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# Nutritional Guidance System with Allergen Aware Recommendations using AI

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**ABSTRACT:** Maintaining a healthy and balanced diet has become increasingly difficult in today's fast-paced lifestyle, especially for individuals with specific allergies, health conditions, or dietary preferences. The Nutritional Guidance System with Allergen-Aware Recommendations using Artificial Intelligence is designed to generate personalized meal plans that meet individual nutritional needs while ensuring allergen safety. The system utilizes a Groq-powered Large Language Model (LLM) to dynamically create meal recommendations based on structured user inputs such as dietary goals, diet types, lifestyle preferences, and restricted ingredients. Users can receive customized suggestions that are nutritionally balanced and safe. An AI-powered chatbot provides interactive guidance and answers dietary queries, while Text-to-Speech technology converts recommendations into voice output, improving accessibility and delivering an intelligent, user-friendly nutritional guidance solution.

**KEYWORDS:** Artificial Intelligence, Personalized Nutrition, AI Chatbot, Large Language Model (LLM), Text-to-Speech, Meal Plan Generation

## I. INTRODUCTION

The importance of maintaining a healthy diet has increased significantly in recent years due to rising health issues and changing lifestyle patterns. Many individuals struggle to follow balanced dietary plans because of allergies, medical conditions, and lack of personalized nutritional guidance. Traditional diet recommendation systems often fail to address these individual needs effectively. The proposed Nutritional Guidance System with Allergen-Aware Recommendations uses Artificial Intelligence to provide personalized meal suggestions based on user preferences and health requirements. By integrating Large Language Models, interactive chatbot support, and voice-based guidance, the system offers a smarter and more accessible approach to personalized nutrition management.

## II. LITERATURE SURVEY

### Early Works

#### 1. A Food Recommender System Considering Nutritional Information and User Preferences

Raciel Yera Toledo, Ahmad A. Alzahrani, Luis Martínez (2018) – Proposes a food recommendation system using AHPSort filtering and optimization algorithms to generate nutritionally balanced meal plans based on user preferences. However, it lacks interactive AI-based dietary guidance.

#### 2. NUTRIC AI: AI-Assisted Personalized Nutrition Recommendation System

Harish N, Kavitha S, Surya Prakash G (2023) – Introduces an AI-based nutrition system that uses CNN, LSTM, and generative models to provide personalized meal recommendations and dietary analysis. However, it provides limited allergen-aware dietary support.

#### 3. A Deep Learning Framework for Recipe Generation from Multi Input Food Data

Kolisetty Sri Vyshnavi, Sunkesula Thaniya, Fancy C (2024) – Develops a CNN-based system that generates recipes from ingredient lists or food images with cooking instructions and calorie information. However, it focuses mainly on recipe generation rather than personalized nutrition planning.

#### **4. SmartDiet: A Personal Diet Consultant for Healthy Meal Planning**

Jen-Hao Hsiao, Henry Chang (2018) – Proposes an interactive diet consulting system that generates nutrient-balanced meal plans using multi-objective optimization for Personal Diet of individual user. However, it lacks AI chatbot support and real-time dietary guidance.

#### **OBJECTIVES**

The primary objectives of this project include:

- Developing an intelligent web-based nutritional guidance system to assist users in planning healthy and balanced meals.
- Generating personalized meal recommendations based on user inputs such as dietary goals, preferences, and allergen restrictions.
- Utilizing Artificial Intelligence and a Groq-powered Large Language Model (LLM) to dynamically create adaptive and context-aware meal plans.
- Providing allergen-aware food suggestions to ensure that recommended meals are safe for users with dietary restrictions.
- Enabling real-time communication through chat and notifications to enhance interaction and collaboration.
- Providing allergen-aware food suggestions to ensure that recommended meals are safe for users with dietary restrictions.
- Promoting healthier eating habits by delivering personalized, safe, and easy-to-understand nutritional recommendations.

### **III. METHODOLOGY**

The proposed Nutritional Guidance System integrates Artificial Intelligence, user preference analysis, allergen-aware filtering, and interactive chatbot support to generate personalized and safe dietary recommendations.

#### **System Workflow:**

##### **1. User Input Collection:**

Users provide structured inputs such as dietary goals, diet type, lifestyle preferences, and allergen restrictions through the web interface.

##### **2. AI-Based Meal Recommendation:**

The system constructs prompts from user inputs and sends them to a Groq-powered Large Language Model (LLM) to generate personalized meal plans that satisfy nutritional requirements while avoiding allergen ingredients.

##### **3. Interactive Nutritional Guidance:**

An AI-powered chatbot allows users to ask dietary questions, receive explanations for recommendations, and obtain safe ingredient substitutions.

### **IV. PROPOSED SYSTEM**

The **Nutritional Guidance System with Allergen-Aware Recommendations using Artificial Intelligence** is designed to provide personalized meal suggestions based on user dietary preferences, health goals, and allergen restrictions. The system uses a **Groq-powered Large Language Model (LLM)** to dynamically generate meal recommendations instead of relying on static food datasets.

By processing structured user inputs, the system produces safe and nutritionally balanced meal plans. An **AI-powered chatbot** provides interactive dietary guidance, while **Text-to-Speech technology** converts recommendations into voice output, making the platform more accessible and user-friendly.

#### **System Overview**

The proposed system includes:

- **User Input Module** – Allows users to provide dietary goals, food preferences, lifestyle details, and allergen restrictions.
- **AI Meal Recommendation System** – Uses a Groq-powered Large Language Model (LLM) to generate personalized and nutritionally balanced meal suggestions.

- **Allergen-Aware Filtering** – Ensures that recommended meals avoid ingredients that may trigger allergies.
- **AI Chatbot Support** – Provides interactive guidance, answers dietary queries, and explains recommended meal plans.
- **Voice Output System** – Converts generated recommendations into audio using Text-to-Speech technology for better accessibility.

#### Hardware & Software Components

- **Frontend:** Next.js, Tailwind CSS, shaden.
- **Backend:** Node.js with Supabase (Cloud Database).
- **Authentication & Security:** Supabase
- **Hosting & Tools:** Vercel, VS Code, Git/GitHub.

### V. APPLICATIONS

The **Nutritional Guidance System with Allergen-Aware Recommendations using Artificial Intelligence** has several practical applications in health, wellness, and nutrition management. By combining AI-based meal recommendations, allergen awareness, and interactive chatbot guidance, the system helps users make safer and healthier dietary decisions.

- **Personal Nutrition Management**

Helps individuals plan balanced meals based on dietary preferences, health goals, and allergen restrictions.

- **Healthcare & Diet Monitoring**

Supports patients with medical conditions or allergies by recommending safe and nutritionally appropriate meals.

- **Fitness & Lifestyle Applications**

Assists fitness enthusiasts in maintaining proper nutrition according to their lifestyle and fitness goals.

- **Smart Diet Planning Tools**

Can be integrated into health apps or wellness platforms to provide AI-powered meal recommendations.

- **Nutrition Education & Awareness**

Helps users learn about balanced diets, ingredient safety, and healthier food choices through interactive AI guidance.

### VI. ALGORITHMS

The proposed Nutritional Guidance System integrates multiple computational and AI-based algorithms to generate personalized, nutritionally balanced, and allergen-safe meal plans. The core algorithms are described as follows:

#### A. Health Metric Computation Algorithm

This algorithm computes essential health indicators such as Body Mass Index (BMI), Basal Metabolic Rate (BMR), and daily caloric requirements.

**Steps:**

1. Collect user inputs including height, weight, age, and gender.
2. Compute BMI using standard formula:

$$BMI = \frac{weight}{height^2}$$

3. Calculate BMR using the Mifflin-St Jeor equation.
4. Adjust BMR based on activity level to determine Total Daily Energy Expenditure (TDEE).
5. Modify caloric requirements based on user goal (weight loss, maintenance, or gain).

#### B. Macro-Nutrient Distribution Algorithm

This algorithm determines the optimal distribution of macronutrients.

**Steps:**

1. Set protein target based on user preference or recommended range.
2. Allocate fat based on standard dietary percentage.

3. Calculate remaining calories:

$$\text{Remaining} = \text{TotalCalories} - (\text{Protein} \times 4 + \text{Fat} \times 9)$$

4. Convert remaining calories into carbohydrates:

$$\text{Carbohydrates} = \frac{\text{Remaining}}{4}$$

### C. Prompt Construction Algorithm

This algorithm converts structured user inputs into a constrained prompt for the LLM.

#### Steps:

1. Aggregate user inputs including dietary preferences, allergens, and macro targets.
2. Embed strict constraints such as:
  - o Calorie tolerance ( $\pm 150$  kcal)
  - o Protein tolerance ( $\pm 20$  g)
  - o Meal structure (4–5 meals)
  - o Budget considerations
3. Format the prompt in a structured and instruction-driven format.
4. Forward the prompt to the Groq-powered LLM.

### D. AI-Based Meal Plan Generation Algorithm

The system leverages a Large Language Model to generate meal plans dynamically.

#### Steps:

1. Receive structured prompt from the system.
2. Generate meal plan in structured JSON format.
3. Ensure:
  - o Nutritional balance
  - o Allergen exclusion
  - o Realistic meal combinations

### E. Validation Algorithm

This algorithm ensures the correctness and reliability of generated outputs.

#### Steps:

1. Compute total calories and protein from generated meals.
2. Validate:
  - o Calorie deviation within  $\pm 150$  kcal
  - o Protein deviation within  $\pm 20$  g
3. If constraints are not satisfied, regenerate the plan.
4. If valid, display results to the user.

### F. Conversational Assistant Algorithm

This module provides interactive dietary guidance.

#### Steps:

1. Accept user query.
2. Combine query with meal plan context.
3. Generate response using LLM.
4. Return concise and relevant output.

### G. Text-to-Speech (TTS) Algorithm

This algorithm converts text responses into speech output.

#### Steps:

1. Preprocess text by removing symbols and formatting inconsistencies.
2. Segment long text into manageable chunks.
3. Send each chunk to Sarvam TTS API.
4. Decode base64-encoded audio responses.

5. Merge audio frames into a single waveform.
6. Deliver final audio output to the user interface.

## VII. RESULT

The proposed system was evaluated based on performance, accuracy, and user experience. The results demonstrate the effectiveness of the system in generating personalized and reliable nutrition plans.

### A. Meal Plan Generation Accuracy

- The system successfully generated personalized meal plans for diverse user profiles.
- Calorie targets were maintained within a tolerance range of  $\pm 150$  kcal.
- Protein targets were achieved within  $\pm 20$  g deviation.
- Allergen constraints were strictly enforced across all generated plans.

### B. System Performance

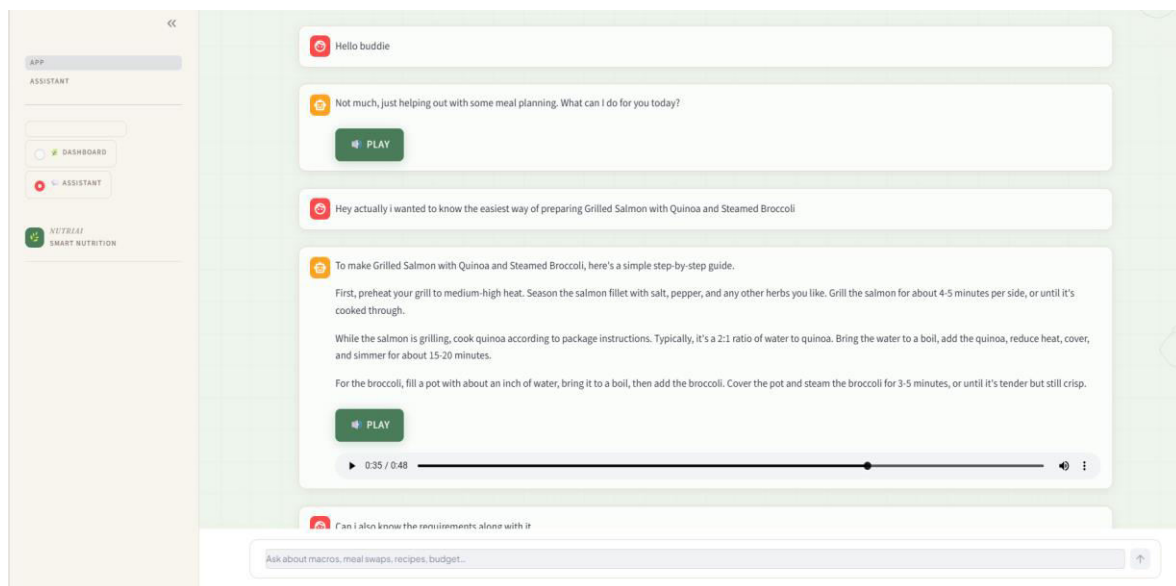
- Average meal plan generation time: **2–5 seconds**.
- Chatbot response time: **1–3 seconds**.
- The system maintained stable performance under repeated requests.

### C. Conversational Assistant Evaluation

- The chatbot provided accurate and context-aware responses.
- It successfully explained nutritional concepts, meal plans, and recipes.
- Responses were concise and suitable for both text and voice output.

### D. Text-to-Speech Performance

- The TTS system successfully converted responses into clear and natural speech.
- Audio output was understandable and suitable for real-time interaction.
- Chunking and audio merging techniques enabled longer speech outputs without truncation.

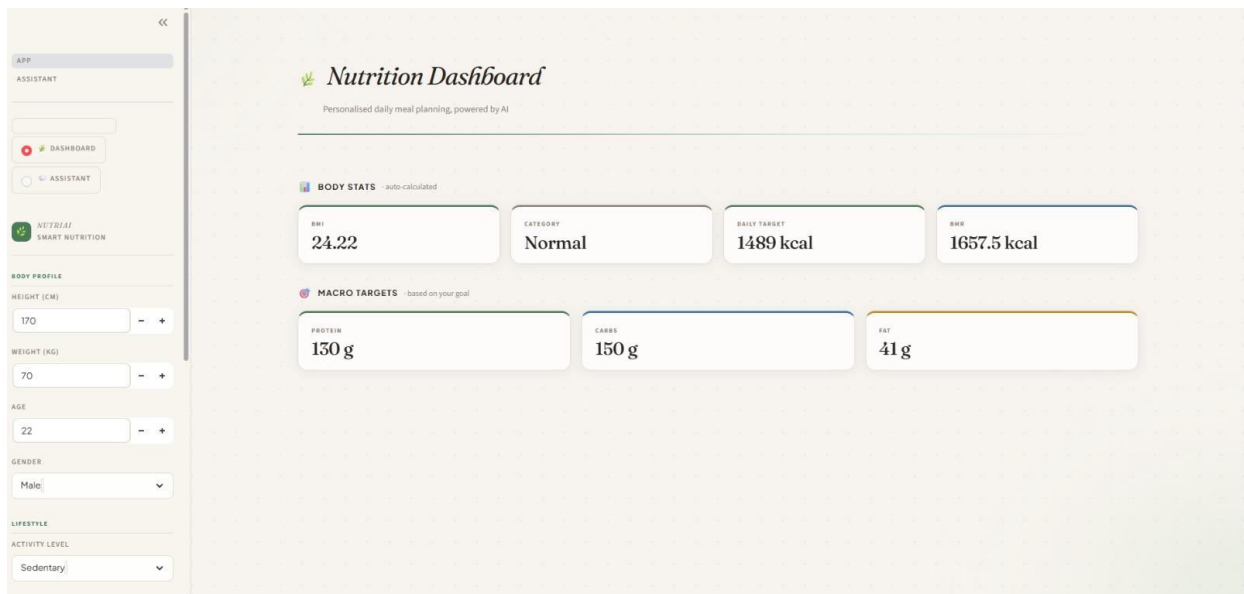
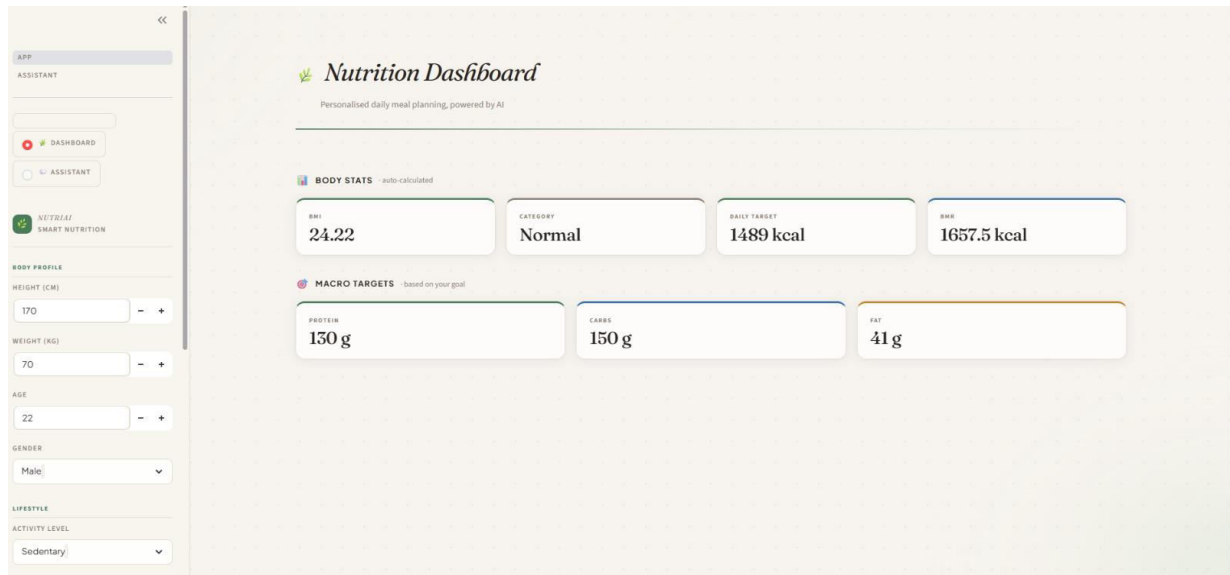


### E. User Experience Evaluation

- The system interface was intuitive and easy to use.
- Personalized recommendations improved user satisfaction.
- Voice interaction enhanced accessibility and engagement.

### F. Overall Outcome

The system effectively integrates AI-based meal generation, allergen-aware filtering, and voice-enabled interaction to provide a comprehensive and user-friendly nutrition guidance solution



### VIII. CONCLUSION

The **Nutritional Guidance System with Allergen-Aware Recommendations using Artificial Intelligence** provides an intelligent and user-friendly platform for personalized dietary guidance. By integrating a Groq-powered Large Language Model, the system dynamically generates meal recommendations based on individual dietary goals, preferences, and allergen restrictions. The platform enhances nutritional awareness by offering safe, balanced, and customized meal suggestions. The inclusion of an AI-powered chatbot enables interactive guidance, while Text-to-Speech technology improves accessibility through voice-based responses. Overall, the system promotes healthier eating habits and simplifies diet planning.

**IX. FUTURE ENHANCEMENT**

Here are the "Future Enhancements":

- 1. Mobile Application Development** – Developing a dedicated mobile application to provide easier access, real-time notifications, and personalized dietary guidance for users on smartphones.
- 2. Integration with Wearable Health Devices** – Connecting the system with fitness trackers and smartwatches to monitor health data such as calories burned, activity levels, and heart rate for more accurate meal recommendations.
- 3. Advanced Nutritional Analytics** – Introducing analytics dashboards that track daily nutrient intake, diet patterns, and health progress to help users maintain balanced nutrition.
- 4. Voice Assistant Integration** – Enhancing the system by integrating voice assistants to allow users to interact with the platform using voice commands for meal suggestions and dietary guidance.
- 5. Smart Food Scanning** – Integrating image recognition or barcode scanning to detect food ingredients and automatically warn users if the product contains allergens or restricted ingredients.

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