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"SMART INGREDIENTS CHECKER: AN AI-ASSISTED TOOL FOR SAFER AND INFORMED FOOD CHOICES"

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ABSTRACT

The Ingredients Checker project is developed to address the growing need for food transparency by empowering individuals to make safer and more informed dietary choices. With the increasing prevalence of food allergies, dietary restrictions, and health awareness, users require a quick and reliable method to analyze food labels for potential allergens or conflicts with their dietary preferences. This application enables users to scan or manually input ingredients, instantly identifying potential risks based on their personalized dietary profile. Leveraging technologies such as image recognition and database cross-referencing the system provides customized alerts for allergens, restricted ingredients, and other health-related concerns, thereby assisting users in navigating complex food choices.

The project employs modern web technologies, including React.js for an interactive front-end and Node.js for a scalable back-end. By integrating with APIs such as the Open Food Facts database , it ensures accurate and up-to-date cross-referencing of ingredient data. Unlike traditional ingredient-checking tools, Ingredients Checker emphasizes personalization, allowing users to tailor alerts and settings to their individual dietary needs. This adaptability makes it useful for a diverse range of users—from those managing specific allergies to individuals following lifestyle-based diets.

Beyond personalization, the project contributes to public health awareness and consumer protection by promoting safer food selection and encouraging accountability among food manufacturers. By providing detailed ingredient analysis, the system builds consumer trust and supports health-conscious decision-making.

Key Words: *Food Transparency, Ingredient Analysis, Allergen Detection, Dietary Restrictions, Health Awareness, Image Recognition, Optical Character Recognition (OCR), Database Cross-Referencing, Personalized Alerts, React.js, Node.js, Open Food Facts API, Web Application.*

I. INTRODUCTION

The Ingredients Checker is a web-based application designed to help users make informed dietary choices. By leveraging OCR (Optical Character Recognition) technologies, it provides a quick, accurate way to analyze ingredients in packaged food products. With a growing number of individuals managing food allergies, dietary restrictions, and specific lifestyle preferences, Ingredients Checker fills a vital need for a tool that can quickly identify allergens, detect dietary compatibility, and make food selection easier.

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1. **OCR Functionality**
Enables users to upload images of ingredient lists from product labels or packaging. Utilizes Optical Character Recognition (OCR) technology to extract text-based ingredient information for further processing [1][2]. Ensures quick and accurate identification of ingredients, reducing manual data entry and improving usability.

2. Allergen and Dietary Compatibility Analysis
Automatically checks extracted ingredients against predefined allergen databases and dietary standards [3]. Identifies potential risks related to common allergens (e.g., gluten, peanuts, dairy) and dietary conflicts (e.g., vegan, keto, halal). Provides instant alerts or warnings to users for unsafe or restricted ingredients.

3. **User Preferences**
Allows users to customize their dietary profiles, specifying allergens, restrictions, or preferred diets. Supports a personalized analysis experience by tailoring results to individual health and lifestyle needs. Offers flexible settings for users to update or refine preferences anytime.

4. Data Storage and Analysis
Maintains a record of previously scanned items and user interaction history.
Enables users to review past ingredient checks for reference or trend analysis.
Provides insights into dietary patterns and helps track adherence to dietary goals.

II. LITERATURE REVIEW

Automated ingredient analysis systems combine image/text extraction (OCR), ingredient parsing (NLP), and domain knowledge (allergen/dietary databases) to help consumers make safer food choices. The growing availability of open food databases and mobile scanner apps has accelerated research and practical deployments in this domain.[1]

OCR / Image-to-text for Food Labels

Research and applied work show that OCR is the first critical step for label-based systems. Studies and implementations use robust OCR engines (Tesseract, PaddleOCR, cloud OCR services) with preprocessing (deskewing, denoising) to extract ingredient lists from packaging images; subsequent pipeline stages correct OCR errors and segment ingredient clauses for parsing. Recent efforts demonstrate good accuracy when images are high-quality but note performance degradation on curved surfaces, multilingual labels, and low-light photos.[2]

Ingredient Parsing and Allergen Detection (NLP & Rule-based)

After OCR, systems parse ingredient strings into tokens (ingredients, additives, E-numbers) and then match tokens against allergen and dietary lexicons. Approaches vary from rule-based string matching (including fuzzy matching and word lists) to NLP and ML methods that handle synonyms, composite ingredients (e.g., “contains wheat, milk”), and ambiguous terms. Reviews emphasize the importance of curated allergen lists and high-quality labeled datasets for reliable detection. [3]

Food Databases & APIs

Open, community-driven databases such as OpenFoodFacts provide extensive product records (ingredients, allergens, nutrition) and developer APIs that are widely used in research and apps. These resources also supply downloadable dumps and SDK packages that facilitate offline or server-side lookups—making them practical back-ends for ingredient-checking tools. [4]

Commercial & Research Applications

Several consumer-facing apps (e.g., Yuka, OpenFoodFacts scanner) and recent academic prototypes demonstrate end-to-end product scanning, ingredient evaluation, and personalized recommendations. Research prototypes typically integrate OCR, rule-based matching, and simple risk-classification UIs; newer studies explore ML/NLP and LLMs to enrich ingredient explanations and map ambiguous ingredient names to known allergens. Empirical work suggests such apps can nudge healthier choices, but usability and trust depend on accuracy and transparency. [4]

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Emerging Trends: ML, LLMs, and Hybrid Systems

Recent 2023–2025 studies propose hybrid pipelines: OCR → NLP → ML classifiers or LLM-assisted interpretation to (a) disambiguate ingredients, (b) infer hidden allergens in composite ingredients, and (c) provide user-friendly explanations. Early results are promising but caution that ML components require careful domain-specific training data and evaluation. [6]

Limitations and Open Problems

Major limitations reported in the literature include:

- OCR robustness on adverse images (curved, glossy labels), multilingual labels, and handwritten inputs.[7]
- Ambiguity in ingredient names, synonyms, and cross-contamination risks which are hard to infer from labels alone. [7]
- Need for up-to-date, well-curated allergen lexicons and localized regulatory knowledge (labeling rules vary by region). [8]
- Privacy and data storage concerns when storing user dietary histories (few studies examine long-term privacy tradeoffs).[9]

Gap Analysis — where *Ingredients Checker* fits

The literature suggests value in combining robust OCR, curated allergen/dietary lexicons (leveraging OpenFoodFacts), and personalization. Key gaps your project can address:

- Focus on personalized profiles (user-customizable allergens/preferences) integrated with automated OCR + parsing pipelines — many existing apps provide product scores but limited personalization.
- Implement improved error-correction and fuzzy-matching strategies for ingredient parsing (to reduce false negatives).
- Provide history & analytics (tracking scans and dietary trends) while designing minimal, privacy-preserving data storage.
- Explore ML/LLM-assisted improvements for ambiguous ingredient interpretation as a future extension.

III. PROBLEM STATEMENT

Many individuals with dietary restrictions, allergies, or specific lifestyle preferences face challenges when selecting safe and compatible food products. The current process of manually reading ingredient lists is time-consuming, often leading to errors or missed allergens, which can pose serious health risks. Additionally, product packaging can be confusing or lack clarity, making it difficult for consumers to identify potentially harmful ingredients. The Ingredients Checker project aims to provide a streamlined, user-friendly solution that simplifies ingredient analysis, allowing users to quickly verify product compatibility with their dietary needs.

The main objective of the Ingredients Checker project is to develop a comprehensive, easy-to-use tool that allows users to:

- Quickly Identify Ingredients: Enable users to scan or upload product information to get instant ingredient analysis.
- Check for Allergens and Dietary Compatibility: Analyze ingredients for allergens and specific dietary needs, such as vegan, gluten-free, and more.
- Provide Personalised Dietary Insights: Offer personalised recommendations based on user preferences to make informed food choices.
- Integrate Advanced Technologies: Implement OCR, and potentially machine learning for ingredient classification and recommendation.

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IV. PROPOSED METHODOLOGY

To ensure a structured, reliable, and quality-driven software development process, the Ingredients Checker project will adopt a CMMI [8] Level 3 Software Development Life Cycle (SDLC) framework. This methodology integrates best practices from DevOps [9], Agile, and the PMBOK [11] Quality Model, along with industry-recognized standards such as ISO 25010 [12] and ISO/IEC/IEEE 29148 [13]. The goal is to deliver a high-quality, user-centric, and maintainable system through well-defined and standardized processes.

1. CMMI Level 3 Framework

The Capability Maturity Model Integration (CMMI) Level 3 emphasizes defined and documented processes across all stages of development. By adhering to these structured practices, the project ensures consistency, predictability, and process improvement, which enhances both quality and productivity.

2. Agile Methodology

The Agile approach will be employed to enable iterative and incremental development, promoting continuous feedback and adaptation. Each sprint will focus on specific functional modules such as OCR processing, ingredient analysis, and user preference management. This ensures flexibility, rapid prototyping, and responsiveness to user needs.

3. DevOps Integration

Incorporating DevOps practices will bridge the gap between development and operations teams. Through continuous integration (CI), continuous delivery (CD), and automated testing, DevOps ensures faster deployment cycles, enhanced collaboration, and early issue detection, leading to a more stable product.

4. PMBOK Quality Model

The Project Management Body of Knowledge (PMBOK) framework will guide project planning, monitoring, and quality assurance. Emphasis will be placed on risk management, stakeholder engagement, and process quality control to ensure that project objectives are met within scope, time, and budget.

5. ISO 25010 – Software Quality Standards

The project will align with ISO/IEC 25010 [12], which defines the key software quality attributes including:

- Reliability – Consistent performance across various conditions.
- Performance Efficiency – Optimized system response time and resource usage.
- Security – Protection against unauthorized access and data breaches.
- Usability – Ease of use and accessibility for a wide range of users.
- Maintainability and Portability – Simplified system updates and platform adaptability.

6. ISO/IEC/IEEE 29148 – Requirements Engineering

The ISO/IEC/IEEE 29148 [13] standard will be followed for the requirements engineering process, ensuring that all system requirements are clear, complete, verifiable, and traceable. This supports effective communication between stakeholders and developers and ensures that the system meets both functional and non-functional expectations.

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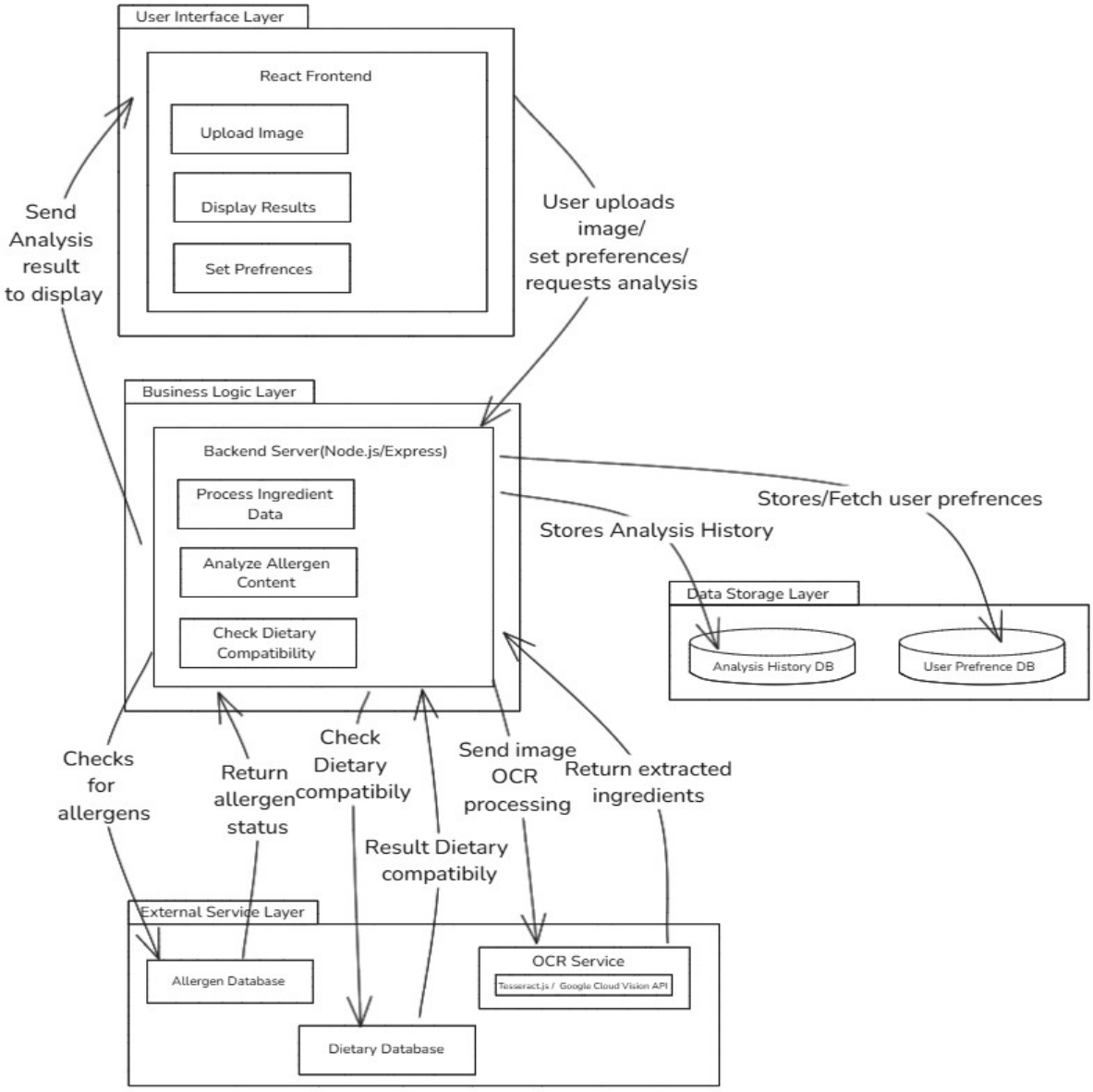

Fig. 1 System Architecture Diagram

The Ingredients Checker application architecture is organized into three layers: the Frontend (React) for user interaction, the Backend (Node.js/Express) for ingredient analysis, and External Services and Databases for OCR, allergen, and dietary compatibility data. The user uploads an image, which is processed via OCR; the extracted ingredients are then analyzed for allergens and dietary compatibility. Results are displayed on the frontend, providing users with alerts and suggestions based on their preferences.

V. CONCLUSION

The Ingredients Checker Application provides an efficient and reliable solution for users who need to quickly and accurately identify ingredients in packaged food products, detect potential allergens, and ensure dietary compatibility. By integrating Optical Character Recognition (OCR) technology for ingredient extraction, the application automates the process of reading and analyzing labels, minimizing the risk of human oversight.

This system is particularly beneficial for individuals with specific dietary preferences, medical conditions, or food allergies, enabling them to make informed and safer food choices. The app not only promotes awareness about food content but also contributes to public health and safety by supporting healthier eating habits.

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