A Review on Food Recognition with Computer Vision for Nutrition Insights and Dietary Recommendations

Ruchitha R[1], Vanajakshi V[2], Soujanya SN[3], Rashmi J[4]
[1,2,3,4] *Department of CSE, Sri Venkateshwara College of Engineering, Bengaluru – 562157*

***Abstract* — With increasing global health concerns like obesity and malnutrition, there is a growing need for tools that can analyze diets and provide personalized recommendations. Computer vision, combined with artificial intelligence, has made it possible to automate nutrition analysis and dietary suggestions using images of food. These systems can recognize food items, estimate their portions, and calculate nutritional content, either through step-by-step methods or end-to-end models. To address challenges such as limited datasets and the complexity of meals, researchers are using innovative techniques like synthetic data generation, advanced segmentation models like Mask R-CNN, and multi-task learning. These advancements make it easier to analyze food in real-world settings accurately. This paper highlights the potential of such technologies for improving health monitoring and suggests future improvements in areas like detailed food classification and better volume estimation techniques for more accurate dietary assessments.**

***Keywords* — Computer Vision, Nutrition Analysis, Dietary Recommendation, Food Recognition, Food Segmentation, Deep Learning, Synthetic Data, Mask R-CNN, Volume Estimation, Personalized Health Monitoring**

I. INTRODUCTION

Recent advancements in computer vision and artificial intelligence have created new opportunities for tackling complex real-world challenges. One promising area for these technologies is dietary analysis and nutrition management. With global health issues like obesity and malnutrition on the rise, there is a growing need for automated systems that can analyze food intake and offer personalized dietary recommendations. Traditional dietary assessment methods, such as food diaries or surveys, tend to be time-consuming, prone to errors, and subjective. To overcome these challenges, researchers in computer science and engineering (CSE) are developing systems that utilize food images to accurately identify food items, estimate portion sizes, and calculate nutritional content.

By employing techniques like image recognition, segmentation, and volume estimation, these systems incorporate deep learning models to automate tasks that once required human expertise. Notably, models such as convolutional neural networks (CNNs) and frameworks like Mask R-CNN have shown great effectiveness in processing food image data. However, challenges such as limited datasets, variability in food presentation, and environmental factors like lighting and occlusion continue to pose significant hurdles. To address these issues, innovative strategies like synthetic data generation and multi-task learning are being explored.

This paper examines the intersection of computer vision and dietary assessment, emphasizing how computational models can revolutionize nutrition monitoring. The integration of these technologies into personalized health applications not only helps tackle dietary challenges but also contributes to broader fields such as healthcare, robotics, and human-computer interaction. Through this research, we aim to showcase the potential of computer vision in creating robust, scalable, and efficient dietary recommendation systems.

II. LITERATURE REVIEW

Deokhwan Park, Joosoon Lee, et al. [1], Recent advancements in computer vision and deep learning have significantly improved food recognition, segmentation, and nutrition estimation, helping to tackle the challenges of dietary assessment. Traditional methods that depended on manually designed features have mostly been replaced by convolutional neural networks (CNNs), which offer better accuracy and scalability. A key area of progress is food segmentation, which is crucial for estimating portion sizes. Innovations like Mask R-CNN and synthetic-to-real (Sim-to-Real) techniques have been developed, using synthetic datasets to overcome the limitations of conventional datasets. Additionally, multi-stage frameworks have been created to combine segmentation with three-dimensional volume estimation for calculating nutritional content. At the same time, the advent of end-to-end models has simplified the overall process, reducing errors and enhancing operational efficiency. Despite ongoing challenges, such as variations in food types and changing lighting conditions, strategies like domain randomization and multi-task learning have been introduced to ensure reliable performance in real-world scenarios. The impact of these advancements goes beyond just dietary monitoring; they also have applications in healthcare robotics, where vision-based systems aid in meal preparation and managing personalized health interventions.

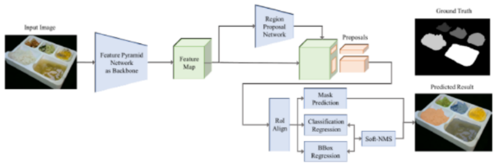

Fig. 5. The architecture of Mask R-CNN using for food instance segmentation.

Wei Wang , Weiqing Min, et al. [2], Recent advancements in computer vision and deep learning have transformed dietary assessment, offering more accurate and efficient alternatives to traditional methods such as food diaries and dietary recalls, which often suffer from errors and biases. Vision-Based Dietary Assessment (VBDA) systems can be divided into multi-stage and end-to-end approaches. Multi-stage systems include tasks like food recognition, segmentation, portion estimation, and nutrient analysis, employing models such as Mask R-CNN and U-Net for segmentation, along with 3D volume estimation for calculating portion sizes. On the other hand, end-to-end models leverage deep learning to simplify the process by predicting nutritional content directly from images, thereby minimizing errors linked to intermediate steps. Despite notable advancements, challenges remain, including limited datasets and diverse food presentations. Researchers are investigating synthetic data, transfer learning, and advanced architectures like Transformers to tackle these challenges. Future efforts are aimed at fine-grained food analysis, enhanced volume estimation using RGB-D sensors, and the integration of multimodal data, making VBDA systems more relevant for personalized nutrition and healthcare.

A review on vision-based analysis for automatic dietary assessment

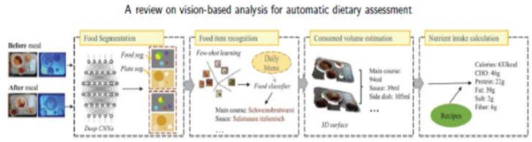

Figure 3: The framework of multi-stage dietary assessment (Lu et al., 2021b).

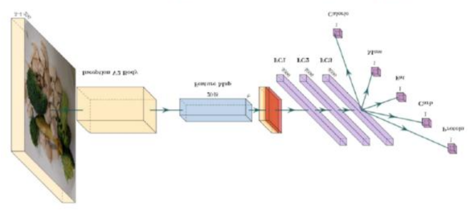

Figure 4: The framework of MTL end-to-end dietary assessment (Thames et al., 2021).

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Michelle Han, Junyao Chen, et al. [3], Recent advancements in computer vision and artificial intelligence have led to the creation of automated dietary assessment systems that combine food detection, nutritional analysis, and personalized meal suggestions. Unlike traditional dietary apps that require users to manually enter their food intake—often a tedious and inaccurate process—new systems like NutrifyAI utilize models such as YOLOv8 for real-time food recognition and nutrient analysis from images. These systems rely on extensive datasets, sophisticated preprocessing techniques, and powerful APIs like Edamam to provide detailed nutritional information. While there are challenges, including limitations in datasets and variations in food items, these technologies are transforming dietary management, with potential applications in healthcare and lifestyle enhancement.

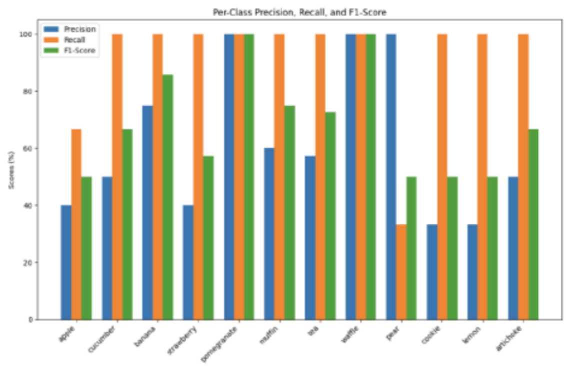
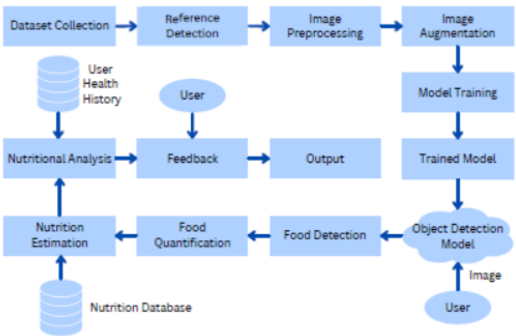


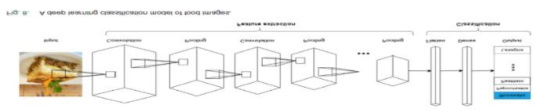
Fig. 8. Precision, Recall and F1 Scores Grouped by Food Classes

Madhumita Veeramreddy, Ashok Kumar Pradhan, et al. [4], Recent advancements in computer vision and artificial intelligence have led to the creation of advanced dietary management systems that automate food recognition, nutritional analysis, and personalized diet recommendations. For instance, systems like NutriVision use models such as Faster R-CNN to accurately identify food items, estimate portion sizes, and calculate nutritional values in real time. By incorporating personalized health data, including individual dietary preferences, BMI, and medical history, these systems offer customized dietary advice and meal plans. NutriVision also boosts user engagement with interactive features like chatbots and personalized recipe suggestions, making it a flexible solution for those focused on health. These innovations tackle the difficulties of manual dietary tracking, enhance dietary adherence, and promote overall health by connecting nutrition science with practical applications in healthcare.



Yudong Zhang, Lijia Deng, et al. [5], The use of deep learning in recognizing food categories has transformed how we manage diets and monitor health. In the past, traditional methods depended on manually crafted features and annotations, which were not only time-consuming but also susceptible to mistakes. However, with the introduction of convolutional neural networks (CNNs) and transfer learning, food recognition tasks can now achieve impressive accuracy, even with extensive datasets like Food-101 and ChineseFoodNet. New approaches such as semi-supervised learning and generative models tackle the issues posed by limited labeled data, leading to stronger performance across various situations. Techniques like data augmentation and synthetic data generation significantly improve model training, particularly for smaller and unbalanced datasets. Additionally, emerging technologies such as hyperspectral imaging and advanced preprocessing methods are enhancing the accuracy of food recognition and quality evaluation. These developments open up new possibilities for practical uses in dietary assessment, personalized health management, and the automation of the food industry.

Fotios S. Konstantakopoulos , Eleni I. Georga, et al. [6], It elaborates on the application of artificial intelligence (AI) to analyze food images in the context of dietary tracking. It describes how AI systems can detect various types of food materials, quantities thereof, and determine their nutritional value, applying photography with smartphone gadgets. Systems such as these make use of techniques, including image recognition and deep learning, to process food images. But challenges remain in the form of creating large food photo databases, food identification accuracy, and volume estimation. To enhance those systems, the paper proposes several measures, such as improving food image labeling, using state-of-the-art AI methodologies, and developing applications that function well under real life conditions. This study aims to lend itself to the general improvement of smarte and more precise dietary and nutritional-monitoring applications.



Jamalia Sultana, Benzir MD. Ahmed, et al. [7], This study revolves around the application of AI and computer vision for the estimation of different kinds of foods from visual representations, announcing aspect to aspects like deep-learning and machine learning-based components aimed at identifying types of food, food image segmentation, and volume estimation of food. Challenges encountered include dataset quality enhancement, variability due to many cuisines, and dealing with irregular shapes of food. The paper discusses novel solutions, such as the use of 3D image reconstruction, reference objects, and GAN models for prediction accuracy. The presented methodologies enable monitoring at the level of individual diets and development of smart nutrition systems through these addressing health problems like obesity.

Ghulam Hussain, Mukesh Kumar Maheshwari, et al. [8], The use of Wearable technology andAI for activity and food recognition targets preventive health care. A system is being developed that combines a smartwatch motion sensor and a piezoelectric necklace sensor to monitor eight physical activities and classify six food types. This work utilizes advanced algorithms such as event similarity search for dynamic segmentation, which use CNN and SVM models for increased accuracy in data classification. The system addresses problems of signal segmentation and user comfort and outperforms previous methods in real-life settings. Future expansions will include broader datasets and the integration of additional health parameters, including sleep monitoring and stress level monitoring.

Hongyang Li 1 and Guanci Yang [9], This research provides a sweet new alternative of explaining dietary nutritional information using machine vision in a smart home. Using deep learning, the authors developed a system for analyzing users' food intake and nutritional composition. The YOLOv5 algorithm for food recognition was employed, along with a highly accurate model on a dataset enlarged from ChineseFoodNet. Coupled with weight calibration and nutritional analysis, the system assesses dietary quality in real-time with a nutritional composition perception accuracy of 90.1%. Tested in a smart home setting with a social robot, the approach showed solid performance and provides a handy tool for monitoring diets and aiding healthy living. This system is unique in that it operates in real time, is resilient, and is a groundbreaking use of machine vision to accomplish autonomous dietary assessment.

Ghalib Ahmed Tahir and Chu Kiong Loo [10], Computer vision techniques for dietary assessments are currently the next big thing these days, addressing food recognition and volume estimation within the machine-learning framework known as convolutions of neural networks. Challenges cited in the literature include variations in food presentation, intra-class similarities, and a variety of environmental factors affecting image quality. This survey also presents datasets such as Food-101 and UECFOOD-256 and discusses the performance evaluation for both traditional and deep learning approaches. Applications of these methods include mHealth apps for automatic dietary tracking. The gaps in this study include unsupervised learning, continual learning, and explainable AI, bringing out their roles in improving model accuracy and increased user engagement in the health space.

Lameck Mbangula Amugongo, Alexander Kriebitz, et al. [11], It provides a systematic overview of mobile computer vision applications for food recognition, volume estimation, and calorie assessment. While outlining the strides made in artificial intelligence, especially deep learning, towards facilitating automatic dietary tracking via smartphones, this review presents various machine learning algorithms, including convolutional neural networks (CNNs), and highlights their deployment in food classification and nutrition evaluation. Interestingly, it mentions challenges such as data size, explainability, and computational cost while applying deep learning models to mobile devices. The study calls to defend ethical considerations, build trust, and provide an accessible explanation of AI-supported dietary assessment tools for health applications.

Ms. V. Lavanya1, R. Karthick, et al. [12], The burgeoning rates of obesity and related health challenges have paved the way for machine learning and computer vision systems for nutrition analysis and diet assessment. Many studies apply convolutional neural networks (CNNs) and other types of deep learning architectures towards food image recognition and nutritional value estimation. Traditional dietary assessment methods can be tedious and error-prone and hence call for automated alternatives. The recent developments include Graph Convolutional Networks (GCNs), ensemble learning, and hybrid frameworks for robust food recognition that can also handle challenges like lighting variation and occlusion. Pre-trained models such as GoogleNet, Inception-v3, and SqueezeNet incorporate transfer learning and data augmentation to formalize the recognition process further. Some innovative systems include "DietPlanner" and a mobile-based approach that offers real-time analysis of dietary intake and personalized diet recommendations through BMI calculations. Future work should focus more on creating robust explainable options, diverse data sets, or lightweight alternatives for applying this technology on mobile platforms. These technologies would pave the way towards achieving healthy eating habits and evidence-based clinical dietary management.

Asst. Prof Apoorva Busad, G S Suchitha**,** et al. [13], In this paper, the author critically reviews the recent advances made in computer vision technologies, specifically those dealing with food recognition and nutrition analysis. This area utilizes machine learning techniques, such as CNN and deep learning, to categorize food items in images or video streams, thereby enabling automatic dietary monitoring and nutrition assessment. By drawing upon such models as YOLO v2 and Mask R-CNN, the accuracy of detection and analysis of different food types and their portions is being improved. Applications include health monitoring, dietary management, and public health improvements, while challenges span diverse datasets, accurate model training, and portion estimation. Some developments in the field indicate a positive outlook for AI-aided dietary solutions.

Phawinpon Chotwanvirat, Aree Prachansuwan, et al. [14], Its main focus is on development in dietary assessment via food image analysis that utilizes artificial intelligence (AI) as a supportive tool toward fully transforming nutrition science. Conventional methods for dietary assessment like the 24-hour recall and food diaries are time-consuming and often inaccurate. The new AI-based IADA stands for Image-Assistance Dietary Assessment, enabling automation in food recognition, portion estimation, and nutrient assessment through the application of computer vision and deep learning. Early systems applied handcrafted algorithms; commercial systems now rely on deep learning, allowing for incrementally improved accuracy of assessment. Complications include a lack of variety in the data set, estimating portion sizes, and bringing in nutritional values specific to ingredients and dish recipes. Having dieticians involved in the system design process and being able to overcome AI's 'black box' nature would be essential in stove a perception of transparent trustworthiness in acceptance within nutrition.

Lili Zhu, Petros Spachos, et al. [15], The paper focuses on the use of machine vision and deep learning toward achieving the goals of efficiency, safety, and quality in food processing. Machine vision systems comprise digital imaging and processing technologies for evaluating food characteristics such as size, shape, texture, and color for grading, quality control, and detection of foreign objects. Traditional machine learning techniques such as SVM, KNN, and Decision Trees, along with their more recently developed cousins, i.e., deep-learning techniques such as CNNs and ANNs, have been used for defect detection, ripeness evaluation, and packaging inspection. Such developments have led to reduced labor costs, greater accuracy, and enhanced food safety therein combatting the constraining factors posed by rising consumer demands and environmental concerns. These include evolving trends and challenges and integration of diverse data sources into real-time processing, among others.

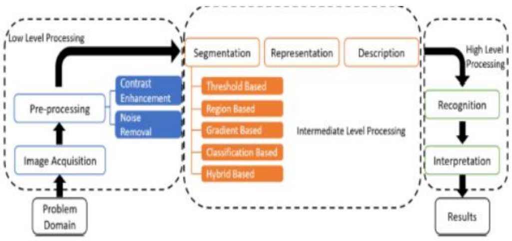
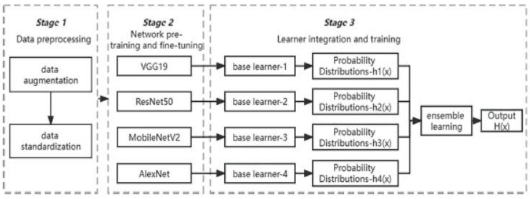


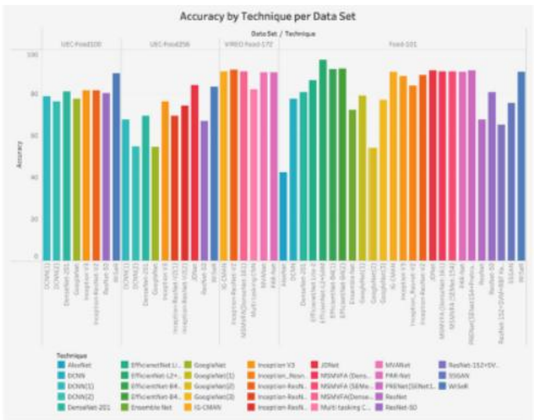
Fig. 2 Different levels in image processing process.

Ananya Bhat V, Raghavendra R [16], Recent advancements in computer vision and machine learning have transformed dietary assessment into an automated exercise of food recognition via image analysis. Existing methods, such as food diaries and self-reports, suffer from biases and inaccuracies that necessitate the development of an automated and more reproducible alternative. Such techniques include convolution neural networks (CNNs) and deep learning models, which excel in food item identification, beyond portion estimation and nutritional insights. Furthermore, areas of application of these technologies include public health, personalized nutrition, and chronic disease prevention. Both large datasets, such as Food-101 and Fruits and Vegetables Image Recognition, have previously been existing in the training of a model for recognizing these different food categories. Through this top-down approach, interfacing mobile applications allow users to take pictures of foods conveniently, and in turn, the systems generate real-time recommendations for dietary behavior. These inventions, despite the various challenges of different food presentations and the maintenance of the model's accuracy under varied situations, pave the way to a proportional revolution in the scalability, user-friendliness, and objectivity composition of dietary assessment.

Le Bu, Caiping Hu, Xiuliang Zhang [17], Food image recognition has continued to gather steam with its applications in dietetics, nutrition management, and health. Traditional machine learning solutions had so far been challenging for the complex structure of food images, given their tiny differences differentiating classes and high variance within class images. Very recent ventures lean onto convolutional neural networks (CNNs) paired with very modern methodologies that leverage transfer learning and ensemble learning to tackle these problems. Transfer learning allows for fine-tuning of already trained models (VGG19, ResNet50) that transferred knowledge from huge datasets like ImageNet to specific food data sets, thus greatly improving recognition performance. Ensemble learning increases accuracy by combining several models' predictions. In this context, the research performed with datasets such as Food-11 has achieved significant increases in accuracy with ensemble models defeating the single model by bringing in combined strengths from across architecture. Such novelties nicely show how AI can drive food recognition systems to promote healthier eating and lessen the effort in real-life nutritional assessments.



Nauman Ullah Gilal, Khaled Al-Thelaya, et al. [18], On food computing from a data-centric view, the present study analyzes and classifies food images using machine learning (ML) and deep learning (DL) techniques. It portrays food computing in light of the technologies like convolutional neural networks (CNNs) and transfer learning that enable addressing issues like food recognition, caloric estimation, and dietary assessments as a rapidly growing area. The authors critically considered over 100 related works touch ground-breaking datasets with geopolitical relevance, calling out issues like visual heterogeneity and regional representation. Among key contributions is the establishment of a public web resource for datasets and a discussion of the futurity of AI in applications like food reverse engineering and robotic chef systems. The paper recommends the construction of geographically diverse datasets and adaptive learning frameworks in order to improve the application of ML for food multimedia tasks.



Nareen O. M.Salim , et al. [19], This research paper presents a relevant overview of food recognition systems through deep learning methodologies for various applications in dietetic evaluation, food safety, and nutritional analysis. They emphasize the challenge of classifying a wide variety of food items that may have high intra-class variability with computer vision and convolutional neural networks (CNNs). Various algorithms are reviewed, including CNNs, SVMs, and PCAs. Reports of accuracies rise as high as 100% for datasets such as Food-101 and Indian Foods. Significant contributions include real-time food recognition for mobiles, calorie estimation, and quality inspection systems. This highlights the effectiveness of deep learning in automating processes related to food, which is beneficial for dietary monitoring and computational efficiency.

Mohammed Ahmed Subhi, Sawal Hamid Ali, et al. [20], This work presents an extensive review of vision-based approaches to computer-aided food recognition and dietary assessment, integrating machine learning and computer vision technologies while dealing with challenges of conventional systems developed for dietary monitoring, and highlighting some of the advances made in creating automated systems using image classification, segmentation, and estimation techniques. Various datasets and algorithms are examined, such as convolutional neural networks (CNNs) and support vector machines (SVMs), to see that the application of the recognition of food types, portion estimation, and inference of nutritional information can be effectively put into action. It also highlights the requirement for rich, broad, diverse databases and inventions in segmentation techniques in order to overcome limitations posed by mixed foods or occluded ones. Future research will focus, among other things, on the enhancement of real-world applicability and on applying advancements in mobile and wearable technologies towards improved dietary assessment.

III. CONCLUSION

The work demonstrates how deep learning might be applied to food instance segmentation with synthetic data. The study employs a Mask R-CNN model, overcoming challenges of either manual data acquisition or labeling using synthetic datasets built with 3D simulation tools. The approach offers reasonable segmentation performance in real scenarios and has potential applications in healthcare robotics and dietary management. Concurrent fine-tuning with real-world data improves performance, reinforcing a strong connection between synthetic and real datasets. The knowledge gained from this combination may be of interest to other domain specifics where detailed object segmentation is required, making its prospects quite appealing for the fields of robotics, healthcare, and smart systems.

Beyond food segmentation, such techniques can open possibilities for autonomous robots, healthcare, and smart systems relying on instance segmentation. This means that the food segmentation algorithms can be employed for the development of automated healthcare robots, in the context of dietary surveillance and assistance in meal preparation. It might also assume more complex operations such as food classification, nutritional assessment, and dietary recommendations, which can directly benefit global health concerns such as obesity and malnutrition.

REFERENCES

[1] DeokhwanPark, JoosoonLee, JunseokLee and KyoobinLee. "Deep Learning based Food Instance Segmentation using Synthetic Data." arXiv:2107.07191v2 [cs.CV] 20 Jul 2021

[2] Wei Wang, Weiqing Min, Tianhao Li, Xiaoxiao Dong, Haisheng Li and Shuqiang Jiang. "A review on vision-based analysis for automatic dietary assessment." Elsevier arXiv:2108.02947v2 [cs.CV] 6 Mar 2022

[3] Michelle Han, JunyaoChen, hengyuan Zhou. "NutrifyAI: An AI-Powered System for Real-Time Food Detection, Nutritional Analysis, and Personalized Meal Recommendations." arXiv:2408.10532v2 [cs.CV] 21 Oct 2024

[4] Madhumita Veeramreddy , Ashok Kumar Pradhan , Swetha Ghanta , Laavanya Rachakonda , Saraju P Mohanty. "Nutrivision: A System For Automatic Diet Management In Smart Healthcare." arXiv:2409.20508v1 [cs.CV] 30 Sep 2024

[5] Yudong Zhang, Lijia Deng, Hengde Zhu, Wei Wang, Zeyu Ren, Qinghua Zhou, Siyuan Lu, Shiting Sun, Ziquan Zhu, Juan Manuel Gorriz, Shuihua Wang. "Deep learning in food category recognition." Elsevier B.V. (2023): https://doi.org/10.1016/j.inffus.2023.101859

[6] Fotios S. Konstantakopoulos, Eleni I. Georga, and Dimitrios I.Fotiadis. "A Review of Image-Based Food Recognition and Volume Estimation Artificial Intelligence Systems." IEEE REVIEWS IN BIOMEDICAL ENGINEERING, VOL. 17, 2024

[7] Jamalia Sultana, Benzir MD. Ahmed, Mohammad Mehedy Masud, A. K.Obidul Huq, Mohammed Eunus Ali, And Mahmuda Naznin. "A StudyonFoodValueEstimation FromImages: Taxonomies, Datasets,andTechniques." (2023) IEEE Access: Digital Object Identifier 10.1109/ACCESS.2023.3274475

[8] Ghulam Hussain, Mukesh Kumar Maheshwari, Mudasar Latif Memon, Muhammad Shahid Jabbar and Kamran Javed. "A CNN Based Automated Activity and Food Recognition Using Wearable Sensor for Preventive Healthcare." Electronics 2019, 8, 1425;doi:10.3390/electronics8121425 www.mdpi.com/journal/electronics

[9] Hongyang Li and Guanci Yang. "Dietary Nutritional Information Autonomous Perception Method Based on Machine Vision in Smart Homes." Entropy 2022, 24,868.https://doi.org/10.3390/e24070868https://www.mdpi.com/journal/entropyEntropy

[10] Ghalib Ahmed Tahir and Chu Kiong Loo. "A Comprehensive Survey of Image-Based Food Recognition and Volume Estimation Methods for Dietary Assessment." (2021) Healthcare 2021, 9, 1676. https://doi.org/10.3390/healthcare9121676; https://www.mdpi.com/journal/healthcare

[11] Lameck Mbangula Amugongo , Alexander Kriebitz, Auxane Boch and Christoph Lütge. "Mobile Computer Vision-Based Applications for Food Recognition and Volume and Calorific Estimation: A Systematic Review." (2023) Healthcare 2023, 11, 59. https://doi.org/10.3390/healthcare11010059 https://www.mdpi.com/journal/healthcare

[12] Ms. V. Lavanya1, R. Karthick, S. Karan Kumar, M. Vincent Leo Vimal. "Nutrition Analysis Using Machine Learning Techniques." (2023) IJARCCE International Journal of Advanced Research in Computer and Communication Engineering

[13] Asst. Prof Apoorva BusadG S Suchitha, Darshan Gowda TS, Lakshmi S, Shalini K Gowda. "Computer Vision based Food Recognition with Nutrition Analysis." (2023)IJCRT2301042 International Journal of Creative Research Thoughts (IJCRT) www.ijcrt.org

[14] Phawinpon Chotwanvirat, Aree Prachansuwan, Pimnapanut Sridonpai, Wantanee Kriengsinyos. "Advancements in Using AI for Dietary Assessment Based on Food Images: Scoping Review." (2024)JOURNAL OF MEDICAL INTERNET RESEARCH; https://www.jmir.org/2024/1/e51432

[15] Lili Zhu, Petros Spachos, Erica Pensini, Konstantinos N.Plataniotis. "Deep learning and machine vision for food processing: A survey." (2021) Elsevier B.V. https://doi.org/10.1016/j.crfs.2021.03.009
[16] Ananya Bhat V, Raghavendra R. "Automated Food Recognition For Nutritional Analysis in Dietary Evaluation." (2024) International Journal of Advanced Research in Science, Communication and Technology(IJARSCT)
[17] Le Bu, Caiping Hu, Xiuliang Zhang. "Recognition of food images based on transfer learning and ensemble learning." PLOS ONE ; https : // doi .org/10.137 1/journal. pone .0296789 January 19, 2024
[18] Nauman Ullah Gilal, Khaled Al-Thelaya, Jumana Khalid Al-Saeed, Mohamed Abdallah, Jens Schneider, James She, Jawad Hussain Awan, Marco Agus. "Evaluating machine learning technologies for food computing from a data set perspective." (2023) Multimedia Tools and Applications (2024) 83:32041–32068
[19] Nareen O. M.Salim , Subhi R. M. Zeebaree , Mohammed A. M.Sadeeq, Hanan Shukur. "Study for Food Recognition System Using Deep Learning" (2021) 2nd International Conference on Physics and Applied Sciences (ICPAS 2021) Journal of Physics: Conference Series
[20] Mohammed Ahmed Subhi,Sawal Hamid Ali, And Mohammed Abulameer Mohammed. "Vision-Based Approaches for Automatic Food Recognition and Dietary Assessment:A Survey." (2019) IEEE Access