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Fitintel: A Healthy Food & Exercise Recommendation Application Using Machine Learning.

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ABSTRACT :

In today's fast-paced world, people often neglect their dietary needs, leading to widespread health issues, particularly chronic diseases. To address this, a web-based application powered by machine learning techniques such as Decision Trees and Support Vector Machines has been developed to provide personalized dietary recommendations based on the user's health profile, which includes factors such as age and health conditions like fever, cold, high blood pressure, and diabetes. The application also focuses on dietary monitoring for individuals, helping to manage their diet effectively. Utilizing recommender systems, it delivers more accurate and targeted advice than existing solutions. This paper also includes a feature for simple exercise suggestions to improve fitness and manage weight. Designed for lower and middle-income individuals with limited access to healthcare, this application aims to promote better health management and support a healthier lifestyle.

Keywords: Chronic diseases, Dietary monitoring, Recommender systems, Health profile, Decision Trees, Support Vector Machines (SVM).

Main text :

Machine learning algorithms, particularly Decision Trees and Support Vector Machines (SVM), form the backbone of our web-based application designed to provide personalized dietary recommendations. Decision Trees manage both categorical and numerical data effectively, making them ideal for classifying dietary options based on user attributes such as age, health conditions, and preferences. By organizing data into a hierarchical structure, the algorithm facilitates clear and interpretable decision-making paths that align with specific health requirements. SVM, on the other hand, excels in handling high-dimensional data and identifies optimal boundaries between categories like "suitable" and "unsuitable" food choices. This ensures precision in predicting the health impacts of dietary options, particularly for individuals with conditions such as diabetes or high blood pressure. The combination of these algorithms allows our application to classify suitable foods accurately and predict their health effects based on the user's health profile. Furthermore, the system integrates features for dietary monitoring and simple exercise suggestions, enabling comprehensive lifestyle management. By leveraging these advanced techniques, the application addresses limitations in existing recommender systems, such as small datasets and inadequate personalization, ensuring more effective dietary guidance. This approach aims to empower users, particularly those in low-income groups, to achieve healthier eating habits and better manage their overall health.

Literature survey :

There are many existing works for Food and exercise recommendation system. In this survey, the different techniques of this research will be discussed.

1.1. Related works

The authors have proposed a time-aware food recommender system that leverages deep learning and graph clustering to suggest personalized food options based on user preferences, health data, and temporal factors (e.g., time of day). The system is designed to enhance recommendation accuracy by integrating a temporal component, addressing limitations in existing recommendation approaches that lack time-sensitivity. By clustering similar users and analyzing dietary trends over time, the model provides tailored meal suggestions that better align with users' eating patterns. The approach is demonstrated to improve recommendation relevance, contributing to healthier, user-centric dietary guidance [1].

The authors have discussed an IoT-assisted patient diet recommendation system that uses machine learning to deliver personalized dietary suggestions. By analyzing data like age, gender, weight, and health conditions, the system identifies suitable foods to improve patient health. The framework integrates multiple algorithms, including Naive Bayes, logistic regression, and deep learning models like LSTM and GRU, to enhance recommendation accuracy. The system's performance was tested with a medical dataset of patient information and food products, achieving high precision and recall with LSTM, particularly for classifying foods into "allowed" and "not allowed" categories. This approach supports better diet management and disease prevention [2].

The paper "Food Recommendation: Framework, Existing Solutions, and Challenges" presents a comprehensive analysis of food recommendation systems, which aim to address unhealthy eating habits by suggesting foods that meet personalized dietary needs. The authors propose a unified framework incorporating context, user preferences, and unique food characteristics to enhance recommendation accuracy. They review current solutions, including personal model construction and multimodal data integration, and identify challenges such as sensor signal fusion, real-time data handling, and user preference dynamics. The paper highlights future directions, including the need for large-scale food datasets, explainable recommendations, and integrating deep learning with knowledge graphs to improve the recommendation's effectiveness and relevance.[3]

The paper "An Open-Source Approach to Solving the Problem of Accurate Food-Intake Monitoring" introduces Libra, a pocket-sized, open-source kitchen scale designed for precise portion-size estimation to aid dietary monitoring. It addresses challenges in food-intake tracking for users with specific dietary needs. Libra features Bluetooth connectivity, low power consumption, and a customizable Android client for recording and tracking intake data. The open-source release of both integration, such as with Nutritics' Libro app, enhancing personalized nutrition monitoring. This innovation supports accurate dietary assessments, benefiting individuals, healthcare professionals, and researchers [4].

The paper introduces AI4Food-NutritionFW, a framework designed to create and analyze food image datasets to track and promote healthy eating behaviors. This user-friendly system allows individuals to capture images of their meals with smartphones, which are then assessed through an AI-powered model that evaluates eating habits based on nutritional guidelines. A unique food image dataset of 4,800 diets from 15 profiles (healthy to unhealthy) was developed, and a Healthy Score algorithm—based on the Mahalanobis Distance—assesses diet quality with high accuracy. The framework and dataset are open-source, supporting advancements in personalized nutrition and public health.[5]

The paper titled "Deep-Learning-Assisted Multi-Dish Food Recognition Application for Dietary Intake Reporting" presents an AI-powered model leveraging the EfficientDet deep learning framework for automatic food recognition. The study addresses key challenges in dietary reporting, including the accurate recognition of single, mixed, and multiple dishes, especially in local Taiwanese cuisines. Using a dataset of 87 food items with 4,733 images, the model achieved a high mean average precision (mAP) of 0.92, outperforming existing architectures like SSD and Faster R-CNN. It features a low inference time (<5 seconds), enabling real-time application in mobile health systems. The system improves usability by identifying multiple dishes simultaneously, supporting meal-based dietary reporting. Future work involves integrating the model into mobile and cloud platforms to enhance real-world usability, addressing diverse food types, and considering additional factors like portion sizes for comprehensive dietary assessment.[6]

The paper introduces FoodScan, an innovative mobile application aimed at simplifying dietary monitoring by analyzing grocery receipts. Targeted primarily at individuals aged 70 and above in rural areas, the app addresses the complexities of manual food tracking. It uses Optical Character Recognition (OCR) to extract data from receipts and integrates it with a food ontology to provide dietary insights and recommendations. Food Scan stands out from traditional calorie-counting apps by enabling automatic registration of purchased items, offering an intuitive interface, and functioning without an internet connection. Users can visualize their dietary patterns through easy-to-understand graphs that highlight food consumption and gaps in recommended intake. A pilot study with 109 participants demonstrated its accessibility and utility, with 93% recommending the app. Key limitations include its focus on purchased rather than consumed food and reliance on user adherence for accuracy. Future improvements include expanding the food ontology, integrating AI to enhance recognition accuracy, and adapting the app for broader demographics and platforms. Food Scan represents a significant step towards accessible and automated dietary monitoring, emphasizing simplicity and privacy while supporting healthier lifestyles. The study underlines its potential impact on public health and its adaptability for varied user groups.[7]

This paper introduces a Smart Plate designed to assist type-2 diabetes mellitus (T2DM) patients in managing their dietary intake through real-time food recognition, classification, and weight measurement. The system leverages the YOLOv5s algorithm for image recognition and Chenbo load cell sensors to determine food weight. It processes food images and measures portion sizes to calculate nutritional values, aiding users in adhering to personalized dietary plans.Using a dataset of 30,800 images representing 50 Korean food types, the system achieved varying recognition accuracies, with up to 62% for spicy beef soup. Weight and nutritional measurements showed 100% accuracy, demonstrating reliable performance for portion and calorie tracking.This study highlights the potential of integrating this technology with mobile diabetes applications to provide holistic health management. Future work aims to refine accuracy, expand food datasets, and incorporate the system into broader diabetes care frameworks.[8]

This paper presents an advanced mHealth recommendation system aimed at promoting physical activity through personalized exercise recommendations. Built on a deep recurrent neural network (RNN) with user-profile and temporal attention mechanisms, the system provides tailored exercise suggestions by analyzing user history and demographic data. It addresses a critical challenge in exercise recommendation systems—the inability to gather user feedback in real-time, unlike traditional click-based platforms. The proposed solution incorporates an expert-in-the-loop active learning framework, which evaluates the system's uncertainty in its recommendations. When confidence is low, it seeks input from experts to refine predictions. This method improves accuracy and personalizes recommendations effectively, especially for new users lacking prior data. Experiments conducted on an mHealth dataset show the system achieves significant accuracy improvements by combining user data with expert feedback. The model also includes an initialization mechanism for new users by leveraging the profiles of similar users, further enhancing its efficacy. The paper highlights the model's scalability and potential to expand to other applications, such as movie recommendations. By integrating active learning and expert input, this system represents a breakthrough in exercise recommendations, enabling more precise and accessible mHealth solutions.[9]

The document presents a novel food recommendation system that utilizes many-objective optimization (MaOO) to enhance personalized nutrition. Unlike traditional recommendation methods that focus primarily on user preferences, this approach addresses the complexities of food data by optimizing four key objectives: user preferences, nutritional values, dietary diversity, and adherence to individual diet patterns. The proposed system employs three Pareto-based algorithms to effectively tackle the recommendation task, leading to more balanced and scientifically sound dietary suggestions. Experimental validation demonstrates the efficacy of this MaOO-based framework in generating personalized and healthier diet plans, significantly improving health outcomes. Future research directions include integrating additional user-centered objectives, conducting further experimentation across diverse data sets, and incorporating machine learning for time-series analysis of food-related data. Overall, the integration of multiple objectives in food recommendations underscores its importance in promoting better health outcomes compared to simpler traditional methods [10].

Comparison table and Results :

Table 1 – Comparison table of related works which consists of techniques, advantages, limitations and gaps

Title	Technique	Advantages	Limitations	Results	Gaps
Health to Eat: A Smart Plate with Food Recognition, Classification, and Weight Measurement for Type-2 Diabetic Mellitus Patients' Nutrition Control (2023)	Artificial Intelligence, Machine learning, YOLO algorithm	Improved data processing, Automatic feature extraction, Real-time food recognition and classification, High accuracy in object detection.	Lack of knowledge about food classification based on food names, Difficulty in data validation and evaluation, Challenges in integration of hardware and software, Testing of the system.	Identification of 50 different types of food using 30,800 images, High accuracy in food recognition and classification, Successful integration of hardware and software, Real-time food analysis on a smart plate.	Further research needed on the application of the system to different types of food and in real-world settings, Exploration of other machine learning algorithms and techniques for food recognition and classification.
Realizing an Efficient IoMT-Assisted Patient Diet Recommendation System Through Machine Learning Model (2023)	Artificial Intelligence, Machine Learning, YOLO Algorithm	Enhanced data processing, Automatic feature extraction, Real-time recognition, High accuracy	Knowledge gaps in food classification, Data validation challenges, Integration issues	Identified 50 food types from 30,800 images, High classification accuracy, Successful hardware-software integration	Need for broader food applications, Exploration of additional machine learning algorithms
AI4Food-NutritionFW: A Novel Framework for the Automatic Synthesis and Analysis of Eating Behaviours (2023)	Artificial Intelligence, Machine Learning, YOLO Algorithm	Enhanced data processing, Automatic feature extraction, Real-time recognition, High accuracy	Knowledge gaps in food classification, Data validation challenges, Integration issues	Identified 50 food types from 30,800 images, High classification accuracy, Successful hardware-software integration	Need for broader food applications, Exploration of additional machine learning algorithms
Many-objective optimization meets recommendation systems: A food recommendation scenario (2022)	Many-objective optimization (Maoo) algorithms, Pareto-based optimization, Balances conflicting objectives like user preference, diversity, and nutrition, Uses metrics to create personalized recommend-ations	Achieves personalized, balanced dietary recommendations, Flexible system adaptable to multiple user objectives, Effective trade-offs through Pareto-based optimization, can integrate additional health metrics beyond nutrition	High computational cost when dealing with many objectives, Limited availability of real-world data for testing, Challenges in visualizing multi-objective trade-offs, Requires advanced user knowledge to interpret complex outputs	Demonstrated superior recommendations compared to traditional approaches, enhanced dietary outcomes using multi-objective strategies, Effective management of conflicting objectives such as health and diversity	Needs further real-world validation in diverse user populations, Does not integrate advanced machine learning techniques like neural networks, Lacks seamless scalability for broader use cases beyond nutrition
A Novel Time-Aware Food Recommender-System Based on Deep Learning and Graph Clustering (2022)	A Novel Time-Aware Food Recommender-System Based on Deep Learning and Graph Clustering (2022)	Personalized Recommendations, Time-Aware Features, Cold Start- Solutions	User Diversity, Evolving Dietary Patterns, Data Quality, Dependence	deliver personalized, context-sensitive meal suggestions, overcoming traditional limitations and fostering healthier dietary choices.	Existing systems often overlook food ingredients, user trust networks, community insights, and the time factor in ratings.

Deep-Learning-Assisted Multi-Dish Food Recognition Application for Dietary Intake Reporting (2022)	EfficientDet-D1deep learning model, Focus on single, mixed, and multiple dish recognition	High mean average precision (mAP) of 0.92, Robust recognition of diverse dishes, Scalable for real-world applications	High computational requirements, Challenges in adapting to dynamic/seasonal menu updates	Significant improvement in precision, recall, and mAP compared to existing models	Dataset limited to Taiwanese local dishes; not generalizable to other cuisines, Requires further dataset expansion and optimization for other regions
An Open-Source Approach to Solving the Problem of Accurate Food-Intake Monitoring (2021)	Open-source, pocket-sized Bluetooth kitchen scale "Libra", Integration with commercial applications like Libro	Low cost, Portable and pocket-sized, High precision (1g resolution), Open-source, enabling integration with other systems	Low cost, Portable and pocket-sized, High precision (1g resolution), Open-source, enabling integration with other systems	Proof-of-concept integration with Nutritics' Libro application demonstrated feasibility	Does not support advanced nutrition monitoring beyond basic connectivity, Lacks region-specific FCD adaptation
FoodScan: Food Monitoring App by Scanning the Groceries Receipts (2020)	Optical Character Recognition (OCR) for text extraction, Food ontologies for categorization, SQLite for local data storage, Visualization through graphs and charts	offline functionality ensures usability in areas with poor connectivity, User-friendly design for elderly populations with limited technical knowledge, simplifies food tracking with receipt scanning, Improves dietary habits with visual recommendations	Focuses on groceries purchased rather than food consumed, requires manual input for some operations, reducing usability, Relies on user adherence for accurate dietary tracking, Limited testing in diverse demographic groups	93% of users found it easy to install and use, 49% reported improved eating habits, successfully tested with 109 elderly users across rural areas, Effective offline functionality and dietary tracking via receipts	Limited to analyzing grocery purchases, not actual food consumption, no evaluation of long-term adherence or impact, Demographic-based personalization features not included
Food Recommendation: Framework, Existing Solutions, and Challenges (2020)	Combines context-aware recommendations (e.g., sensors for heart rate, GPS), personal model construction (e.g., preferences, allergies), multimodal food analysis (images, text, nutrition), collaborative filtering, and Knowledge Graphs for semantic understanding.	Enhances personalization by integrating health, dietary needs, and preferences; supports multimodal data; and improves accuracy using hybrid models.	Challenges in fusing heterogeneous data, noisy sensor information, lack of large-scale datasets, limited dynamic modeling, and minimal use of food-oriented Knowledge Graphs.	Reviewed existing methods, emphasizing context and multimodal data, but experimental results were not provided.	Calls for large-scale datasets, advanced sensor fusion, food-specific Knowledge Graphs, real-time dynamic modeling, and explainable AI for better food recommendations.

Conclusion and Future scope :

1.2. Conclusion

this web-based application leverages advanced machine learning techniques to offer personalized and data-driven dietary recommendations, empowering users to better manage their health and mitigate the risks of chronic diseases. By focusing on individual health profiles and providing tailored suggestions, including diet and exercise recommendations, the application not only enhances dietary awareness but also supports overall well-being. Its user-friendly design, targeted toward individuals with limited healthcare access, makes it a valuable tool for promoting healthier lifestyles in underserved communities. Ultimately, this solution aims to bridge the gap in personalized health management, fostering long-term health improvements and disease prevention.

1.3. Future scope

The future potential of this web-based application is extensive, with numerous opportunities for further development and innovation. As advancements in machine learning and data analytics progress, the application's ability to provide even more precise and personalized dietary recommendations can be enhanced through the use of more sophisticated algorithms and expanded datasets. Future versions could also integrate real-time health data from wearable devices, enabling users to receive adaptive dietary and exercise suggestions based on their current health status.Additionally, the app could expand its scope to address a broader range of health conditions, including mental health issues or specialized dietary needs, making it applicable to a wider demographic. Incorporating features such as virtual consultations with nutrition experts, social support communities, or integration with healthcare networks could further improve its utility and impact.

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