IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Nutritrack – Real Time Foodfuel Monitoring System

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Abstract: A growing need for effective dietary management tools has arisen due to an increasing prevalence of obesity and diet-related diseases. Here, a novel ML-based approach is introduced for food calorie detection. We leveraged large datasets with images of different types of food, along with the associated caloric value. Using convolutional neural networks (CNNs) and other machine learning algorithms, we trained models to predict food calories based on visual features. We also applied data preprocessing steps like image augmentation and normalization to improve model accuracy. Model accuracy was then tested through established metrics with high accuracy within caloric estimation. These results suggest that our machine-learning framework can help users make better dietary decisions through real-time calorie data from food images. This study adds to the growing body of literature looking at nutritional technology as a means of scaling up calorie tracking and helping people eat healthier. Future research would be directed toward diversifying datasets and modeling to enhance precision and usability across a wide variety of food and culinary classes.

Keywords: Machine Learning, CNN, Prediction, Classification.

I. INTRODUCTION

The importance of a balanced diet and caloric intake management has become an elephant in the room with the global spread of obesity and diet-related health problems in recent years. The need for systematic tools to manage food is ever-growing and people are trying to have healthy food habits. Conventional approaches for monitoring dietary caloric consumption, including manual logging and estimation, are labor-intensive and far from accurate. This work identifies the development of food calorie and nutrient detection.

The rapid adoption of smartphones combined with improvements in computer vision makes this a promising opportunity to make use of technology in helping individuals track their food intake. Through a series of machine learning algorithms, we can create a machine that, when given an image of food, can provide

a rough estimate of the caloric amount present in the food displayed in the image. Real-time analysis is, therefore, this method not only-it is simplifying the calorie tracking system, but also makes it possible to users.

This hands-on project builds a solid framework for predicting food classification and calories and nutrient content of the food using CNN and other ML classification models from images. We will collect in an exhaustive dataset that covers all kinds of food, so the model can be applied to any diet and any culinary tradition.

This research has the potential not only for individual-level applications but also populational-level implications, as our goal of allowing users to know the calories of the menu of stores would lead to better habits, thus contributing towards improving public health and addressing to the issue of obesity and related diseases. This introduction suggests the importance of the problem, personal diet management capabilities also through machine learning and the focus of our project, as a basis for a comprehensive extraction and elaboration of our methods and results.

II. LITERATURE REVIEW

2.1 INDIAN FOOD:

Obesity and overweight are a growing worldwide concern, threatening millions of children and adults, especially in certain regions such as Africa and Asia. According to the latest estimates, 38.2 million children under the age of 5 were overweight or obese worldwide in 2019. Tracking daily food intake and calories can be a mundane and strenuous task when done manually. In order to overcome this issue, a new method is proposed by using a Convolutional Neural Network (CNN) -based technique, which is YOLOv8, to detect food items and to calculate the calories of their values [12].

Whereas InceptionV3 and like models are computationally costly and inaccurate, YOLOv8 performs a single step for real-time object detection, improving speed and efficiency. In this research proposed model would to facilitating the users to identify food calories by feeding images/Videos of food that they are going to eat. Preliminary training results indicate that YOLOv8 was able to identify 30 categories of food images with high accuracy at 93.1% over 48 epochs, marking a significant advancement in dietary tracking technology [3].

Sr. No	Paper Name	Author Name	Published Year	Doman	Methodology	Algorithm	Our finding
1.	Indian Food Recognition and Calorie Estimation using Yolov8	V.Gayatri .M.Thanua and et. al.	2023	Deep Learning	The CNN-based model called YOLOV8 is used for food recognition. It is trained on the dataset from Roboflow.	CNN, The YOLO (You Only Look Once) algorithm in an Object detection algorithm Used.	Accuracy of the model using this methodology is 93.1%.
2.	Food Recognition and Calorie Measurement Using Machine Learning	Maganti Vasudha, D. Rashmi, and B. A. Mahalakshmi Jain	2024	Machine learning	Machine learning, CNN	CNN	The system's 99.89% accuracy in food detection and calorie measurement demonstrates its dependability and distinguishes it from competing options.
3.	Food Recognition and Calorie Measurement using Image Processing and Convolutional Neural	V Hemalatha Reddy, Soumya Kumari et.al.	2019	Deep Learning	Deep Learning, Convolutional Neural Network	Convolutional Neural Network	Our experimental results on food recognition showed 78.7% testing accuracy with 93.29% training

	Network						accuracy.

Table No. 1 – Indian Food

2.2 Fruits and Vegetables :

This study applied a methodology that was composed of three main modules: object detection, image segmentation, and calorie estimation. As the researchers stated, the Faster R-CNN algorithm was used for object detection, which showed its speed in recognizing food particulars. Consequently, the Grab Cut algorithm was chosen for image segmentation to separate the food from its background. In the end, the volume of the marked food was calculated taking into account the shape and then the estimates were derived on the basis of predefined formulas that relate calorie content to the mass and volume of the food. The studies presented a very high level of accuracy in the estimation of calorie, which indicated the validity of the proposed idea [12] [13].

Sr. No	Paper Name	Author Name	Published Year	Domain	Methodology	Algorithm	Our findings
1.	Food calorie estimation using machine learning and image processing	Wasif Shaikh Mohd. et al.	2019	Deep Learning	Initially, the dataset is manually created. Then the Faster R-CNN model is trained for food detection and Grabcut for seg-segmentation. After that the calorie lookup table to generate output.	Faster R-CNN And Grab Cut Algorithm	Using Faster R-CNN and Grabcut Algorithm model achieved 90% accuracy.
2.	Food Image Recogniti on and Calorie Prediction	Narayana Darapaneni, Anwesh Reddy Paduri. et.al.	2021	Deep Learning	The model employs Mask R-CNN deep learning technique for the mask	Mask R-CNN Algorithm is used for image recognition	Use Mask R-CNN technique to create mask and

						and calorie prediction is done using approximate proportion approach format.	bounding boxes.
3.	Lightweight and Parameter-Optimized Real-Time Food Calorie Estimation from Images Using CNN-Based Approach	Rakib Ul Haque , Razib Hayat Khan , A. S. M. Shihavuddin et.al.	2022	Convolution Neural Networks (CNN)	data set selection, data set pre-processing, data augmentation, and model construction.	CNN	optimum CNN model is developed, experimenting with varied configurations and scoring around 85% in accuracy.

Table No. 2 – Fruits and Vegetables

2.3 Fast food:

This study is focusing on a new method which improves the segmentation of images for the purpose of speeding up the process for a better recognition and classification of the food items that are available in various dishes, a process that is used in the educational program for learning to eat healthier. Data from the UNIMIB database is collected then pre-processing is done before the analysis is done. The research is gaining ground in the use of a mix of sophisticated methods that include Faster R-CNN which is good in detecting foods and RefineNet which is another method good for precise segmentation of food components. By using these ways, the use of machine learning algorithms and their capability to identify and analyze food products automatically are the better. Such an approach is a worthwhile avenue for promoting nutrition and health monitoring, making it possible to be more accurate in dietary assessment and intervention strategies [9].

A convolutional neural network (CNN) is a feed-forward algorithm for food detection and calorie estimation, based on Inception V3 and ResNet models. It is one of the systems that can recognize multiple foods in one image with a high accuracy rate with a group comprised of 23 categories of food and probably over 23,000 images. The system's evaluations performed well as it showed probabilities for foods such as

hamburgers (99.69%) and donuts (99.88%). The future the idea of creating an app with an embedded calorie counter according to the medical data of the user. The limitations are visual confusion between similar-looking foods and the affectation of the accuracy of detection by differences in image angles [8].

Sr. No	Paper Name	Author Name	Published Year	Domain	Methodology	Algorithm	Our finding
1.	Refined Image Seg-Segmentation for Calorie Estimation of Multi-plet Dish Food Items.	Parth Poply, J. Angel Arul Jothi, and et. al.	2021	Deep Learning	First, data is collected from the UNIMIB database and data pre-processing is done. For food detection and segmentation the Faster R-CNN and RefineNet are used resetively.	Faster R-CNN and RefineNet	After training model on UNIMIB 2016 database accuracy obtained for single food items is 90.80%, and for whole meal it is 93.06%.
2.	FoodieCal: A Convolu-tional Neural Network Based Food Detection and Calorie es-timation system	Shahriar Ahmed Ayon, Abir Bin Yousuf and et. al.	2021	Deep Learning	Initially con-structing da-taset,then Data pre-processing. After that train-ing the Inception V3 model and ana-lyzing outputs.	Inception V3 a convo-lutional neural network (CNN) model	For certain fast food items the model was 96% accurate and for some less than that.

Table No. 3 – Fast Food

Methodology	Purpose	Techniques Used	Advantages	Limitations	Example Use Case
Image Classification	Classify food items from images	CNNs, Transfer Learning (VGG16, ResNet)	Fast, simple for single-item images	Cannot handle multiple food items	Identifying "Pizza" or "Burger" from an image
Object Detection	Detect and locate multiple foods	YOLO, Faster R-CNN	Handles multiple food items, real-time	Requires large datasets, complex models	Detecting "Apple" and "Sandwich" on a plate
Regression Models	Predict calorie values	Linear Regression, XGBoost, Random Forest	Easy to interpret, efficient for numeric predictions	Requires accurate feature extraction	Predicting "200 kcal" for a banana
Semantic Segmentation	Identify food portions and shape	U-Net, DeepLab	Pixel-wise accuracy, useful for mixed dishes	Computationally expensive, needs precise labeling	Distinguishing rice from curry on a plate
Multimodal Learning	Combine images and text	Vision Transformers (ViT), BERT	Improves accuracy by using multiple data types	Complex implementation, needs multi-format data	Using image and description for calorie estimation
Generative Models	Simulate food characteristics	GANs (Generative Adversarial Networks)	Data augmentation, improves model generalization	High training time, complex to fine-tune	Generating food images to enhance prediction models

Table No. 4- Different Methodology Available for food classification with strength and Limitations

Methodology	Purpose	Techniques Used	Strengths	Limitations
Image-Based Prediction	Predict calories from food images	CNNs, YOLO, Faster R-CNN, U-Net, and DeepLab	- Works well with visual food identification - Useful for real-time applications	- Requires large labeled image datasets
Ingredient-Based Prediction	Estimate calories from ingredient lists	NLP models (BERT), Regression (Linear, RF)	- Accurate for known ingredient compositions - Handles textual data effectively	- Requires detailed and accurate ingredient input - Struggles with portion size estimation
Volume and Portion Estimation	Measure food portions to calculate calories	Depth Estimation (Stereo Vision, LiDAR), Geometric Models	- Improves accuracy by assessing portion size - Useful for multi-item meals	- Needs specialized hardware (3D cameras) - Difficult for irregular food shapes
Multimodal Learning	Combine multiple data sources (image + text)	Vision-Transformer (ViT), BERT, and Fusion Models	- More accurate by integrating diverse data - Handles both image and textual input	- Computationally intensive - Requires advanced models and large datasets
Regression Models	Predict calories from quantitative features	Linear Regression, XGBoost, Random Forest	- Fast and computationally efficient	- Limited in capturing complex food patterns
Deep Learning Models	Model complex patterns for calorie prediction	Feedforward Neural Networks (FNN), RNN	- Captures complex, non-linear relationships	- Requires extensive training and large data

Table No. 5 - Different methodologies available for food classification with strengths and limitations

III. MATHEMATICAL MODEL FOR FOOD CALORIE PREDICTION

A mathematical model for food calorie detection generally involves identifying the nutritional content of a food item (especially its macronutrient breakdown: carbohydrates, proteins, and fats) and calculating the total caloric content based on these macronutrients.

1. **Caloric Values for Macronutrients:**

   Every food we eat gets its calories from three main macronutrients — carbohydrates, proteins**,** and fats — each contributing a different amount of energy:

   - Carbohydrates**:** 4 calories per gram
   - Proteins**:** 4 calories per gram
   - Fats**:** 9 calories per gram

   Calculating Total Calories:

   To figure out the total number of calories in a food item, we use a simple formula:

$$\textbf{Calories from food} = (\text{Carbs (g)} \times 4) + (\text{Proteins (g)} \times 4) + (\text{Fats (g)} \times 9)$$

2. **Estimating Calories Using Nutritional Data:**

   We can build a food calorie detection model using machine learning, trained on data that links food items to their calorie counts.

   This data usually includes details about the nutritional content of each food — like the amount of carbs, proteins, fats, and even micronutrients.

   By learning from this information, the model can predict the calorie content of a food item based on its nutritional makeup, giving a more accurate estimate of its energy content.

3. **Using a Regression Model:**

   Regression models, a type of machine learning technique, can be used to estimate the calorie content of food items.

   A simple linear regression model can predict the total calories by taking the grams of macronutrients (carbs, proteins, and fats) as input. For more complex datasets, we can use advanced methods like multiple linear regression, decision trees, or even neural networks to capture deeper patterns in the data.

   These models help create more accurate calorie predictions by learning how different nutrients contribute to the overall energy content of food.

4. **Example of Simple Linear Regression Model:**

Food Item	Carbs (g)	Proteins (g)	Fats (g)	Calories (kcal)
Apple	25	0.5	0.2	95
Chicken (100g	0	30	3.5	165
Avocado (100g)	9	2	15	240

From this data, a simple regression model could be trained to predict calories based on the input macronutrients.

5. Advanced Approaches (Using Computer Vision):

For more advanced approaches — like in mobile apps or food detection systems — we can use computer vision (CV) models to estimate calories directly from food images.

Here's how it works:

1. **Food Detection:** The model analyzes the image to identify the food item.
2. **Nutrient Estimation:** It then estimates the macronutrient content (like carbs, proteins, and fats), often by referencing a food database.
3. **Calorie Calculation:** Finally, the model uses this nutritional information to calculate the total calories.

These deep learning models — especially convolutional neural networks (CNNs) — are powerful tools for recognizing food items and predicting their calorie content with impressive accuracy.

For example:

$$\textbf{Predicted Calories} = f(\textbf{Detected Food Item})$$

Where f() is a mapping function learned from historical data.

6. Food Database Integration:

A crucial part of advanced calorie detection models is integrating a comprehensive food database — like the USDA Food Database or similar resources.

These databases store nutritional details for thousands of foods, including the amounts of carbs, proteins, fats, and other nutrients. Once the model identifies a food item, it can quickly pull the relevant nutritional data from the database. This allows for more accurate calorie estimates by combining real-world food information with the model's predictions.

Fig 1. Block Diagram

IV. FUTURE SCOPE

AI-powered food recognition holds the future of the technology in the staggered graphics with some of the possibilities being enhanced nutritional analysis, food allergen, and seamless integration with kitchen appliances. These steps forward are right at the edge of changing the way of perception and handling of nutrition and controlling dietary habits.

We designed a food model that can be used to describe, detect, and identify several food types from multiple regions and cuisines. Moreover, we plan to make our dataset that has a large number of food types.

V. CONCLUSION

There are existing models out there that can only calculate calories for a single food item at a time, and the project will be to propose a model of a new one that can approximately estimate the calories of various items in a single dish. The model will be the ML model. These methods developed will facilitate accurate estimates and data sharing for this pilot study.

With hands-on experience and development opportunities, even otherwise unengaged students would be motivated and engaged for higher grades combined with social benefits that follow "newcomer" behavior. By including the meals and their interactions and combinations, our real-world model not only will give a more realistic calculation but will also help you to stay on track and consume well-balanced meals.

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