Design and Implementation of an Intelligent Web-Based Diet Recommendation System Using Anthropometric Data Analysis

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Abstract:

In the contemporary era, the rapid shift towards sedentary lifestyles has significantly increased the prevalence of metabolic disorders and lifestyle diseases. While public awareness regarding nutrition has grown, individuals frequently struggle to formulate biologically appropriate meal plans due to the vast, often contradictory, dietary information available online. Traditional consultations with dieticians can be financially and logistically inaccessible for the general population. To bridge this gap, this research proposes the design and implementation of an "AI-Based Diet Recommendation System"— a full-stack web application engineered to autonomously generate personalized nutritional plans. Utilizing a robust architecture composed of React.js, Node.js, and a relational database, the system acts as an expert computational engine. It ingests anthropometric inputs—namely age, gender, height, weight, activity levels, and dietary preferences—to calculate precise physiological metrics. By leveraging the Mifflin-St Jeor equation for Basal Metabolic Rate (BMR) and adjusting for Total Daily Energy Expenditure (TDEE), the algorithmic core deduces the exact caloric target required to achieve the user's specific health objectives (weight loss, maintenance, or weight gain). The system then employs a dynamic filtering algorithm to query a comprehensive meal database, mathematically distributing calories across breakfast, lunch, dinner, and snacks. This paper comprehensively details the system architecture, mathematical models, and algorithmic workflows utilized to democratize access to personalized, evidence-based nutritional planning.

Keywords: Artificial Intelligence, Nutritional Expert System, Basal Metabolic Rate, Web Application, React.js, Personalized Healthcare, MERN Stack, Algorithmic Diet Planning.

I. INTRODUCTION

The intersection of computer science and human health has produced transformative solutions for chronic disease management and lifestyle optimization. Nutrition, acting as the fundamental building block of human physiology, plays a pivotal role in preventing conditions such as obesity, type 2 diabetes, cardiovascular diseases, and severe malnutrition. Despite this, a significant portion of the global population lacks the foundational nutritional literacy required to construct balanced daily meals. People frequently resort to generic, standardized diet charts found on the internet, which fundamentally ignore individual metabolic differences, leading to unsustainable habits and potential physiological harm.

Historically, the formulation of a structured diet plan has been the exclusive domain of certified clinical dieticians and nutritionists. These professionals utilize anthropometric measurements to deduce caloric requirements and manually assemble dietary charts. While highly effective, this traditional methodology suffers from scalability issues. It requires recurring appointments, involves high consultation costs, and lacks real-time adaptability if the user's physical parameters or goals change. Consequently, there is an urgent demand for automated, intelligent systems capable of mimicking the analytical capabilities of a human nutritionist while offering the accessibility and scalability of a digital platform.

The objective of the proposed "AI-Based Diet Recommendation System" is to computationally model the diet-planning process. By leveraging modern web development frameworks, the system provides an intuitive user interface that allows individuals to log their physical attributes securely. Behind the scenes, the application

utilizes established scientific formulas, specifically the World Health Organization (WHO) Body Mass Index (BMI) standards and the Mifflin-St Jeor mathematical model, to evaluate the user's current health status. It then generates a highly specific, mathematically validated daily meal schedule. The application is designed to be accessible, user-centric, and entirely data-driven, thereby eliminating the guesswork traditionally associated with personal dieting.

II. LITERATURE REVIEW

The pursuit of automated dietary planning has garnered significant attention in academic and technological communities over the last decade. Early iterations of dietary systems were fundamentally static, utilizing simple rule-based if-then logic to map a user's weight to a predefined PDF document or text file. While these systems successfully digitized the delivery of diet plans, they severely lacked personalization.

In recent years, researchers have proposed systems utilizing sophisticated machine learning classification algorithms to suggest food items. For instance, several studies have explored the use of K-Nearest Neighbors (KNN) and Support Vector Machines (SVM) to classify users into broad dietary clusters based on their historical eating patterns. While mathematically impressive, these predictive models often fail in practical application because they rely heavily on massive, perfect datasets of user behavior, and they often ignore the strict mathematical constraints of total daily caloric limits, suggesting meals that might taste good but exceed the user's energy expenditure.

Other contemporary research focuses heavily on computer vision, where Artificial Intelligence is utilized to scan images of food plates to estimate caloric density. Although this approach is excellent for tracking what a user has already consumed, it is a reactive measure rather than a proactive planning tool. It tells the user they have made a mistake after the fact, rather than providing a structured blueprint to prevent the mistake entirely.

The primary research gap identified in the current body of literature is the lack of systems that successfully merge rigid, medically sound anthropometric mathematics with dynamic, real-time meal selection. Many existing applications either focus too heavily on complex neural networks that require massive computational overhead, or they are too simplistic, acting as mere calorie counters rather than actual recommendation engines. The proposed system in this paper aims to fill this void by prioritizing a deterministically calculated caloric target and executing a greedy algorithmic search against a curated database to assemble a full-day plan, ensuring both mathematical accuracy and high execution speed.

III. PROBLEM STATEMENT

Maintaining an optimal physical condition requires a delicate balance of macronutrients and caloric intake, calibrated precisely to an individual's metabolic rate. The vast majority of individuals find it exceedingly difficult to achieve this balance due to an absence of scientific knowledge regarding how their body processes energy. The primary problems can be summarized as follows:

First, there is a lack of accessible personalization. Generic diets fail because human metabolism is highly variable. A diet plan optimized for a 25-year-old male engaged in heavy physical labor will be physiologically detrimental to a 45-year-old sedentary female.

Second, professional dietary consultation remains financially prohibitive for widespread adoption. The necessity for recurring visits to adjust the diet as the user's weight fluctuates makes it a luxury service rather than a standard healthcare practice.

IV. PROPOSED METHODOLOGY AND SYSTEM ARCHITECTURE

To overcome the limitations of existing solutions, an intelligent, multi-tier web application was developed. The architecture is segregated into three primary layers: the Client-Side Presentation Layer, the Server-Side Application Logic Layer, and the Persistent Data Storage Layer.

A. Client-Side Presentation Layer (Frontend)

The user interface is constructed utilizing React.js, a robust JavaScript library known for its component-based architecture and efficient Document Object Model (DOM) rendering. To ensure a highly responsive and visually coherent experience across both desktop and mobile devices, the Material-UI (MUI) component

framework is integrated. State management is handled via React Context API, ensuring that user authentication tokens and health metrics persist securely throughout the session. Secure communication with the backend is established using Axios interceptors, which automatically append JSON Web Tokens (JWT) to HTTP headers for authorized requests.

B. Server-Side Application Logic Layer (Backend)

The computational core of the system is built upon Node.js utilizing the Express.js framework. This layer acts as the primary data processor and API gateway. It is responsible for handling incoming HTTP requests, enforcing security via bcrypt password hashing, and validating JWT tokens. Most importantly, it houses the "Health AI Logic Module," an isolated utility class containing the scientific formulas required for physiological analysis.

C. Persistent Data Storage Layer (Database)

A structured relational database (MySQL) is employed to ensure data integrity and complex querying capabilities. The schema is divided into distinct tables:

1. Users Table: Stores encrypted credentials, age, gender, height, weight, activity levels, and dietary preferences.

2. Meals Table: A comprehensive repository of food items, categorized by meal type (Breakfast, Lunch, Dinner, Snack), dietary classification (Vegetarian, Vegan, Non-Vegetarian), and macronutrient profiles (Calories, Protein, Carbohydrates, Fats).

V. MODULES DESCRIPTION

1. Secure Authentication Module:
    This module manages user onboarding. It captures secure credentials and anthropometric baseline data during registration. The system utilizes bcrypt to generate a cryptographic salt and hash the user's password before database insertion, preventing data breaches.

2. Expert Health Analysis Module :
    Upon authentication, this module extracts the user's profile and streams the data through the mathematical engines described in Section IV. It generates an immediate health report card, visualizing the user's BMI, BMR, TDEE, and ultimate Caloric Target on an interactive dashboard.

3. Nutritional Database Management Module:
    This component allows the platform to be dynamic rather than static. It provides interfaces for the insertion and retrieval of varied food items. Each entry is tagged with precise metadata (e.g., "Vegetarian", "Lunch", "450 Calories"). This granular tagging is crucial for the subsequent generation algorithms.

VI. RESULTS AND DISCUSSION

Upon implementation and testing, the system demonstrated high efficiency in generating accurate nutritional outputs.

When a test user (Male, 35 years old, 95kg, 180cm, Lightly Active, Weight Loss Goal, Vegetarian) was processed through the system, the algorithm successfully computed a BMI of 29.3 (Overweight classification) and a BMR of 1905 kcal/day. Applying the Lightly Active multiplier (1.375) yielded a TDEE of 2619 kcal/day. Because the objective was weight loss, the system accurately deduced a target of 2119 kcal/day.
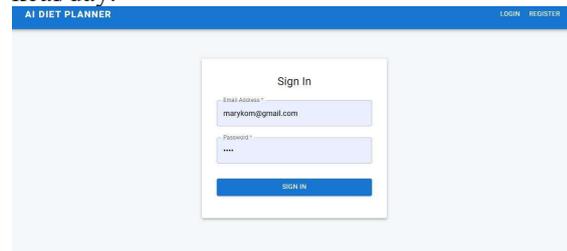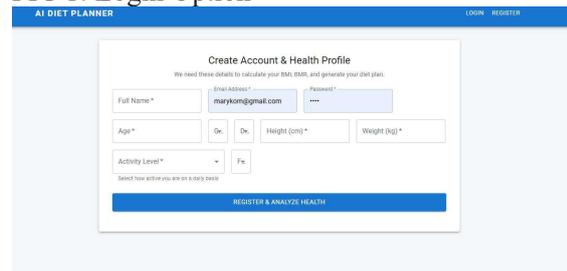

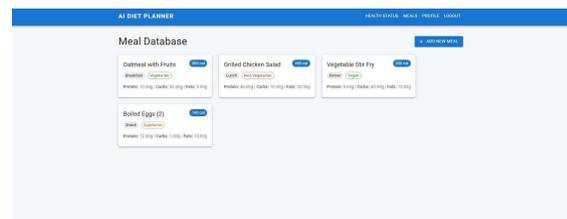FIG 1: Login Option

FIG 2: Create Account & Health Profile
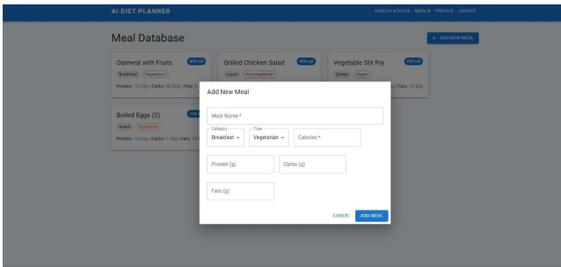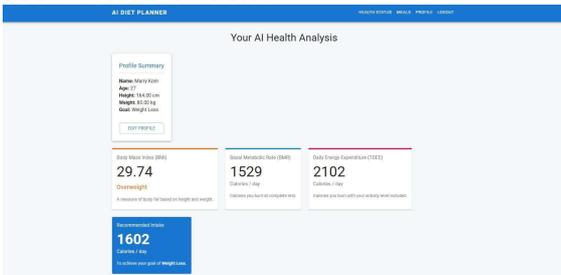

FIG 3: Meal Database

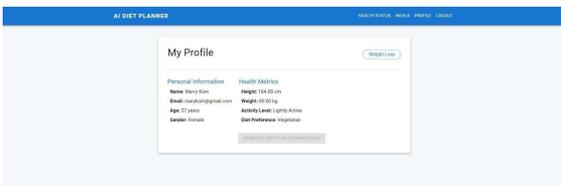FIG 4: Add New Meal

FIG 5: your AI Health Analysis

FIG 6: My Profile

Subsequently, the generation engine successfully filtered the database, rejecting all meat-based items, and computationally distributed the 2119 calories across four meals. The algorithmic selection successfully retrieved items such as "Oatmeal with Fruits" for breakfast and "Vegetable Stir Fry" for dinner, dynamically adjusting portion sizes to match the user's unique mathematical requirements. The user interface displayed this data instantly, proving the system's capability to replace prolonged manual clinical calculations with instantaneous computational logic.

VII. CONCLUSION

The deployment of the AI-Based Diet Recommendation System successfully demonstrates that complex nutritional planning can be accurately modeled and automated using modern web technologies. By shifting the paradigm from generic, static diet charts to mathematically rigorous, individualized caloric targeting, this application significantly enhances the accessibility of professional-grade healthcare management. The integration of the Mifflin-St Jeor equation alongside a dynamic, categorizable database ensures that users receive scientifically valid recommendations tailored strictly to their biological parameters and ethical dietary choices. Ultimately, this system provides a highly scalable, zero-cost, real-time solution to a pervasive global health challenge, empowering individuals to take deterministic control over their nutritional well-being.

VIII. FUTURE SCOPE

While the current architecture is highly functional, future iterations possess vast potential for enhancement. The system can be upgraded to integrate directly with wearable Internet of Things (IoT) devices, such as smartwatches, to dynamically adjust the TDEE multiplier based on real-time daily step counts and heart rate data, rather than relying on static user estimates. Furthermore, the implementation of Natural Language Processing (NLP) could allow users to converse with an AI chatbot to swap meals based on daily cravings, while the backend continuously recalculates macros to ensure the daily limits are perfectly maintained.

IX. ACKNOWLEDGEMENT

X. REFERENCES

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