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Food Calories Generator through Deep Learning

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Abstract

Identifying food and calculating calories are key components of encouraging good eating habits and controlling dietary intake. These days, it's easier to create smart systems that can recognize food items from images or videos and calculate their calorie content using artificial intelligence, computer vision, and machine learning. This study gives an overview of the latest methods and tools for calorie counting and food identification. It looks at the challenges of accurately identifying different foods, including complex dishes and foods from various cuisines, and addresses the variables taken into account when determining the calorie content of food items, including ingredient composition, portion size, and nutritional makeup. To enhance user experience and enable comprehensive calorie tracking, it explores real-time processing capabilities, user-friendly interfaces, and integration with other health and fitness platforms. Additionally, it provides a list of potential recipes. The interface developed in the proposed system is currently trained to identify and provide the calories of 100 food items, including basic food items, fruits, vegetables, and processed foods. The research work uses a real-time dataset for training and employs software such as YOLOv8, and TensorFlow for practical implementation.

Keywords: Artificial Intelligence, Computer Vision, Machine Learning, Calorie Counting, Food Identification.

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1. Introduction

The integration of computer vision and nutrition science has paved the way for innovative approaches to dietary habits and nutritional awareness in the age of smart technology and artificial intelligence[6-8]. The proposed work utilizes artificial intelligence to calculate the calorie count of a particular food identified. The main goal of this research is to create a sophisticated food recognition system that can identify different foods in real time. by utilizing advanced algorithms and nutritional databases, the calorie estimation tool gives users a precise idea of how much energy is contained in the food items it has identified [9,11]. Concurrently, by providing information about the ingredients of the identified recipes, the ingredients estimation capability of the proposed system seeks to raise user awareness. Furthermore, one important feature that sets the proposed system apart from other alternatives already in use is its lightweight design. The system is efficient with computational resources, as shown by its "lightweight" design, which makes it appropriate for deployment on a range of platforms, such as embedded systems and mobile devices. This makes it easy for many people to use, helping them make smart food choices wherever they are. This research offers a new way to identify food and meets the growing need for smart solutions that support well-being in today's busy world by using YOLOv8 and advanced algorithms[12-15].

2. Related Work

Lukas Bossard [1] et al. presented a novel method for automatically recognizing dishes in food images using Random Forests. They introduce the concept of "discriminative parts" to identify key components of dishes, sharing knowledge among various food categories. Their approach is efficient, focusing on patches aligned with image superpixels. Testing it on a challenging dataset of 101 food categories, the model achieves an accuracy of 50.76%, outperforming many methods except for Convolutional Neural Networks (CNNs). This work represents a significant advancement in food recognition and has practical applications in image organization and calorie tracking for users.

WeiqingMin [2] et al. discussed analyzing the multifaceted aspects of food to enhance various applications, including food summary and recommendation. They introduce a framework called Multi-Attribute Theme Modeling (MATM), which can handle a wide range of continuous and discrete attributes along with textual content in recipes. Additionally, they use a multi-modal embedding approach to connect the textual themes learned by MATM with visual features extracted from deep learning networks. This allows them to achieve several goals: understanding flavor patterns from various dimensions like region and course, creating multi-dimensional food summaries with both visual and attribute information, and offering recipe recommendations based on specific attributes. The framework is flexible, enabling the integration of diverse attributes and modalities. Their method is validated through qualitative and quantitative evaluations on the Yummly dataset, demonstrating its effectiveness in food analysis and recommendation.

Ahmed et al [3] reviews the recently available information on the dietary food intake and the nutrition status of the citizens of Malaysia.

Palakorn [4] et al. explores the impact of food journaling, a popular method of self-monitoring dietary choices, on healthy eating behaviors. It investigates whether active food journalists exhibit healthier eating habits compared to the general population. While prior research has highlighted the effectiveness of food journaling in weight loss programs, this study aims to provide a more comprehensive understanding of its broader influence on individuals' dietary choices. By analyzing the public food diary entries of MyFitnessPal users and comparing their eating behaviors to established dietary guidelines and general population data, the research seeks to determine if food journalists are more likely to adhere to evidence-based healthy eating practices.

Zhang [5] et al. presents a survey that comprehensively reviews state-of-the-art methods, datasets, algorithms, and approaches for food identification and nutrition estimation in dietary assessment. The authors states that Image-based computer vision and AI techniques support dietary assessment by classifying food items and estimating portion sizes, but varying food shapes and appearances challenge accuracy.

S. A. Ayon [10]et al. discusses on the value of eating a balanced diet and the drawbacks of keeping food records by hand. It explains the advantages of image-based food recognition systems (IBFRS) over manual approaches and presents them as a viable option. The review shows the potential of IBFRS to increase user compliance and the accuracy of dietary assessments by comparing it with existing methods.

3. Proposed Work

The proposed system utilizes advanced computer vision methods and deep learning models like YOLO to accurately detect ingredients in images uploaded by users. These identified ingredients are compared against a comprehensive database that tracks numerous food items and their nutritional data, including calorie content, macronutrients, and micronutrients. It goes further by estimating the calorie content of each food items that are identified and provides users with valuable nutritional information. User interface is developed mobile app, allows users to upload the image of the meal , manually enter ingredients, and specify dietary requirements. A feedback mechanism is also in place, encouraging users to rate suggested recipes and provide input on taste, ease of preparation, and modifications. This feedback is crucial for improving system functionality and personalization. The system prioritizes continuous updates and learning by regularly adding new recipes, ingredients, and nutritional information, while adjusting machine learning models to enhance the accuracy of calorie estimation and ingredient identification over time. Figure 1 shows the flow diagram of the proposed.

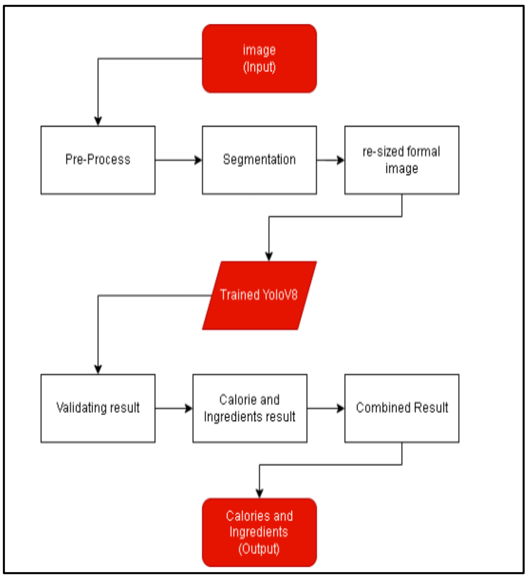

Figure 1. Flow Diagram

Input Image: A picture of food is used as the input image when the procedure starts. This image might have been taken by the user's device or downloaded from another location.

Preprocessing: To improve its quality and prepare it for additional analysis, the input image is pre-processed. To increase the accuracy of later stages, preprocessing techniques including noise reduction, contrast correction, and picture normalization may be used.

Segmentation: To identify specific food items or areas of interest, the pre-processed image is next divided into segments. By separating various elements within the image, this stage facilitates the analysis and classification of each food item independently.

Resizing: After segmentation, the segmented regions are resized to a standard input size required by the YOLO (You Only Look Once) model. Resizing ensures consistency in the input dimensions and facilitates efficient processing by the model.

Training with YOLO Model: The resized segmented regions are then fed into the YOLO model for training. The model learns to recognize various food items based on the training data provided.

Validation of Results: Once the YOLO model is trained, it is validated using a separate validation dataset to assess its performance and accuracy. This step ensures that the model can accurately detect and classify food items in unseen images.

Calorie and Ingredient Estimation: After successful validation, the trained YOLO model is used to detect food items in input images. For each detected food item, the system estimates its calorie content and identifies its ingredients using nutritional databases and algorithms.

Recipe Generation: Based on the detected food items and their ingredients, the system generates a recipe or suggests potential recipes that can be prepared using the identified ingredients. This step provides users with creative ideas for meal planning and preparation.

Output in App: Finally, the combined results of calorie estimation, ingredient identification, and recipe generation are displayed to the user through a mobile or web application interface. Users can view detailed information about the detected food items, their nutritional values, and suggested recipes, empowering them to make informed dietary choices and promote healthier eating habits.

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Noise reduction, contrast correction, and image normalization were effectively performed using TensorFlow. Noise reduction was achieved by applying Gaussian filters to minimize unwanted variations in the images. Contrast correction improved the image quality and visibility of food items by adjusting contrast levels, making features more distinct. Image normalization standardized the pixel values to have zero mean and unit variance, which enhanced the consistency of the input data. Segmentation was performed using a pre-trained U-Net model within TensorFlow, which isolated individual food items for further analysis. This involved identifying and segmenting specific food items from the image. Resizing standardized the input size for the YOLO model, ensuring uniform image dimensions for accurate detection. This step adjusted image dimensions to match the model's input requirements.

The pre-processed images were converted into YOLO format by transforming bounding boxes and labels into the required format. The images and label files were organized in a structure compatible with YOLOv8. YOLOv8, implemented in PyTorch with the necessary packages, was then trained using these images.

4. Results and Discussion

The proposed food calorie estimator was trained on images that were collected in real-time along with the details of the calorie content. The complete research was executed on Google Colab. The proposed work at present was trained with the images and the calorie content of 100 basic food items including processed foods.

The user interface that was developed enhance the user experience in knowing the calories of the food they eat was built using the Streamlit application. This involved several packages like TensorFlow for handling image preprocessing, PyTorch for training and running the YOLOv8 model, Ultralytics YOLOv8 to provide the YOLOv8 model and it supporting utilities, and Pillow is for basic image processing tasks such as opening and manipulating images. Additionally, the Scikit-learn, OpenCV, and the Numpy were also used to enhance the model performance.

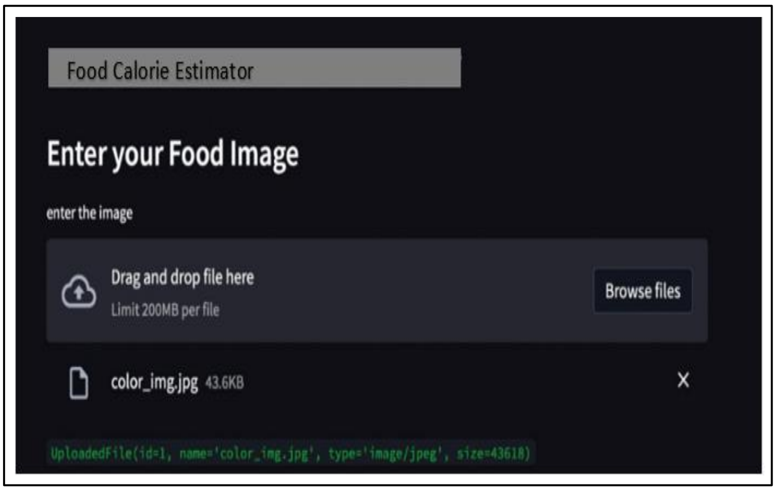

Figure 2. Home Page

Figure 3. Loading Input Image

A deep learning model trained on the recipe collection of 100 basic food items including the processed foods estimate the calories in food item loaded. Giving users a better understanding of nutrition allows them to investigate interesting cooking possibilities and make well-informed choices. The Figure 2-4, shows the results obtained from the user interface for the food that was upload along with the calorie content.

Figure 4. Calorie Estimated

Table 1 shows the performance scores of the YOLOv8 model in identifying the ingredient and displaying the corresponding calorie.

Table 1. Performance Metrics

Metrics	Performance Score
Precision	84.6%
Recall	79.9%
Loss	0.25
Response Time	1.8 seconds

The proposed work should consider the quality and variety of the data used to train the model, as it affects the model's performance. Biased data can lead to inaccurate results, such as calorie counts specific to certain dishes. Additionally, it's crucial to ensure that calorie estimates are accurate to prevent negative health effects. To address these issues, a range of well-labeled datasets should be used, and the model must be thoroughly tested for accuracy and safety. Users should also be able to adjust recipe settings and understand the model's limitations to maintain the human element in cooking. By addressing these challenges, we can maximize the benefits of deep learning to improve our food knowledge and creativity while ensuring ethical and responsible use.

4.1 Future work

The proposed work faced several challenges, as it was trained only with basic food items. Future work will focus on developing a more accurate calorie calculator by increasing the dataset to include a broader range of food images with their calorie counts. Additionally, future efforts will also aim to generate new recipes based on the ingredients identified in the uploaded food images.

5. Conclusion

In conclusion, the Real-Time Intelligent Lightweight Food Identifier with Calorie and Ingredients Estimation System using YOLOv8 marks a significant advancement in food detection and analysis. By utilizing YOLOv8's speed and accuracy, the system effectively identifies various food items, estimates calorie counts, and detects key ingredients in real-time. Its seamless integration into different platforms and devices without compromising performance is a notable achievement. In the future, the system can support applications such as meal planning, nutritional analysis, and dietary monitoring, addressing the increasing demand for precise and accessible nutritional information. Its flexibility and user-friendliness make it a valuable tool for both individuals and nutrition professionals. Future improvements will focus on expanding the food database, incorporating user feedback, and collaborating with experts to enhance the system's accuracy and utility. Overall, this innovative system has the potential to promote smarter, healthier food choices and improve lives through better dietary decisions.

References

[1] Bossard, Lukas, Matthieu Guillaumin, and Luc Van Gool. "Food-101–mining discriminative components with random forests." In Computer vision–ECCV 2014: 13th European conference, zurich, Switzerland, September 6-12, 2014, proceedings, part VI 13, Springer International Publishing, 2014. 446-461.

[2] Min, Weiqing, Shuqiang Jiang, Linhu Liu, Yong Rui, and Ramesh Jain. "A survey on food computing." ACM Computing Surveys (CSUR) 52, no. 5 (2019): 1-36.

[3] Ahmed, Ferdoushi, and Chamhuri Siwar. "Food intake and nutritional status among adults: Sharing the Malaysian experience." Pakistan Journal of Nutrition 12, no. 11 (2014): 1008-1012.

[4] Achananuparp, Palakorn, Ee-Peng Lim, and Vibhanshu Abhishek. "Does journaling encourage healthier choices? Analyzing healthy eating behaviors of food journalers." In Proceedings of the 2018 International Conference on Digital Health, Lyon France. 35-44. 2018.

[5] Zhang, Shumei, Victor Callaghan, and Yan Che. "Image-based methods for dietary assessment: a survey." Journal of Food Measurement and Characterization 18, no. 1 (2024): 727-743.

[6] Pouladzadeh, Parisa, Pallavi Kuhad, Sri Vijay Bharat Peddi, Abdulsalam Yassine, and Shervin Shirmohammadi. "Food calorie measurement using deep learning neural network." In 2016 IEEE international instrumentation and measurement technology conference proceedings, Taipei, Taiwan, IEEE, 2016. 1-6.

[7] Reddy, V. Hemalatha, Soumya Kumari, Vinitha Muralidharan, Karan Gigoo, and Bhushan S. Thakare. "Food recognition and calorie measurement using image processing and convolutional neural network." In 2019 4th International Conference on Recent Trends on Electronics, Information, Communication & Technology (RTEICT), Bangalore, India, IEEE, 2019. 109-115.

[8] Turmchokkasam, Sirichai, and Kosin Chamnongthai. "The design and implementation of an ingredient-based food calorie estimation system using nutrition knowledge and fusion of brightness and heat information." IEEE Access 6 (2018): 46863-46876.

[9] Shen, Zhidong, Adnan Shehzad, Si Chen, Hui Sun, and Jin Liu. "Machine learning based approach on food recognition and nutrition estimation." Procedia Computer Science 174 (2020): 448-453.

[10] S. A. Ayon, C. Z. Mashrafi, A. B. Yousuf, F. Hossain, and M. I. Hossain, “FoodieCal: a convolutional neural network based food detection and calorie estimation system,” in

2021 National Computing Colleges Conference (NCCC), Taif, Saudi Arabia, 2021.1–6.

[11] Teng, Jianing, Dong Zhang, Dah-Jye Lee, and Yao Chou. "Recognition of Chinese food using convolutional neural network." Multimedia Tools and Applications 78 (2019): 11155-11172.

[12] Ma, Peihua, Chun Pong Lau, Ning Yu, An Li, and Jiping Sheng. "Application of deep learning for image-based Chinese market food nutrients estimation." Food Chemistry 373 (2022): 130994.

[13] Kadam, Prachi, Sharnil Pandya, Shraddha Phansalkar, Mayur Sarangdhar, Nayana Petkar, Ketan Kotecha, and Deepak Garg. "FVEstimator: A novel food volume estimator Wellness model for calorie measurement and healthy living." Measurement 198 (2022): 111294.

[14] P. by Blogger, Indian food calorie https://indianfoodrecipeswithpictures.blogspot.com/

[15] World Health Organization (WHO). Obesity and Overweight. WHO. (2016). http://www.who.int/mediacentre/factsheets/fs311/en/index.html.