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A Machine Learning-Based Application for Assessing Packaged Food Healthiness and Suggesting Healthier Alternatives

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Abstract: *This project focuses on developing an AI-powered platform for assessing the healthiness of packaged food products and suggesting healthier alternatives. The system scans product barcodes, extracts ingredient details, and evaluates health impact using machine learning models. The application provides real-time feedback on food quality, detecting harmful additives, excess sugars, and unhealthy fats. The AI engine then recommends better alternatives based on the user's dietary preferences. This solution aims to enhance consumer awareness and promote healthier eating habits through AI-driven insights.*

Keywords: Packaged Food, Machine Learning, Barcode Scanner, Ingredient Analysis, Food Health Assessment, Alternative Suggestion, AI-Driven Nutrition.

I. INTRODUCTION

In today's fast-paced world, consumers are increasingly reliant on packaged food products due to convenience and accessibility. However, understanding the health implications of these products remains a challenge, as nutrition labels can be complex and difficult to interpret. Many individuals struggle to assess the nutritional value of packaged foods, leading to unhealthy dietary choices that contribute to obesity, diabetes, and other lifestyle-related diseases.

This project aims to bridge this gap by developing a user-friendly application that leverages artificial intelligence (AI) and machine learning (ML) to analyze packaged food products and provide users with real-time health evaluations. By scanning product barcodes, users can instantly access detailed insights about food composition, including the presence of harmful ingredients, excessive sugar or sodium content, and artificial additives. The system assigns a health score based on predefined nutritional guidelines and scientific research, allowing users to make informed purchasing decisions.

A key innovation of this application is its ability to suggest healthier alternatives tailored to individual dietary preferences and restrictions. By integrating a comprehensive ingredient database and ML-driven recommendation algorithms, the system identifies suitable substitute products that align with users' health goals. Whether a user is looking for gluten-free, low-calorie, or organic alternatives, the application provides personalized suggestions to encourage healthier eating habits.

The core functionalities of this project include barcode scanning for instant product identification, ingredient analysis for health impact evaluation, a dynamic recommendation system for healthier alternatives, and an intuitive user interface for seamless interaction. The implementation of machine

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learning enhances the accuracy and efficiency of product analysis, ensuring that users receive reliable and data-driven recommendations.

By simplifying the process of nutritional analysis, this project empowers consumers to take control of their dietary choices, fostering a culture of health-conscious decision-making. With the growing global emphasis on wellness and preventive healthcare, this application serves as a valuable tool in promoting public health by enabling individuals to make informed food choices effortlessly. Ultimately, this system aspires to contribute to a healthier society by enhancing transparency in packaged food consumption and encouraging sustainable dietary habits.

II. OBJECTIVES

1. Develop an intelligent mobile application that enables users to scan barcodes on packaged food products and retrieve detailed ingredient information from a comprehensive database, ensuring easy access to nutritional data.
2. Implement an AI-driven evaluation system that assesses the healthiness of food products based on predefined nutrition standards, scientific guidelines, and established dietary recommendations to provide accurate and insightful assessments.
3. Provide real-time health risk analysis, alerting users about potentially harmful ingredients such as excessive sugars, high sodium levels, trans fats, and artificial additives that may have adverse effects on health.
4. Offer personalized alternative recommendations by leveraging machine learning algorithms that consider user preferences, dietary restrictions, and health goals to suggest healthier substitute products.
5. Enhance user awareness and decision-making by presenting health impact scores and comparative insights between scanned products and their alternatives, fostering informed purchasing choices.
6. Ensure seamless user experience through an intuitive interface that simplifies navigation, product scanning, and result interpretation, making the application accessible to a wide range of users.
7. Continuously improve the recommendation system by integrating user feedback and refining AI models to enhance the accuracy and relevance of health assessments and alternative suggestions.
8. Promote health-conscious consumption patterns by educating users about nutrition, encouraging mindful eating habits, and contributing to long-term dietary improvements.

III. PROBLEM STATEMENT

Consumers often lack the knowledge and tools to accurately evaluate the healthiness of packaged food products, leading to uninformed dietary choices that can have long-term negative health consequences. Many individuals rely on food labels that are difficult to interpret or misleading, resulting in increased consumption of products with excessive sugars, unhealthy fats, and artificial additives. Existing solutions, such as generic nutrition apps or manual label reading, fail to provide personalized, data-driven insights that align with an individual's dietary needs and health goals. These

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limitations create a significant gap in consumer awareness and the ability to make well-informed decisions regarding packaged food consumption.

This project addresses these challenges by developing an AI-powered mobile application that utilizes machine learning to analyze packaged food products in real time. The system evaluates the nutritional composition of products, assigns a health score based on scientific standards, and provides instant feedback on potential health risks. Furthermore, the application suggests healthier alternatives tailored to users' dietary preferences, restrictions, and wellness goals. By leveraging advanced AI algorithms and an extensive ingredient database, this solution empowers consumers to make smarter food choices, ultimately promoting a healthier lifestyle.

IV. LITERATURE REVIEW

With the increasing prevalence of diet-related health issues, various research efforts have explored the intersection of mobile technology, food tracking, and machine learning. Numerous mobile applications have been developed to assist users in maintaining healthy diets by offering food logs, calorie counters, and diet recommendations. However, most of these applications require manual data entry, which can be time-consuming and error-prone.

Previous studies have investigated the integration of barcode scanning to simplify the process of food item identification. Applications like MyFitnessPal and Yuka use barcode scanning to access product details from nutritional databases. Similarly, the OpenFoodFacts database has been widely utilized in academic and industrial settings due to its openness and extensive product catalog.

From a technical standpoint, Firebase has become a preferred backend solution due to its real-time capabilities, easy authentication mechanisms, and integration with Android apps. Google ML Kit has also been extensively employed for on-device scanning tasks due to its reliability and speed.

In terms of health analysis, prior research has shown the effectiveness of machine learning in predicting food healthiness based on nutritional values. Models such as Linear Regression, Support Vector Machines, and Decision Trees have been used in similar contexts to classify food items based on their nutritional impact. These models take input features such as sugar, fat, salt, and calories to output a health score or rating.

Despite these advancements, there remains a gap in creating a unified system that provides real-time product scanning, automated nutritional analysis, and machine learning-based scoring — all while maintaining secure and user-specific tracking. This project aims to bridge that gap by combining multiple proven technologies into a single, accessible mobile application.

V. PROPOSED SYSTEM

5.1 Overview:

The proposed system is an Android-based mobile application designed to scan packaged food barcodes, fetch nutritional information from the OpenFoodFacts API, and evaluate the healthiness of the product using a machine learning model deployed on a cloud platform. It also stores user data and scanned history securely using Firebase services. The system architecture is divided into five main components:

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1. User Authentication
2. Barcode Scanning
3. Product Information Retrieval
4. Health Score Prediction using Machine Learning
5. Cloud-Based Storage and Data Management

5.2 System Workflow:

1. User Authentication (Firebase Authentication):
   - Users sign up or log in using email and password.
   - Firebase Authentication verifies credentials
   - Upon successful login, users are redirected to the home screen.
2. Barcode Scanning (Google ML Kit):
   - Users press the "Scan Now" button.
   - The ML Kit-based scanner detects and extracts the barcode value from the camera in real time.
3. Product Information Retrieval (OpenFoodFacts API):
   - The barcode is sent to the OpenFoodFacts API.
   - Product details such as name, brand, image, and nutritional values are fetched.
   - These details are displayed in the Product Details screen.
   - The data is saved under the user's UID in Firebase Realtime Database.
4. Health Score Prediction (Machine Learning Model using Flask):
   - On clicking the “Check Health Score” button:
     - Nutrition values like sugar, salt, fat, and energy are parsed from JSON.
     - These values are sent to a Python-based ML API deployed on Render.
     - The ML model (Linear Regression) calculates a health score.
     - The score is sent back to the Android app and displayed in a separate screen with a UI indicating the health level.
5. Data Storage and Management (Firebase Realtime Database):
   - Each scanned product is saved under the authenticated user’s data in Firebase.
   - Products can be accessed later for review or history tracking.

VI. SYSTEM IMPLEMENTATION

The proposed system is implemented as an Android mobile application developed using Java. The application integrates multiple technologies to ensure seamless barcode scanning, real-time product retrieval, and nutritional health evaluation.

6.1 User Authentication:

The application begins with secure user authentication implemented using Firebase Authentication. Users can register and log in using their email and password. Upon successful login, the system

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redirects the user to the main dashboard, while unverified users are sent to the login screen. Authentication ensures personalized data storage and access.

Backend Integration:

- Firebase stores user credentials securely.
- Logged-in users are identified via FirebaseAuth.getInstance().getCurrentUser().

6.2 Barcode Scanning and Product Retrieval:

Once authenticated, users can scan packaged food barcodes using Google ML Kit integrated with CameraX API. The barcode value is captured and used to fetch product details from the OpenFoodFacts API.

Backend/API Flow:

- Barcode value → API call using Volley → OpenFoodFacts JSON response.
- Parses and displays product name, brand, image, and nutritional info.

6.3 Firebase Realtime Database Storage:

Every scanned product is saved under the user's unique Firebase UID using Firebase Realtime Database. This allows historical tracking and personalized storage of scanned products.

Data Stored Includes:

- Barcode
- Product name
- Brand
- Product image URL

6.4 Machine Learning-based Health Score Prediction:

After viewing the product's details, users can tap Check Health Score, which extracts key nutritional components such as sugar, fat, salt, and energy from the API data. These are sent to a hosted Flask API that runs a Random Forest Regression model to predict a healthiness score out of 100.

Workflow:

- Nutrients sent via Volley as POST request.
- Flask API receives and processes input.
- ML model predicts score.
- Score returned to app and displayed in a new activity with classification (e.g., "Healthy", "Moderate", "Unhealthy").

6.5 Deployment:

- Flask API is deployed on Render, a cloud platform.
- It remains live and accessible for real-time health score prediction.
- Android app connects using RESTful API architecture via HTTP POST.

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VII. CONCLUSION

In this project, we successfully developed a comprehensive Android application that allows users to scan food product barcodes, retrieve nutritional data, and assess the healthiness of the product using a machine learning-based prediction system. By integrating Firebase Authentication, Realtime Database, the OpenFoodFacts API, and a custom ML model hosted on the cloud, we created a practical and user-friendly tool that encourages informed food choices.

The application not only enables real-time scanning and information retrieval but also introduces a health score prediction mechanism, which enhances the decision-making process for health-conscious consumers. The use of modern tools such as Google ML Kit, Firebase, and a Flask-based ML server demonstrates a harmonious integration of mobile development with machine learning and cloud computing.

This project can be further extended by including more advanced health metrics, food category classification, and real-time health alerts based on user profiles. The current system lays a solid foundation for future research and development in AI-powered mobile health applications.

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