International Journal of Computer and Organization Trends
ISSN: 2249 – 2593 / https://doi.org/10.14445/22492593/IJCOT-V16I2P303

Volume 16 Issue 2, 21-26, May-Aug 2026

Original Article

Target Diet Recommendation for Health Optimization using Random Forest and Rule-Based AI

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Received: 04 May 2026 Revised: 06 June 2026 Accepted: 23 June 2026 Published: 09 July 2026

Abstract *- Maintaining a balanced and nutritious diet is essential for preventing lifestyle-related diseases and enhancing overall well-being. However, conventions diet planning approaches often provide generalized guidelines that do not account for individual health conditions, allergies, lifestyle habits, or personal food preferences. Because of this, many individuals follow diet plans that may not be suitable for their specific nutritional needs. Recent advancements in artificial intelligence and machine learning have enabled systems to generate personalized recommendations. This research proposes an AI-driven personalized diet recommendation system that generates customized diet plans based on user health information. The system collects parameters such as age, gender, height, weight, dietary preferences, allergies, and medical conditions. A Random Forest algorithm is employed to determine the most appropriate diet category. A rule-based filtering mechanism is applied to ensure that the recommended diet follows medical guidelines and avoids foods that may be harmful. The system also calculates important health indicators such as Body Mass Index (BMI), Basal Metabolic Rate (BMR), and daily calorie requirements to support accurate nutritional analysis. In addition, an AI chat-bot is integrated to provide dietary guidance and answer user queries related to nutrition. The system is implemented as a web application using the Flask framework and demonstrates the ability to generate safe and personalized diet recommendations.*

Keywords *- Artificial Intelligence, Diet Recommendation System, Personalized Nutrition, Machine Learning, Random Forest, Healthcare Informatics.*

1. Introduction

A healthy diet is important for maintaining good health and plays a major role in preventing chronic diseases such as obesity, diabetes, hypertension, and heart-related problems. In modern lifestyles, unhealthy eating habits and a lack of nutritional awareness have increased the risk of these diseases. Traditional diet plans often provide general recommendations that are designed for a large population instead of focusing on individual needs. As a result, many people find it difficult to follow such diet plans because they do not match their personal health requirements.

Artificial Intelligence and Machine Learning technologies have created new opportunities for developing systems that can provide personalized diet recommendations. Machine Learning algorithms can analyse user health data and identify patterns that help in predicting suitable diet plans for individuals. Among various algorithms, the Random Forest algorithm is widely used because it can handle both numerical and categorical data effectively and provide high-accuracy results. However, relying only on machine learning models may sometimes lead to recommendations that are medically safe. For example, a model might recommend sugary foods to a patient with diabetes. To overcome this limitation, the proposed system combines machine learning techniques with rule-based artificial intelligence to make sure that dietary recommendations follow medical guidelines. The system also removes food that may cause allergies and integrates an AI chat-bot to assist users with nutrition-related questions.

2. Literature Survey

Personalizing diet recommendation systems has become an important area of research due to the increasing need for intelligent healthcare solutions that can improve nutrition and prevent lifestyle-related diseases. Several studies have focused mainly on Artificial Intelligence, Machine Learning, and flexible meal planning techniques to generate customized dietary recommendations based on individual health parameters.

The study by Kyriakos Kalpakoglou et al.[1] presents an AI-based nutrition recommendation system that focuses on generating a personalized diet plan using a structured dataset and nutrition modelling. The research highlights the importance of combining artificial intelligence with domain knowledge of nutrition to create balanced and culturally relevant diet recommendations. The system was validated using Mediterranean diet data and demonstrated the effectiveness of AI in work. The proposed system adopts the concept of using a machine learning model to generate personalized and nutritionally balanced diet recommendations.

Another study by Sena Karamanli Aydin et al.[2] proposed an integrated AI framework that combines Machine Learning and natural language processing for personalized nutrition. The study emphasizes the importance of interactive and user-friendly systems in diet recommendations. The results show that combining predictive models with intelligent interfaces improves user engagement and understanding of dietary recommendations. Inspired by this approach, the proposed system integrates an AI-based chatbot to assist users in understanding diet plans and provide real-time nutritional guidance.

In addition, Maryam Amiri et al. [3] developed a personalized meal planning system designed for individuals with diet-related health conditions. The study focuses on creating flexible and adaptive meal plans based on medical requirements and user preferences. The research demonstrates that personalized meal planning improves adherence to dietary guidelines and helps users maintain healthier lifestyles. Based on this work, the proposed system incorporates rule-based filtering to ensure that diet recommendations are safe for users with medical conditions such as diabetes and hypertension.

Existing diet recommendation systems often provide generalized dietary advice and lack proper personalization. Many systems do not consider factors such as medical conditions, allergies, and preferences, which results in ineffective or unsafe diet plans. Additionally, some systems lack interactive features and real-time assistance, making it difficult for users to understand and follow the recommendations.

From the analysis of these studies, it is observed that:

- AI-based system improves personalization but doesn't always enforce strict medical constraints
- Integrated framework improves user interaction but requires better filtering mechanisms
- A flexible meal planning system supports health conditions, but needs automated prediction, models

Therefore, the proposed system combines the strengths of these approaches by integrating:

- Machine learning-based diet prediction using Random Forest
- Rule-based filtering for medical conditions and allergies
- Personalized meal plan generation
- AI chat-bot for interactive dietary guidance

This integrated approach aims to provide a comprehensive, safe, and personalized diet recommendation system that improves nutrition management and supports healthier lifestyles.

3. System Overview

The proposed personalized diet recommendation system is designed as an intelligent health platform that analyses user health information and generates customized diet plans [4][5]. The system combines several functional modules such as a user interface, backend processing server, machine learning prediction module, rule-based filtering system, food filtering module, meal plan generator, nutritional analysis module, and an AI chat-bot assistant. These components work together to ensure that diet recommendations are accurate, personalized, and safe.

The system begins with a web-based interface through which users provide their personal health details[6]. This information is transmitted to the backend server, which processes the data and calculates health indicators such as BMI and BMR. The processed data is then passed to the machine learning model that determines the most appropriate diet category for the user. After prediction, the rule-based filtering system ensures that the recommendation follows medical dietary restrictions. The system then removes foods that conflict with allergies or dietary preferences and generates a balanced meal plan that is calculated and presented to the user along with graphical health information.

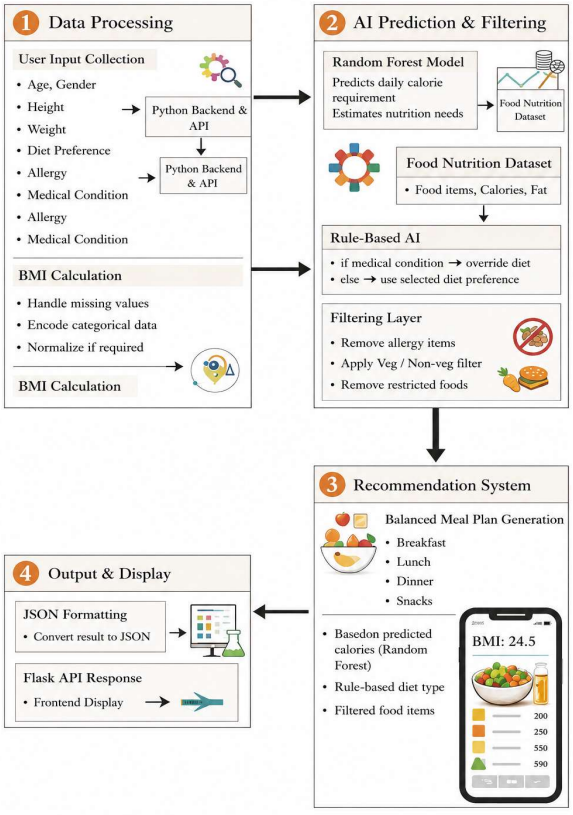

Fig. 1 Overall System Architecture

4. Dataset Description

The performance of a machine learning system mainly depends on the quality and structure of the dataset used during training the model [7][8]. In this system, a structured dataset was created to train the Random Forest model to predict suitable diet categories. The dataset contains multiple records representing individuals with different health characteristics and dietary requirements. Each record

contains details such as age, gender, height, weight, BMR, BMI, dietary preference, allergies, medical conditions, and recommended diet type.

Each attribute in the dataset contributes significantly to determining the appropriate diet plan for a user. Age and gender influence metabolism and nutritional requirements, while height and weight are used to calculate BMI, which indicates whether a person is underweight, normal weight, overweight, or obese.

Dietary preferences help determine acceptable food types, and allergy information ensures that the system avoids foods that could cause health problems. Medical conditions such as diabetes or hypertension also influence diet recommendations.

Before training the model, the dataset undergoes pre-processing to ensure that it is suitable for machine learning algorithms. Categorical variables such as gender and diet preference are transformed into numerical values by applying label encoding techniques.

After pre-processing, the dataset is then split into input features and the target variable. The input features include user health attributes, while the target variable represents the recommended diet category.

Table 1. User Inputs and System-Generated Outputs for the AI-Based Personalized Diet Recommendation System

Category	User input (provided by the user)	Calculated by the system
User profile	• Age • Gender • Height (cm) • Weight (kg)	• Body Mass Index (BMI) • Body Metabolism Ratio(BMR) • Daily calorie requirement • Health category (Normal/ Underweight/Overweight/Obese)
Diet preference	Diet Preference (Normal, Vegetarian, High Protein, Low Carb, No Sugar, Other-user specified)	Recommended Diet Type
Allergies	Peanuts, Dairy, Seafood, Sweets, Other - user specified	Food Restrictions Applied
Medical Conditions	Diabetes, BP, PCOS, PCOD, Other - user specified	Personalized Disease-Based Diet Plan
Meal Planning	- - - - -	Breakfast Suggestions Lunch Suggestions Dinner Suggestions Snack Suggestions
Nutrition Analysis	- - -	Meal-wise Calories Total Daily Calories Protein, Carbohydrates, Fat
AI Assistant	User Diet Question	Chatbot Diet Advice
Visualization	-	BMI Graph

5. Materials and Methods

The proposed system uses a combination of machine learning algorithms and rule-based artificial intelligence to generate personalized diet plans[9][10]. The process starts with data pre-processing, where the user input is converted into a structured format suitable for machine learning analysis.

Numerical values such as height and weight are validated, and categorical attributes are converted into numerical form using label encoding techniques. The system calculates important health indicators such as Body Mass Index (BMI) and Basal Metabolic Rate (BMR). BMI is calculated by dividing the user's weight by the square of their height to determine the user's body weight status.

BMR is calculated by using the Mifflin-St Jeor equation, which estimates the amount of calories the body requires for basic metabolic functions. The daily calories requirement is then estimated by multiplying the BMR value by an activity factor.

5.1. Random Forest Algorithm

This algorithm is applied to predict the most suitable diet category based on individual user data. Random Forest is an ensemble learning method that constructs multiple

decision trees and combines their predictions to improve accuracy.

5.2. Rule based AI

After predicting the diet category, a rule-based filtering system verifies whether the user has any existing medical conditions that require specific dietary restrictions. If such conditions are detected, the rule-based system overrides the prediction generated by the machine learning model.

The system also implements a food filtering mechanism that removes foods associated with user allergies or dietary preferences. After filtering unsuitable foods, the system generates a daily meal plan consisting of breakfast, lunch, dinner, and snack options. The nutritional analysis module calculates the calories and macronutrient content of the recommended meals.

6. Implementation and System Workflow

The diet recommendation system is implemented as a web application using the Flask framework in Python. The frontend interface is developed using HTML, CSS, and JavaScript, while the backend server processes user inputs and executes machine learning predictions. When a user enters their health condition through the web interface, the entered data is then transmitted to the backend server for processing.

The system workflow begins with collecting data from the user. After pre-processing the input data, the system calculates BMI and BMR values to evaluate and understand the user's health condition more effectively. The processed input features are then provided to the Random Forest model to predict the appropriate diet category. The rule-based filtering engine ensures that the prediction follows medical guidelines, and the food filtering module removes allergenic foods. A meal plan is generated from the filtered food database, and the nutritional analysis module calculates calorie and nutrient values. The final diet recommendation, along with nutritional information and BMI visualization, is displayed to the user through the web interface. The chat-bot component also allows users to ask questions related to diet and receive instant responses.

7. Experimental Results

The proposed system was evaluated using multiple user input scenarios representing different health conditions, dietary preferences, and allergies. The experiments were conducted to test the accuracy of the rule-based filtering system and the functionality of the meal generation module.

The Random Forest algorithm was able to successfully predict suitable diet categories for different users based on their health parameters. The rule-based filtering engine ensured that diet recommendations followed medical guidelines, particularly for conditions such as diabetes and hypertension. The food filtering mechanism affectively removed foods associated with allergies and ensured that recommended meals matched user dietary preferences.

The meal generation module produced balanced daily diet plans containing breakfast, lunch, dinner and snacks. Nutritional analysis provided calorie and macronutrient values for the generated meals. The web interface displayed BMI visualization. The chat-bot also responded effectively to user questions related to nutrition and healthy eating.

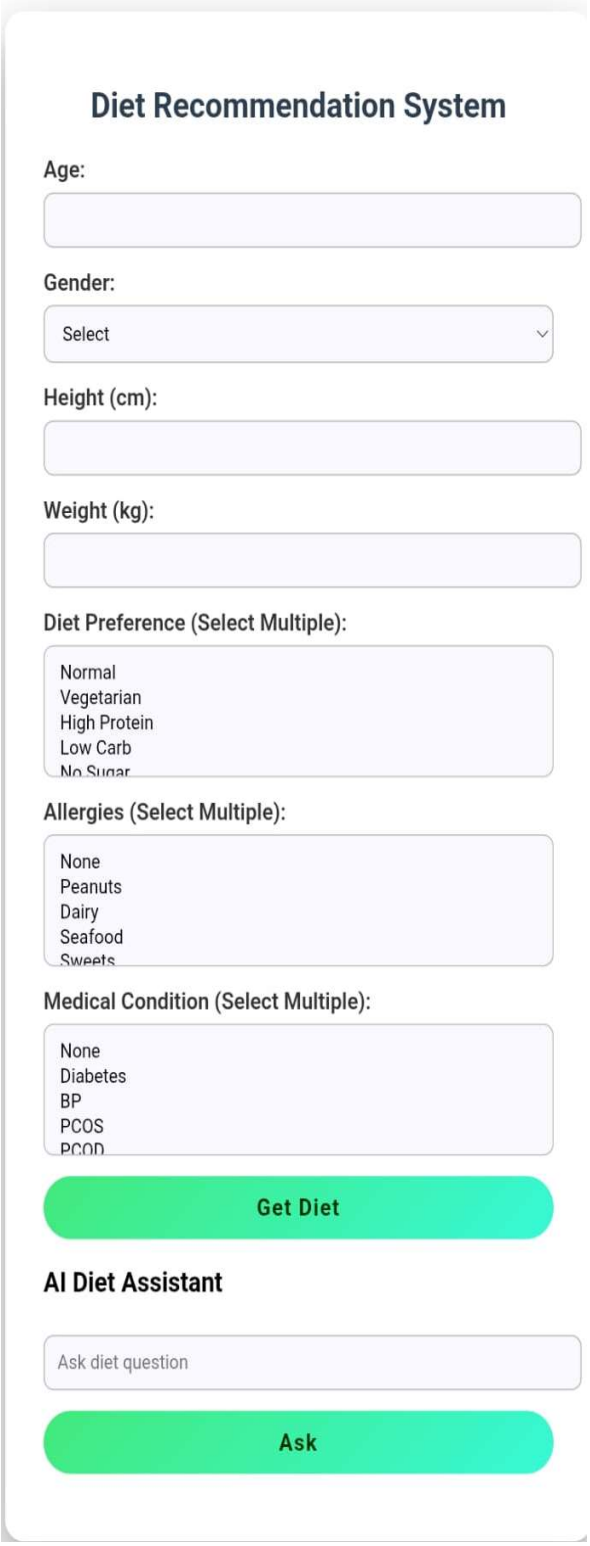

Fig. 2 User Interface

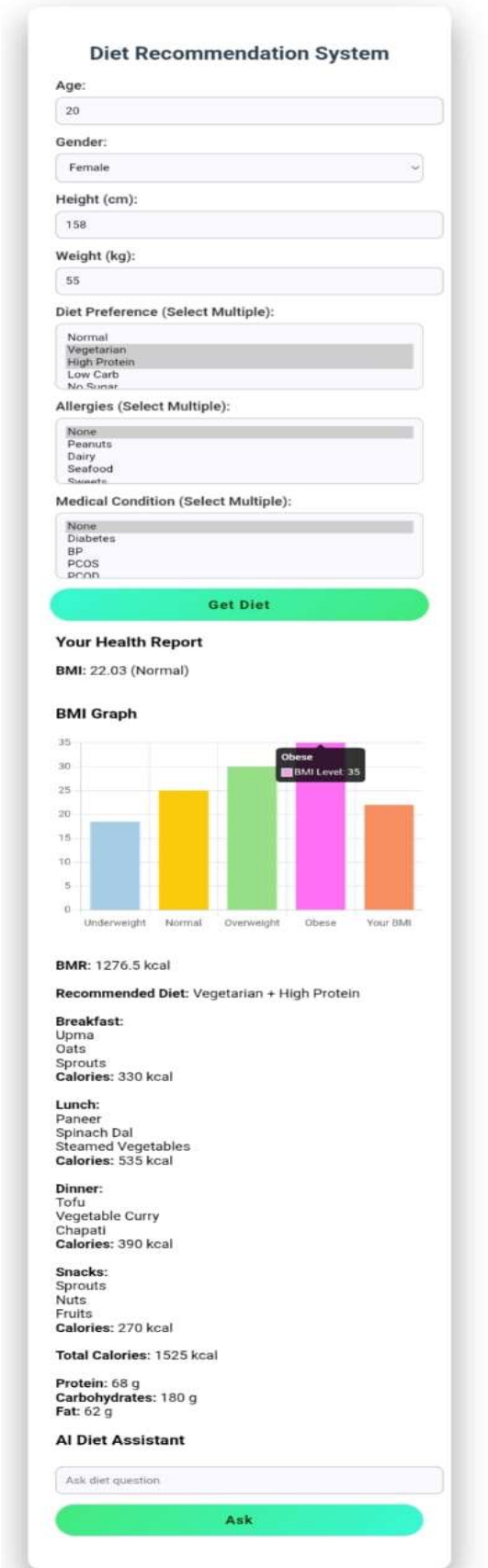

Fig. 3 Output

8. Conclusion and Future Scope

The proposed AI-driven personalized diet recommendation, system provides an intelligent solution for generating customized diet plans based on user health information. The system integrates machine learning, rule-based filtering, and nutritional analysis to ensure that diet recommendations are both personalized and medically safe. By analysing user parameters such as age, gender, BMI, dietary preferences, allergies, and medical conditions, the system can generate balanced meal plans that support healthy eating habits. The experimental results demonstrate that the system successfully predicts diet categories, filters unsuitable foods, and generates nutritionally balanced diet plans.

In the future, the system can be enhanced by expanding the dataset with real-world health data to improve prediction accuracy. Additional health parameters, such as physical activity levels, sleep patterns, and lifestyle habits, could also be incorporated to provide more comprehensive diet recommendations. Advanced machine learning techniques, along with deep learning approaches, may help to further enhance the overall prediction performance. Integration with wearable health devices and development of a mobile application could also improve accessibility and allow real-time monitoring of health data. These improvements would help transform the system into a more advanced digital healthcare platform for personalized nutrition management.

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