with personalized insights into their dietary patterns. The custom report, categorized as "Custom," encompasses a range of essential metrics and visual aids to enhance users' understanding of their nutritional habits.

Report Components:

a. **Unique Id:** Every FOODSNAP report is uniquely identified, ensuring accuracy and ease of reference for users seeking specific insights into their dietary behavior.

b. **Name:** Personalization is prioritized with the inclusion of the user's name, making the report more relatable and usercentric.
c. **Age and Gender**: Crucial demographic information that influences dietary recommendations and nutritional needs is considered in the report.
d. **Weight and Height**: Recorded for precise caloric calculations, these details ensure dietary suggestions align with the user's unique body composition and health goals.
e. **Required Calories Per Day:** This calculated figure serves as a benchmark, representing the user's daily caloric intake requirement for optimal nutrition.
f. **Weekly Caloric Balance**: A summary of the user's caloric intake and expenditure over the week, aiding users in tracking their progress toward dietary and fitness objectives.
g. **P: F:C Ratio& Pie Chart:** Providing insight into macronutrient distribution, the report illustrates the proportion of proteins, fats, and carbohydrates in the user's overall diet.



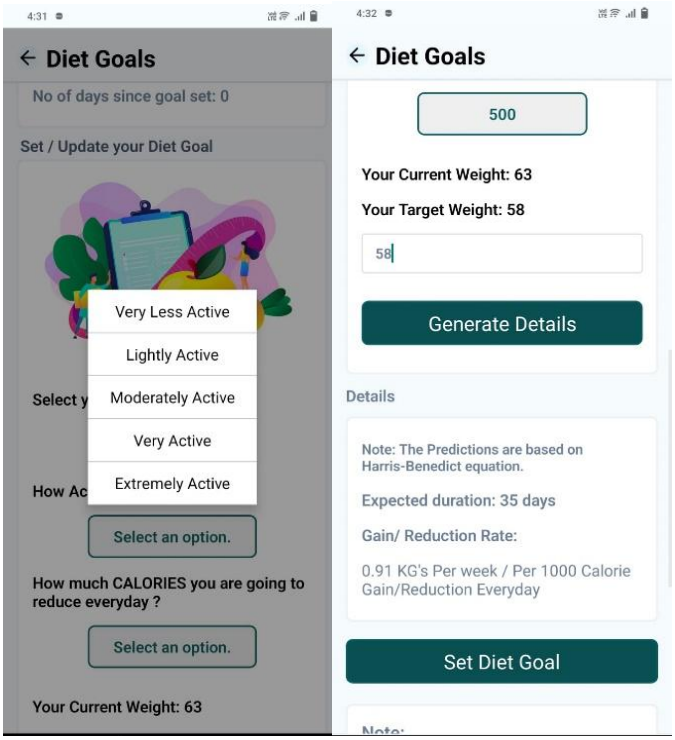
FOODSNAP's report generation is seamlessly integrated with MongoDB, leveraging the power of this robust NoSQL database to fetch and compile user-specific data for insightful reports. MongoDB serves as the centralized repository, storing critical information such as user profiles, food entries, and dietary preferences. Through efficient queries and data retrieval mechanisms, the report generation process dynamically pulls information from MongoDB, ensuring real-time accuracy and personalization in each report. This integration not only enhances the performance and scalability of the report generation feature but also underscores FOODSNAP's commitment to delivering a reliable and datadriven dietary management experience for its users.

Goal Setting and Tracking:

1. The Unique Physical Characteristics serve as crucial parameters for establishing and monitoring Diet Goals. The Harris-Benedict equation [5] is a method to estimate the Basal Metabolic Rate (BMR), indicative of the calories required by the body at rest.
2. As Described before, the total Calories are computed by multiplying BMR with the Activity Factors (Activity levels

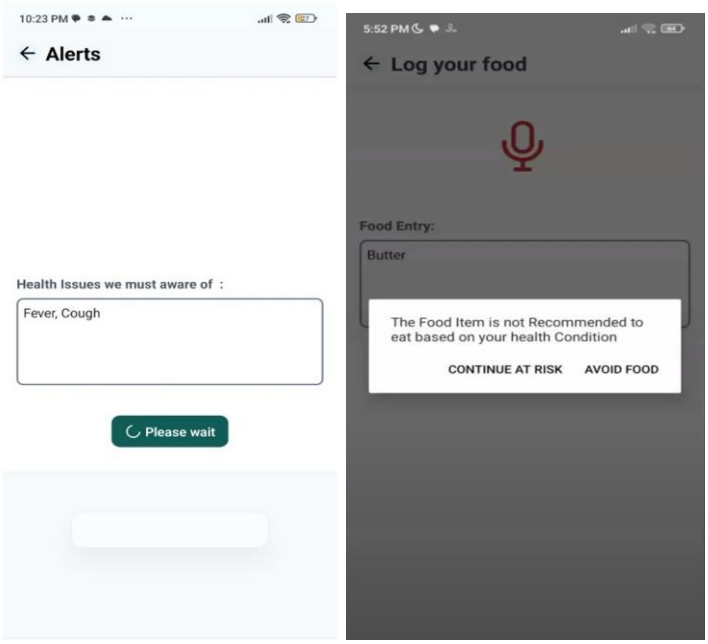
vary, depending on activity levels such as Sedentary, Lightly Active, Moderately Active, Very Active, and Extremely Active)

3. Applying specific criteria, such as a 500-calorie daily deficit, aiming for a 1-pound per week loss, and considering a sedentary activity level, we can effectively set and monitor user goals for weight loss, weight gain, etc. [4]



Allergen Alerts:

Allergen Alerts are delivered to users through Google's Gemini API. When logging food, the system checks against the user's health issues that are previously recorded in user's profile. Then they are used to notify whether a particular food item is recommended or not.



CONCLUSION

The development and implementation of FOODSNAP mark a significant stride toward revolutionizing dietary management through innovative technologies. As evidenced by the initial results and discussions, FOODSNAP exhibits promising outcomes in various aspects, from user engagement to the accuracy of image recognition and the effectiveness of personalized meal recommendations. The amalgamation of YOLOv8 [6] for image recognition, GPT for food name prediction, food allergen alerts, gamification features and MongoDB for robust data management forms the backbone of FOODSNAP success. The application's user-centric approach, encompassing gamification features and personalized recommendations, resonates with users, fostering consistent engagement and adherence to dietary goals. Therefore,FOODSNAP emerges not only as a sophisticated mobile application but as a holistic dietary companion. Its user-friendly interface, coupled with advanced technologies, empowers individuals to make informed choices about their dietary habits and overall well-being. As we continue this journey, the commitment to excellence, user satisfaction, and a healthier lifestyle remains at the core of FOODSNAP's mission. The fusion of cutting-edge technology and user centric design positions FOODSNAP as a transformative force in the realm of dietary management, poised to make a lasting impact on the lives of health-conscious individuals.

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