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Generative AI-Enhanced Food Insight System for Safer Choices

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ABSTRACT: As health concern grow in worldwide it is important to make healthy food choices to prioritize healthier life also to avoid increasing health issues we have to pay attention on food safety . Our research project is an enhanced platform which scrutinizes the nutritional value of food, give personalized dietary recommendations and detects Food Adulteration using generative AI. System utilises techniques like LangChain and LLaMA to build an enhanced platform. Generative Adversarial Networks (GANs) are used to identify food items and analyse food images for accurate detection of adulteration in real time. Users are able to upload photos of food item or ingredient list and the system processes the data using a Large Language Model (LLM) to identify food ingredients. After identification system will deliver an analysis of that food image as well as other healthy alternatives. In simple words this system provides healthier food recommendation, personalized dietary plan , detection of adulteration for healthy life.

KEYWORDS: Computer Vision, Food Safety, Generative AI, Nutrition Analysis, Personalized Healthcare.

I. INTRODUCTION

In today's era, we all want to live healthy life but we often forsake our food habit, leading to Global health problem. As prediction of World Health Organisation (WHO) ,Obesity will become next Global disease. One of the reason of this Global problem is the lack of nutritional diet as well as healthy food choices affect overall well being and also contribute to chronic diseases like Diabetes, Endocrine imbalances and Kidneystone. Also we all commonly consume processed food in our day to day life. These processed foods contain harmful adulterants, additives, artificial food colours and artificial flavours which causes health risks. Also we are not aware about the substitute or scientific names of ingredients used in this processed and package food so that's why we are not able to get the idea that this package food is healthy or harmful. In addition to that even if we identify the food item is unhealthy , sometimes we can't find the healthy alternative for it.

We pinpoint these challenges in order to develop effective system to to give solutions for these problems. This system utilizes advance generative AI and its technologies for analysing food nutritional value, providing calorie estimation, identifying adulteration and providing healthier alternatives. Convolutional neural networks (CNN) has demonstrated remarkable success in various domains including food recognition, nutritional analysis, calorie estimation and adulteration detection. Also CNN methods have highly memory complexity and limited adaptability which is the main drawbacks of Machine Learning models.

By recognising this drawback and overcome these limitations of existing system we are using generative AI. Generative AI enhances the efficiency and adaptability of system. System uses generative AI models like Large Language Model(LLM) as well as Generative Adversarial Network(GAN) which is able to generate realistic depiction of food data and generate synthetic data. This will make the system more robust. By capitalising on generative AI this system offers an efficient approach for living a healthy life ,preventing chronic diseases, possessing healthy eating habits and ensuring food safety.

II. LITERATURE SURVEY

A critical initial step in providing nutritional insights is accurately determining the calorie amount of the meal consumed. Dietary decisions that are calorie-conscious can greatly enhance health results [1]. For calorie estimate, current systems usually use object identification algorithms and neural networks [8]. In order to undertake nutritional

analysis, these techniques entail collecting food photos, building databases, and training them with CNN and object identification models. Sarode et al. [1], for example, store annotated datasets in PostgreSQL and train them using Deep CNN-based models to determine caloric values. In order to recognize food, Nivedhitha P et al. [2] use the YOLOv4 algorithm with Food101 and EDA datasets, which yields faster results than conventional CNN approaches [2]. For Thai food roaches, Sombutkaew R. et al. [3] use Mask-RCNN for Thai food detection, providing additional features like food area and depth analysis for nutrient evaluation [3]. Gözde ÖZSERT YİĞİT et al. [9] compare CNN models, including AlexNet and CaffeNet, demonstrating insights into customized CNN designs [9].

Beyond calorie estimation, ingredient analysis and adulteration detection are vital for food safety. Ingredient analysis highlights nutrients, allergens, and additives [6]. Menichetti et al. [6] use "FoodProX" to evaluate food processing through Fpro-scores and Random Forest classification. Meanwhile, Erban Alexander et al. [7] analyze metabolomic data with Random Forest classifiers. Saranya P. et al. [5] investigate CNN and image processing techniques for adulteration detection, while Agrawal U. et al. [4] use HOG and LBP for spice adulteration. Sudharson K. et al. [8] explore AI-based personalized nutritional systems. Kuzlu et al. [11] propose an AI-driven Streamlit platform for NextG use cases, and Xu Guo et al. [10] investigate LLMs and synthetic data generation, forming the backbone of our proposed approach.

III. METHODOLOGY

This system integrates advanced Generative AI techniques, such as LLMs (Large Language Models), GANs (Generative Adversarial Networks), and LangChain, to analyze nutritional values, detect food adulteration, suggest personalized diet plans, and recommend healthier food alternatives. It processes user-provided data, including images and text, to ensure accurate analysis. By combining image and textual inputs, the system delivers detailed calorie estimations and precise recommendations. To enhance user interaction, Streamlit is used to build an intuitive interface, enabling effortless communication between the user and the system. The platform also utilizes the Google Gemini Pro API for advanced natural language understanding and multimodal processing, ensuring reliable and insightful outputs.

For image analysis, OpenCV-based techniques play a crucial role. Gaussian Blur is used for noise reduction, while CLAHE enhances image clarity for better recognition. These techniques improve the accuracy of food and text recognition, enabling precise classification of food items using GANs. This detailed classification helps in estimating nutritional content and detecting adulteration effectively. The system seamlessly integrates image processing and Generative AI, providing a holistic solution that accepts query images from users and delivers accurate outputs in text form, bridging the gap between technology and healthier living.

IV. EXPERIMENTAL RESULTS

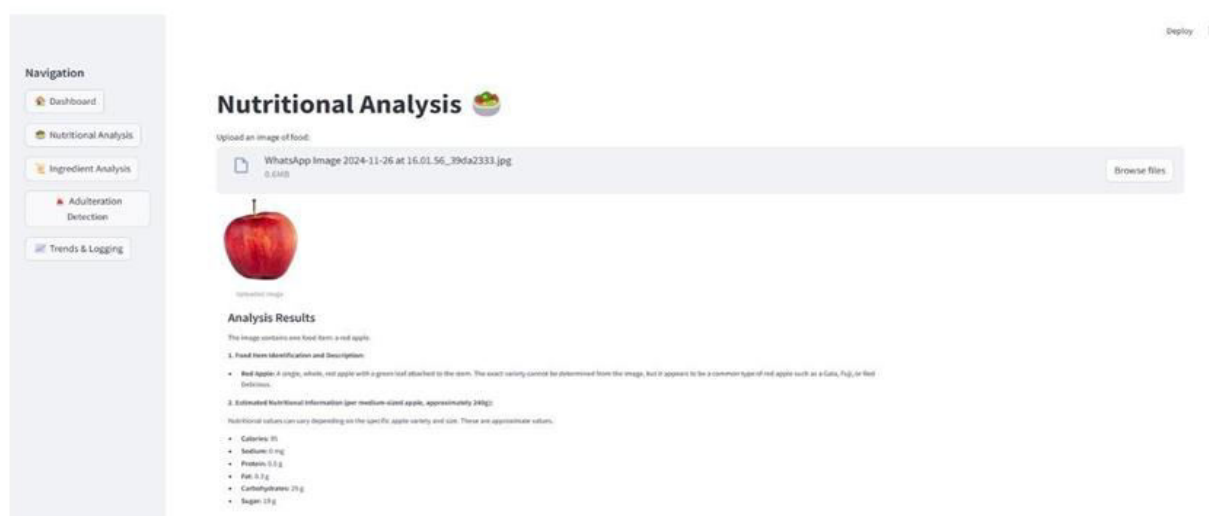


fig.(a) Analysis of Nutritional value

Navigation

- Dashboard
- Nutritional Analysis
- Ingredient Analysis
- Adulteration Detection
- Trends & Logging

Packaged Food Ingredient Analysis

Choose an option:
 Analyze Single Ingredient List
 Compare Two Ingredient Lists

Upload an ingredient list:

Ingredients: Refined Date (25%), Caneled Fruit and Nut (20%), Caneled Caneled (10%), Almonds (10%), Sugar, Salt Flour (10%), Baking Powder (5%), Preservatives: Flour (2%), Honey, Nut Extract, Wheat Flour (2%), Wheat Flour (2%), Inulin (2%), Sorbitol, Baking Flour (2%), Vitamins, Baking Agent (INS 200), Baking Soda (INS 201)

CONTAINS ADDED FLAVOURS (NATURAL IDENTICAL AND ARTIFICIAL CREAM FLAVOURING SUBSTANCES) CONTAINS GLUTEN, ALMONDS, MAY CONTAIN TRACES OF SOY AND MILK

Ingredient	Health Benefits	Potential Health Risks	Allergens	Natural/Artificial	Additives/Preservatives
Refined Date	High in fiber, good source of magnesium, improves digestion	Can cause bloating in some individuals	Gluten (if not certified gluten-free)	Natural	No
Caneled Caneled	Source of antioxidants	High in added sugar	None (inherently)	Artificial (pand-red)	Sugar is a preservative
Almonds	High in healthy fats, vitamins E, protein	Potential allergen	Almonds	Natural	No
Sugar	Quick energy source	High consumption linked to weight gain, diabetes	None	Natural	No (though may be a stabilizer, adding sugar in the process)
Wheat Flour	Similar benefits to refined oats	Can cause bloating in some individuals	Gluten (if not certified gluten-free)	Natural	No
Palmitic Oil	Source of energy	High in saturated fat if not refined	None	Natural	No
Salt	Source of electrolytes	Can be low in iodine if not fortified	None	Natural	No
Whole Wheat	High in fiber, nutrients	Can cause digestive issues in some individuals	Gluten	Natural	No

fig.(b) Ingredient analysis of packaged food

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Detailed Comparison Table

Criteria	Ingredient 1	Ingredient 2	Comparison
1 Nutritional Value	High in essential nutrients, low in calories	Moderate in nutrients, high in sugars	Ingredient 1 has a better nutritional profile, while Ingredient 2 is higher in sugar content.
2 Health Benefits	Improves immune function, rich in antioxidants	May support cardiovascular health	Ingredient 1 offers stronger health benefits with more antioxidants.
3 Potential Health Risks	Contains traces of allergens like nuts	Contains preservatives that could trigger allergies	Ingredient 1 has fewer allergenic risks than Ingredient 2, which contains preservatives.
4 Allergens	No harmful chemicals, minimal preservatives	Artificial preservatives, may affect gut health	Ingredient 1 is safer due to fewer additives and less artificial preservatives.
5 Additives & Preservatives	Natural	Artificial	Ingredient 1 is better in terms of scientific backing for natural ingredients.
6 Natural vs. Artificial	Backed by numerous studies on immunity enhancement	Limited evidence, potential risks outweigh benefits	Ingredient 1 has more scientific support for its natural composition.
7 Scientific Evidence of Benefits	Data not available	Data not available	Data not available

Overall Assessment

Based on the ingredient profiles, Ingredient 1 is healthier due to fewer additives and a more natural composition.

fig.(c) Comparative analysis of two different ingredient list

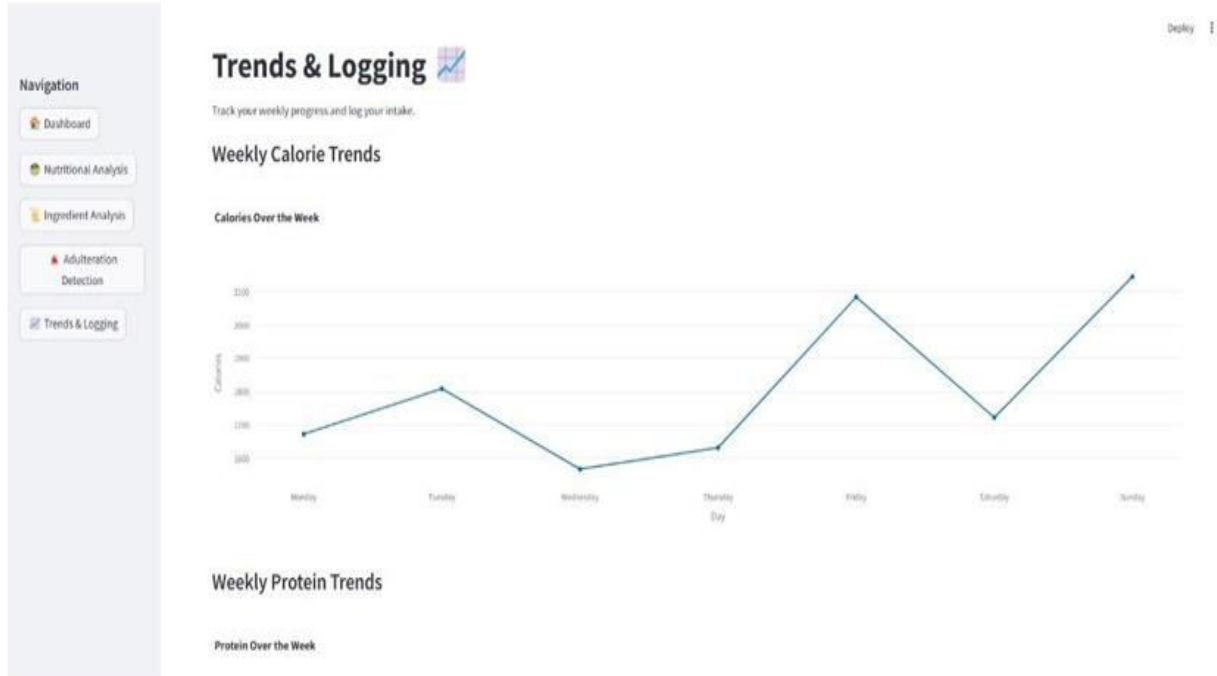


fig.(d) Tracking of weekly process

V. PERFORMANCE MEASURES

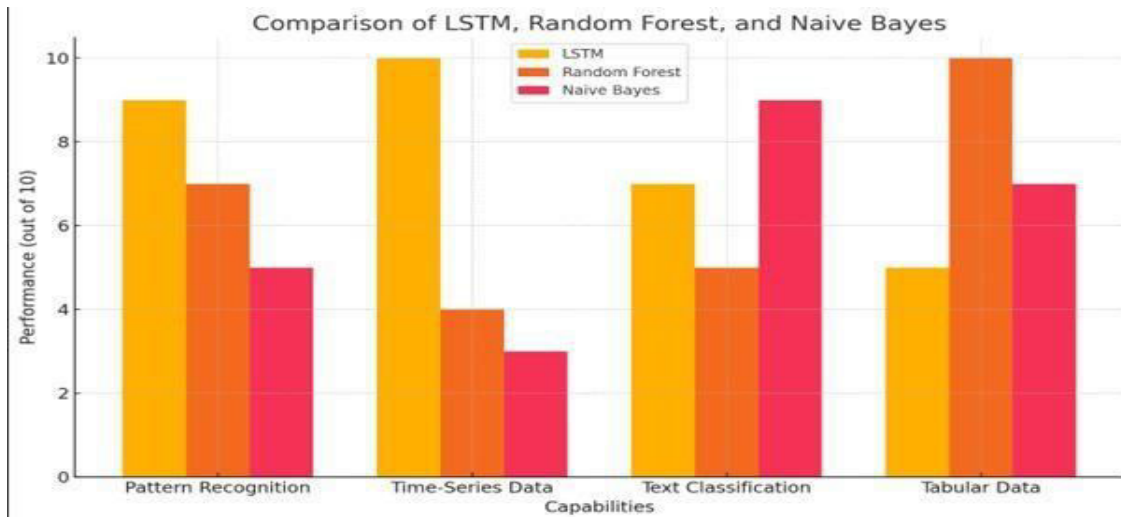


fig.(e) Performance of algorithms based on capabilities

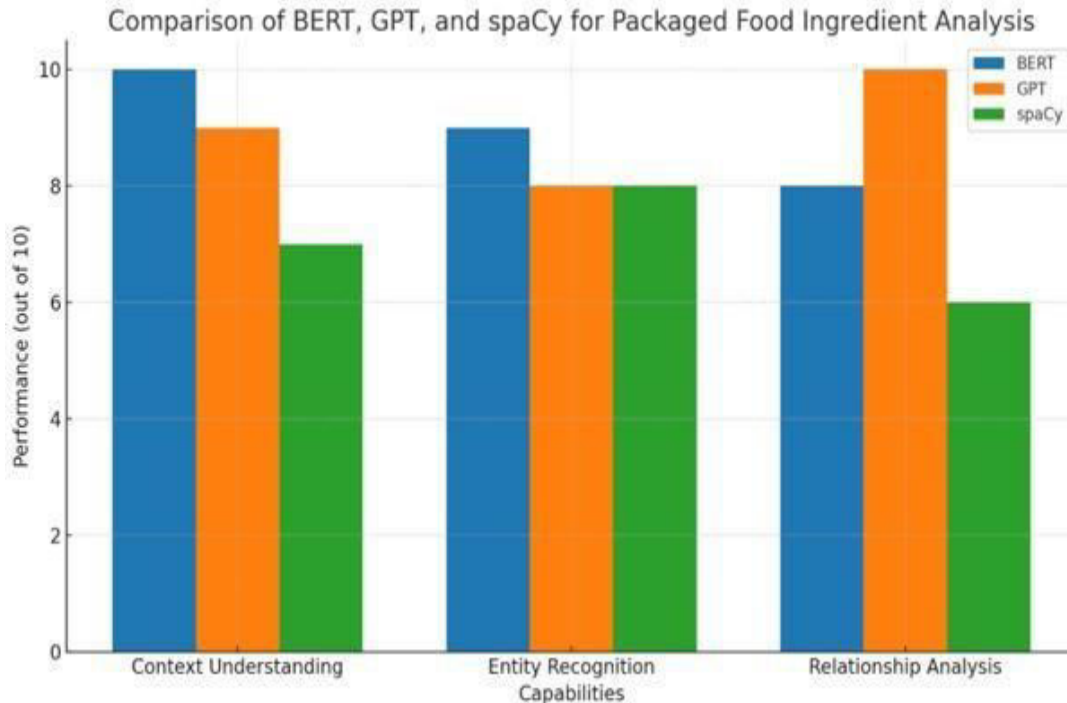


fig.(f) Performance of GEN-AI algorithms based on capabilities.

VI. CONCLUSION

We are developing an integrated system to deliver personalized nutrition plans , provide healthy food alternatives, identify nutritional value and detection of adulterated food. The proposed system utilizes advanced generative AI technologies like Large Language Models(LLM), LangChain , Generative Adversarial Network(GAN) to facilitate tailor food recommendations, adulteration detection and precise calorie estimation.

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