NUTRIEYE: AN ANDROID-BASED FOOD NUTRITIONAL VALUE RECOGNITION APP USING YOLOv8 ALGORITHM

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Abstract

Good nutrition is essential for a healthy lifestyle, yet many people consume calorie-dense, low-nutrition foods, contributing to malnutrition. While food recognition systems exist, few cater specifically to Filipino dietary needs. This study developed *NutriEye*, an Android-based app that identifies the nutritional content of common Filipino foods and recommends portion sizes based on user profiles and dietary needs. Using the Food Nutrition and Research Institute's (FNRI) Philippine Food Composition Table and Dietary Reference Intake Chart, the app leverages the YOLOv8 algorithm to analyze food images, estimate nutritional values, and calculate suitable servings. The app's accuracy was tested through evaluation metrics and validated using ISO/IEC 25010 standards for quality, including functionality, efficiency, usability, and security. Feedback from 100 respondents confirmed the app's effectiveness in promoting better nutrition management tailored for Filipino users.

1. Introduction

Proper nutrition is vital for healthy living, yet malnutrition remains prevalent globally, including in the Philippines. Despite programs from WHO and other organizations aiming to end hunger and improve nutrition, challenges persist due to unhealthy food choices and limited awareness of proper dietary management. Middle-income households, despite their financial capacity, often fail to maintain balanced diets, resulting in insufficient or imbalanced nutrient intake and rising cases of malnutrition, obesity, and related diseases.

Existing nutrition and fitness applications offer solutions but face limitations such as inadequate personalization, high costs, and database issues. Moreover, these tools often lack a localized focus, making them less effective for addressing specific dietary needs in the Philippine context. To bridge this gap, the *NutriEye* app was proposed. Utilizing the YOLOv8 algorithm, *NutriEye* aims to recognize common Filipino foods, calculate nutritional content, and recommend portion sizes based on the user's dietary profile and Philippine dietary reference standards, offering a targeted solution to improve nutrition management and combat malnutrition. As the primary purpose of this study is to develop a mobile application that focuses on food nutritional value recognition.

1.1 Literature Review

Health and nutrition play a vital role in individual well-being. Malnutrition, whether from nutrient deficiency or excess, remains a significant issue, including in the Philippines, which faces the "double burden" of malnutrition. Despite middle-income households having access to adequate resources, imbalanced diets are still prevalent. To address this, the UN launched the *Decade of Action on Nutrition* (2016-2025) with goals aligned with SDG 2 and 3, focusing on nutrition and health.

Technology, including machine learning (ML) and algorithms like YOLOv8, has become a crucial tool in tackling nutritional challenges. ML-powered applications, such as NutriEye, use these technologies for real-time food analysis and portion recommendations based on user needs. While similar apps exist, many face limitations such as lack of personalization, data accuracy issues, or high costs. NutriEye is tailored for local needs, integrating the *Philippine Dietary Reference Intake* (PDRI) and *Philippine Food Composition Tables Online Database* (PhilFCT). This system considers factors such as age, weight, physical activity, and health conditions to provide relevant, sustainable, and efficient nutritional recommendations, ensuring its significance in the Philippine context.

The evolution of machine learning, particularly the YOLO algorithm, has significantly advanced object detection, including food recognition systems. Introduced in 2015 by Redmon et al., YOLO's grid-based framework enabled real-time object detection, with continuous improvements leading to YOLOv8, known for its superior speed and accuracy (Huang et al., 2024; Talib et al., 2024). Studies, such as those by Afdhal et al. (2023) and Barlybayev et al. (2024), demonstrate YOLOv8's versatility, from autonomous vehicles to PPE classification and cultural preservation, while its application in health and nutrition research aids in food safety and nutrition management (Vora & Shekhawat, 2022).

Food image recognition systems, leveraging machine learning, have grown in popularity for dietary assessment and health monitoring (Kader et al., 2020; Salim et al., 2021). They provide insights into dietary patterns and promote sustainable food practices (Sahakian et al., 2018). Studies like Romadhon et al. (2023) and Gayatri & Thaniya (2023) affirm YOLOv8's high accuracy in food detection, with precision scores over 90%, making it a reliable tool for nutritional analysis. Food recognition systems combined with nutritional value calculation further enhance dietary monitoring and informed decision-making (Dalakleidi et al., 2020; Zecevic et al., 2021). These applications, as noted by Ocke et al. (2021), address imbalanced diets and improve nutrition management among Filipino adults (Shah et al., 2019; Angeles-Agdeppa & Custodio, 2020). The reviewed studies collectively highlight the potential of these tools to deliver tailored dietary solutions and improve public health outcomes. Despite varying inputs and technologies, all studies report promising results, underscoring the value of mobile-based food recognition and nutrition applications in modern health services.

2. Research Methods

The theoretical framework of the study is built upon the **Health Belief Model (HBM)**, which explores the factors influencing individuals' engagement in health-related behaviors. This model provided a structural basis for the development of the NutriEye application, helping clarify and solidify its design and objectives. The HBM highlights the importance of designing interventions that promote healthy behaviors, such as improved nutrition intake, by addressing users' perceptions and encouraging positive changes. By incorporating elements like personalized recommendations and positive feedback, the framework aims to enhance self-efficacy, empowering users to adopt and sustain healthier dietary habits, ultimately contributing to improved public health outcomes (Urich, 2020).

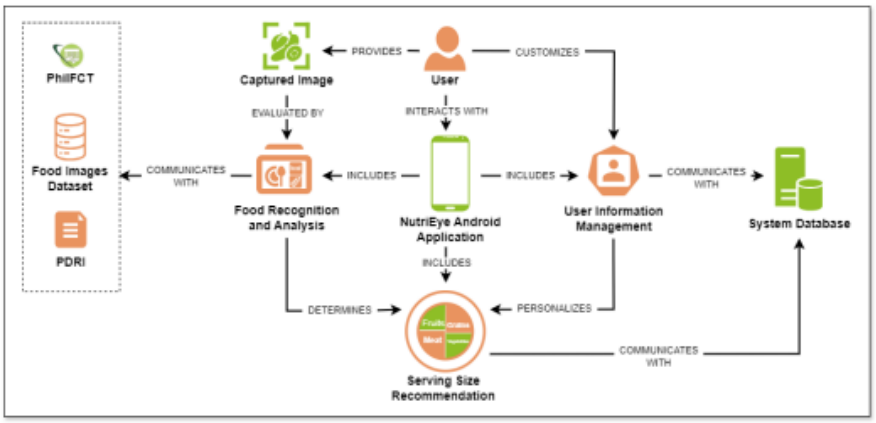

Fig. 1 System Architecture

The application workflow begins by prompting users to indicate if they are new or returning. New users are directed to register and authenticate their accounts, while returning users log in with their credentials. Once logged in, the dashboard provides navigation options, including accessing the device camera for core functionalities, managing personal information through the profile page, or logging out. Upon logout, users can choose to log back in or exit the app.

The development of the NutriEye application involved various software and hardware components to ensure functionality and performance. **Software** utilized included Java and Android Studio for mobile app development, Figma for UI/UX design, and Python with Jupyter Notebook and TensorFlow Lite for machine learning integration. Firebase was employed for database management, while GitHub and GitBash handled version control. Documentation and data handling relied on Microsoft Word, Excel, and Google Forms. **Hardware requirements** recommended for optimal performance include a smartphone with an Octa-core processor, 8GB RAM, 256GB storage, a full HD display, a 12MP camera, a 4000mAh battery, Android 9 Pie or higher, and Wi-Fi connectivity. Minimum specifications, such as a Quad-core processor, 8GB RAM, 128GB storage, HD display, an 8MP camera, a 3000mAh battery, and Android 5.0 Lollipop, are also supported for basic functionality.

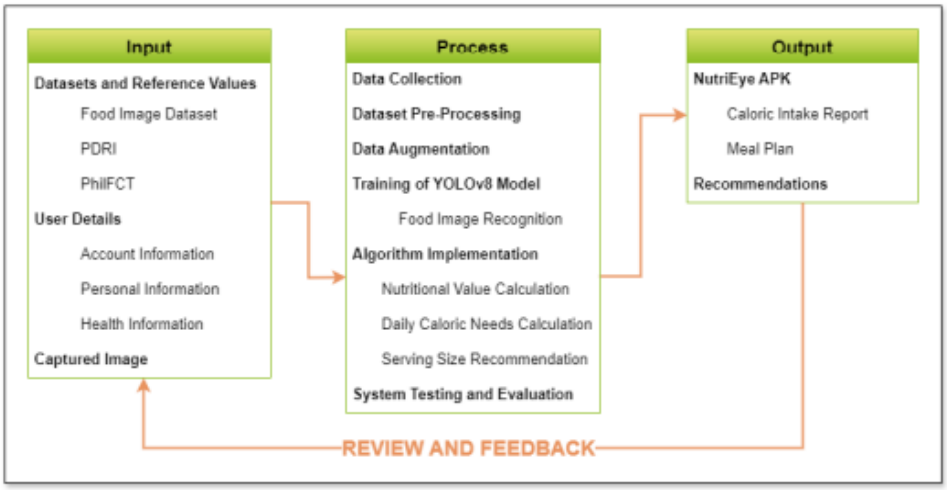

Fig. 2 Aplication Workflow

3. Result and Discussion

Sprint 1 focuses on **User Information Management**. Upon launching the app, an animated loading screen with the logo, app name, and catchphrase appears, followed by the Home Page, which is the Login Page. The login process includes fields for email and password, a login button, options for saving user credentials, password masking for security, and a password reset feature. Additionally, the app provides a Logout Popup, accessible within the user account, to terminate the session and log out of the application.

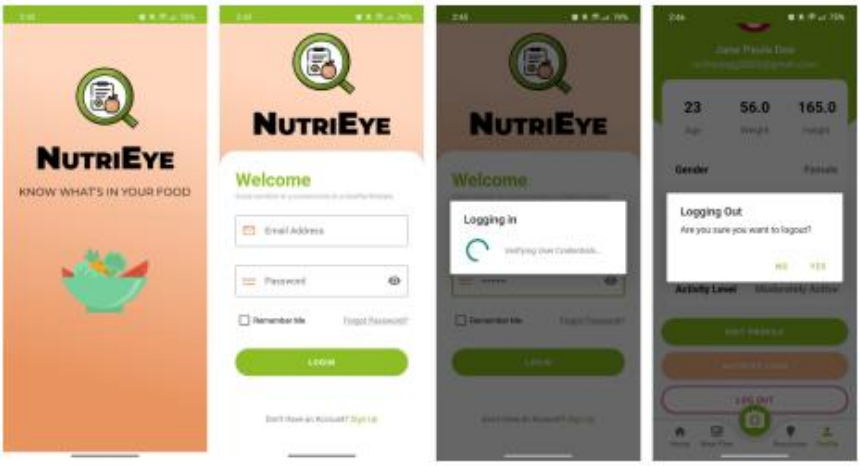

Fig. 3 UI & UX Aplication

Sprint 2 focuses on **Food Nutritional Value Calculation**. This involves integrating the YOLOv8 machine learning model, accessed through the Camera function in the app. Users scan food items with the camera, and a bounding box with class probabilities and serving size is displayed. The results are then shown on a separate screen, where users can choose to add the item to their meal plan, saving it in the app's database, or discard it. If recognition fails, an error alert is triggered.

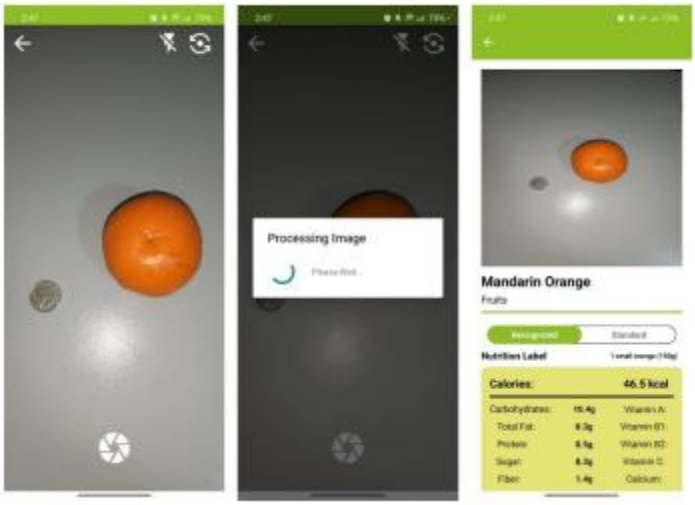

Fig. 4 Item Rcognition and Nutrient Value Calculation Process

In **Sprint 3**, the saved meal entries from the previous module appear on the **Meal Plan Summary Page**, where users can confirm if a meal has been consumed. Upon confirmation, the nutritional content is added to their daily nutrient intake, monitored through their **DCN**, and displayed on their dashboard. The dashboard provides a summary of the nutrient intake with options to filter results and alerts when the user approaches or exceeds the recommended nutrient intake. The application is then evaluated using the **ISO/IEC 25010 Software and Data Quality Model**, which assesses seven quality characteristics: **Functional Suitability** (effectiveness of functions), **Interaction Capability** (ease of use for specific tasks), and **Security** (data protection). Additionally, the system is evaluated on **Performance Efficiency** (resource and time efficiency), **Reliability** (performance under specified conditions), **Maintainability** (ability to adapt to changes), and **Flexibility** (portability across different environments).

Fig. 5 Meal Planer and Calori Intake Traker

4. Conclusions

This study sought to bridge the gap concerning the lack of free and accessible nutrition management devices. It is specifically focused on addressing the scarcity of food labeling, nutritional calculation, and dietary recommendation tools in the Philippine context by designing and developing a mobile application that recognizes a Filipino food image then estimates the recommended serving size based on the Filipino dietary reference intake. This is achieved through the utilization of deep learning algorithm, particularly the You Only Look Once (YOLO) version 8 as the object detector of the food item. This model was integrated into the proposed NutriEye application developed using Java programming language and Firebase database. The YOLOv8 model has yielded 83% accuracy rating in predicting both the bounding boxes and segmentation masks for the 23 class labels. Particularly, the bounding box achieved a precision score of 0.874, recall score of 0.824, and mAP of 0.851. In relation, the segmentation mask garnered a score of 0.874 for the precision, 0.822 for the recall, and 0.846 for the mAP.

The best weights have been exported as the model to be utilized and integrated into the NutriEye application. The model size was at 22.7 MB, and the model speed was at 1.4ms as the preprocessing time, 11.4ms as the inference time, and 3.5ms as the postprocessing time. The developed application was evaluated by 100 respondents from the middle-class population within Calamba City, Laguna. 10 among them were nutrition-related professionals and three were IT-related professionals. They answered a survey questionnaire adapted from ISO/IEC Product Quality Evaluation Model to determine the user acceptance. The data collected had undergone data analysis with the weighted means as its statistical method.

The salient findings were shown as follows:

- The implemented User Information Management module garnered positive responses represented as "Strongly Agree" in Functional Suitability (TWM 4.70), Interaction Capability (TWM 4.65), Security (TWM 4.76), and Nutritionists' Assessment (4.26).
- The developed nutritional analysis component, through the Food Nutritional Value Calculation module had yielded favorable marks corresponding to "Strongly Agree" in Functional Suitability (TWM 4.51), Interaction Capability (TWM 4.60), Security (TWM 4.85) and Nutritionists' Assessment (TWM 4.60).
- The engineered dietary needs calculator and optimal portion size estimator, through the Nutrient Intake Monitoring module, had demonstrated positive results translated as "Strongly Agree" in 129 Functional Suitability (TWM 4.70), Interaction Capability (TWM 4.67), Security (TWM 4.83), and Nutritionists' Assessment (TWM 4.30).
- The developed NutriEye application achieved a high rating, with a verbal interpretation of "Strongly Agree" in terms of Performance Efficiency (TWM 4.54), Maintainability (TWM 4.27), and Flexibility (TWM 4.75). On the other hand, Reliability got an "Agree" interpretation with a total weighted mean of 4.08.

This study aims to develop and deploy NutriEye, an Android-based food nutritional value recognition app using YOLOv8. Based upon the results and findings, it can be concluded that: The survey participants also strongly agreed that the User Information Management module and its components are working under normal conditions, are accessible and available, and are equipped with data protection mechanisms. The YOLOv8 model is an effective object detector to be included in the Food Nutritional Value Calculation with 83% accuracy rate. The respondents strongly agreed that the module functions as intended under ideal conditions, can be utilized within the defined context of use, and is safeguarded against malicious actors and events. The evaluators also strongly agreed that the Nutrient Intake Monitoring module effectively performs adequately well under optimal circumstances, can be operated easily, and has with security measures against potential breaches. 130 The NutriEye application, as a whole, has passed the user acceptance test where the users strongly agreed that the system is complete, correct, and appropriate to their needs; its components is easily navigable and identifiable; and has high fault tolerance and recoverability rating. Moreover, the system also has effective resource usage and time efficiency, along with fail-safe mechanisms against possible software failure and data loss, and can be utilized under several platforms and environments.

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