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Implementation of Real-Time Food Calorie Estimation system using Image processing

Krishnali Kondekar[1] and Sushma Ghose[2]
[1]Student, Siddhant College of Engineering, Sudumbre, Pune
[2]Professor, Savitribai Phule Pune University 2023-24

Abstract: *In order to monitor the calorie intake and prevent the onset of various illnesses, such as weight gain, obesity, diabetes, high cholesterol, and heart attacks, which can result from an imbalanced diet, careful monitoring of food calorie estimation is important. To accurately measure calories in food, it is essential to utilize image processing systems for the detection of food ingredients. It is often challenging for individuals to accurately determine the calorie content of their meals. While they can seek assistance from experts to estimate the calorie count, this approach is not always practical and does not provide real-time information prior to consuming the meal.*

Thus this paper presents a Food Calorie Estimation System from Images using Convolutional Neural Networks (CNNs). The system captures an image of the food like Breakfast, Lunch, Evening Meal and Drinks and Snacks, and through the implementation of FCTH and the CEDD feature, the Convolutional Neural Network identifies the food type such as idli , Dosa, Medu vada, Samosa and poha. The system conveniently displays the calorie count of the captured food. The system shows the accuracy of 91.82% in detecting the calorie count of captured food image.

Keywords: *Food Classification, Calorie Estimation, Calorie count, Image Processing, FCTH Features, CEDD feature, Convolutional Neural Networks (CNNs).*

I. INTRODUCTION

Food calorie estimation is important for a number of reasons, including nutrition awareness, individual health, and wider societal consequences. Estimating calories is a useful tool for creating balanced diets that satisfy each person's nutritional requirements. It assists in making certain that vital nutrients are consumed in the right amounts, promoting general health and wellbeing. Accurate calorie counting is essential for people with specific medical disorders (such as diabetes, cardiovascular problems) to manage their condition and preserve optimal health [1].

Therefore, calorie estimation functions as a teaching tool, informing people about the energy content of food and promoting a better comprehension of the connection between nutrition and health. People now have easy-to-use tools for measuring calories in real-time, thanks to technological advancements like wearables and smartphone apps. This makes it simpler to keep an eye on and control one's diet [7].

Food calorie estimation with image processing is a multidisciplinary approach that integrates computer vision, image processing, and machine learning approaches to deliver useful information on the nutritional value of meals [2]. In order to increase prediction accuracy, the suggested system estimates dietary calories using convolutional neural networks, or CNNs. Food images are complex and varied, demonstrating differences in sizes, shapes, colours, and textures [5]. This makes it an ideal subject for CNN's ability to automatically extract hierarchical characteristics from such visual data. Furthermore, CNN is more effective than linear models at

capturing complicated, non-linear correlations because to its numerous layers and activation functions. Enhanced accuracy was achieved in food type detection by the utilisation of CEDD and FCTH features.

A. Research Contributions

Given the significance of the calories that users consume, an attempt is being made to give users a simple method of obtaining food's calories, which can help people achieve their health and wellness objectives by controlling their daily calorie consumption. The objectives of the proposed system are as follows:

- To detect Real-Time Food Calorie using food image.
- To measure and manage the daily food intake of the user.
- To detect the food type using food image.
- To recommends the user to keep body profile like fitness, reduce weigh or increase weight.

II. Literature Survey

Numerous studies on the process of identifying food have been conducted using a different methodology. But they are all limited in different ways. After going over a few of the previously suggested models, Ayon et al.[1] developed a brand-new neural network-based model that can identify food items in an image and estimate their calories. A dataset including approximately 23000 images was created, covering 23 unique food groups. By training CNN using features retrieved by Inception V3, a system is constructed that is capable of identifying various foods. To have our algorithm forecast a food item and estimate its calories in real time, the user must upload an image of the food item to the webpage.

Kasyap et al. [2] used Convolutional Neural Networks to determine meal calories. This computed model takes an image of food as its input. The suggested CNN model calculates the food calorie value by detecting food objects. The primary parameter of the outcome is volume error estimation, whereas the secondary component is calorie error estimation.

Raikwar et al. concentrate on determining the food's calorie count in [4] by utilising pictures as input. Before being applied to the SVM, the food image is treated using a number of image processing methods. But the real-time feature for the estimation is not covered by the author.

Kumar Kundan and others [5] Provide a Food Recognition System (FRS) that can be used to determine nutrient values and calories. After classifying and analysing the images, the algorithm determines the type of food and its portion size. It then uses this knowledge to compute how many calories the item contains. By utilising CNN, a more accurate classification will be obtained.

Kamble et al.[6] proposed a system that allows users to understand how many calories they will absorb with each meal using SVM. The feature vector was produced by combining multiple texture and colour properties, and the food photographs were classified using SVM. The experiment is conducted on Thai cuisine. It has been proved that the system is highly essential in the field of biomedicine, estimating the number of calories from food image.

III. Proposed work

The main aim of this paper is to present a system that detect the type of food by capturing an image and provides total calorie content of that food using calorie content database. Figure 1 shows the architecture of proposed system for calorie estimation of captured image.

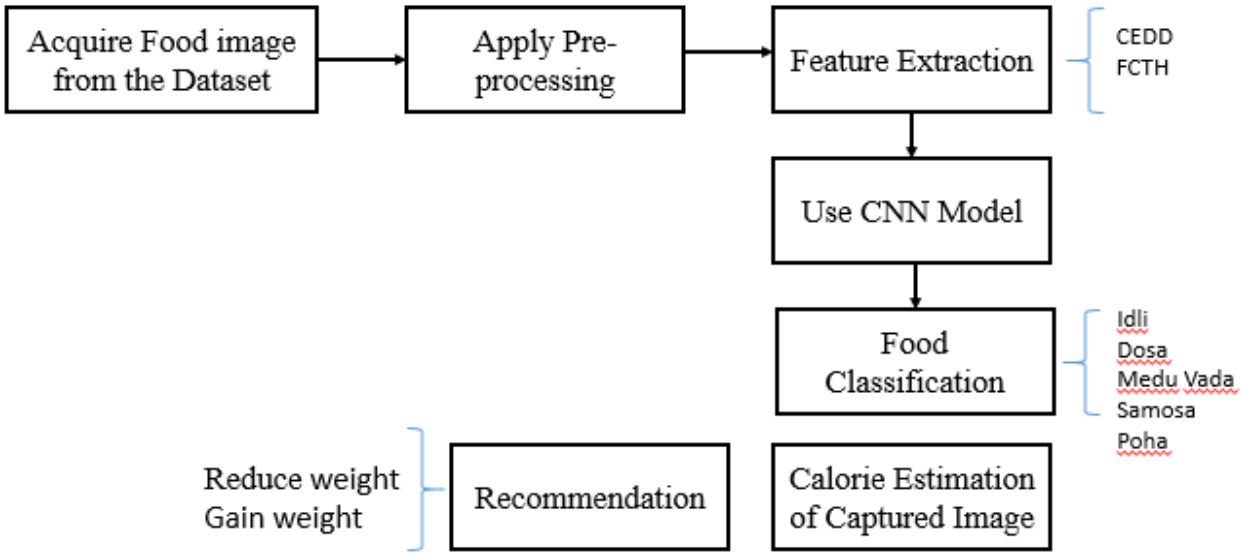

Figure 1: System Architecture

Image Acquisition: Users must take images of food in order to determine the calorie content of that food. To precisely record the amount of food consumed, images have been taken either before or after the meal. Images of meals such as breakfast, lunch, dinner, drinks, and snacks can be taken by the user.

Image Pre-processing: Resizing, normalizing, and noise reduction are image processing technique are used to increase the accuracy of the image processing stages. The input image can be processed by the system. It verifies image dimensions, quality, etc. Additionally, the input image is resized to 128 X 128.

Feature Extraction: Features are extracted from pre-processed images. When classifying food images, the CEDD and FCTH features aid in the appropriate retrieval of images, especially in conditions of distortion.

CEDD (Color and Edge Directivity Descriptor): The CEDD function aids in detecting variations in the illumination of food image situations. The application of CEDD features in food images gives a reliable and efficient method of capturing colour, texture, and edge information. Thus, these qualities have been useful for presenting colour and edge information in food images.

FCTH (Fuzzy colour and Texture Histogram): FCTH can improve the discriminative power of image representation in the context of food images, where minor differences in colour or texture may suggest various components or cooking approaches. This feature aids in the portrayal of an image's visual features by combining colour and texture information, resulting in a more accurate representation of the visual content of food images.

Classification of food images: The CNN model is trained for the food image in order to recognize the different types of food once the characteristics have been extracted and normalized. To discover the association between visual elements and calorie content, the model is trained using a variety of datasets of food images with known calorie values. The technique specifically determines the number of calories in foods like idli , Dosa, Medu vada, Samosa and poha.

Recommendation: The system analyzes the calorie content of the food and provides recommendations for various body functions, including whether the user is obese, overweight, needs weight loss, or needs weight gain. A person's calorie intake may be easily and accurately tracked thanks to image processing, which enables individualized nutrition management based on dietary requirements and objectives.

a. System Flowchart

Figure 2 depicts the suggested system's flowchart, which begins with the capture of food images and arrives with the estimation of calorie counts.

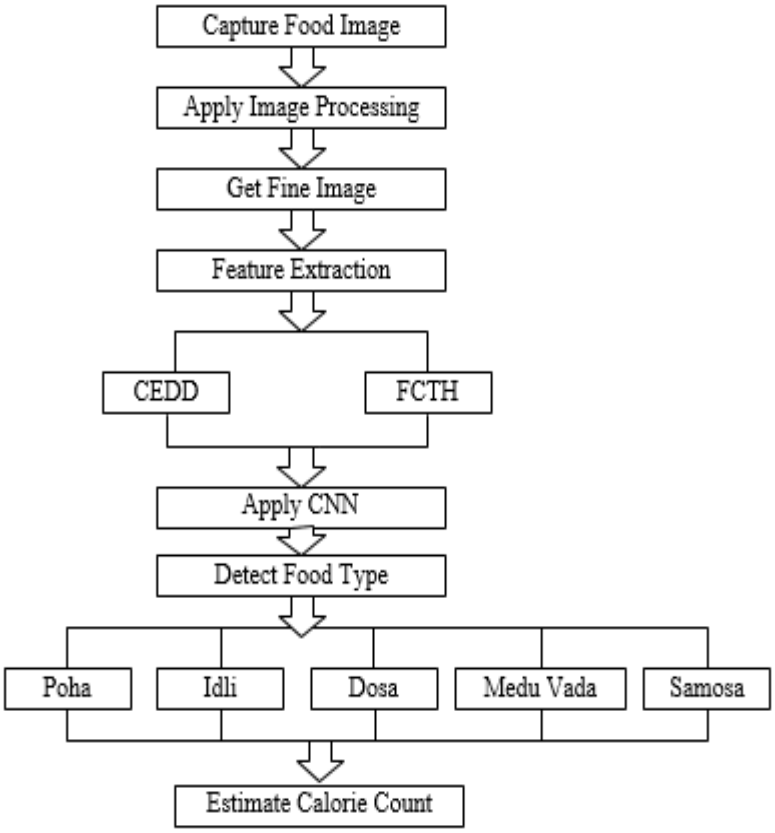

Figure 2: System Flowchart

IV. Algorithm Used

Convolutional Neural Network (CNN)

An input layer, an output layer, and several unidentified layers make up a CNN. CNN's hidden layers frequently consist of convolutional, pooling, fully connected, and normalising layers. The image analytics engine will be trained on CNN to identify important data included within images.

Since CNN can handle a wide range of visual changes, it is a good choice for calorie calculation from food images. Since a CNN constantly learns to extract more significant data from a picture, it is more accurate because it frequently uses multiple layers of processing. The steps of CNN are convolution, subsampling, activation, and complete connectivity. The way CNN helps with food image classification and calorie estimate is explained below.

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Input: - Food Image (idli , Dosa, Medu vada, Samosa and poha) of size W1×H1×D1

Output: - Detect Food type and Estimate calorie count

Step 1. The input images are captured and passed to the first convolutional layer.

Step 2. Convolution layer

The output volume of all filters and images is computed in this layer using the dot product.

I. Accommodates a volume of any size W1×H1×D1

(W is the width, H is the height, and D is the depth of the image.)

II. Four hyperparameters are required:
- The quantity of filters K
- Their spatial range F
- The stride S
- The quantity of padding that is not zero P

III. Create a volume with the dimensions W2×H2×D2 where:
- W2 = (W1−F+2P)/S+1
- H2 = (H1−F+2P)/S+1
- D2=K

Step 3. ReLu Layer

In this layer, the activation function applies to the output of the convolution layer. Activation function like max (0, x) thresholding at zero.

If x<0 then

f(x)=0

Else

f(x)=x

Step 4. Polling Layer

This layer is used to shrink the image stack into a smaller size.

i. Pick a window size
ii. Pick the stride
iii. Move this window across the filtered image
iv. From Each window take the max value

Step 5. Fully Connected Layer

This layer accepts the preceding layer's input and calculates the class score. This output is represented in a 1 D array whose size is identical to the class size.

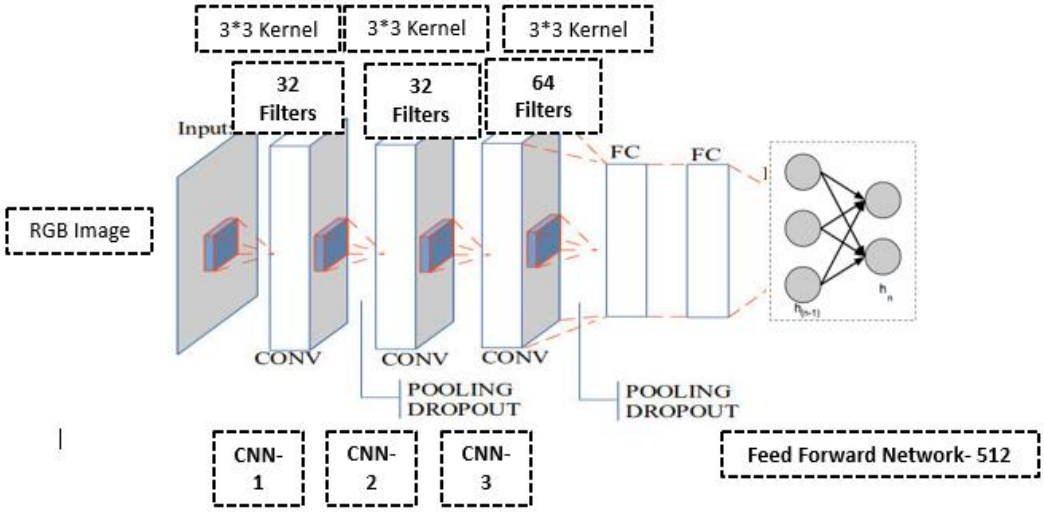

Figure 3: Working of CNN for food calorie Estimation

CNN analyses the calorie estimation for the food. Convolution with dimensions of 32, 32, and 10 and 32 layers is utilised here. These layers also help with feature extraction and food calorie estimate. CNN is significant because we're analysing food images.

V. Implementation Details

The image dataset that is being used has nearly 800 images of the 5 type of food. Thus the after applying CNN to the image dataset, it shows the calorie count of the food from 5 classes such as

- Class 0 - idli
- Class 1 - Dosa
- Class 2 – Medu vada
- Class 3 – Samosa
- Class 4 - Poha

CNN can generate the classification report as shown below, after applying image dataset. Where accuracy and precision are calculated based on false positives images, i.e. which are items incorrectly labeled as belonging to the class and false negatives, which are items which were not labeled as belonging to the positive class but should have been.

Table I: Classification report

	TP	TN	FP	FN
Class 0	6	28	4	1
Class 1	4	30	1	2
Class 2	1	33	0	0
Class 3	1	29	0	1
Class 4	18	16	3	4

For the mentioned classes the accuracy and precision is calculated by using the below formula.

$$Precision = \frac{TP}{TP \times FP}$$

$$Recall = \frac{TP}{TP \times FN}$$

Table II : Confusion Matrix

Class	Accuracy	Precision	Sensitivity	Specificity
Class 0	87.18%	60.00%	85.71%	87.50%
Class 1	91.89%	80.00%	66.67%	96.77%
Class 2	100.00%	100.00%	100.00%	100.00%
Class 3	97.14%	100.00%	83.33%	100.00%
Class 4	82.93%	85.71%	81.82%	84.21%

The graphical representation of the above table is represented in following graph;

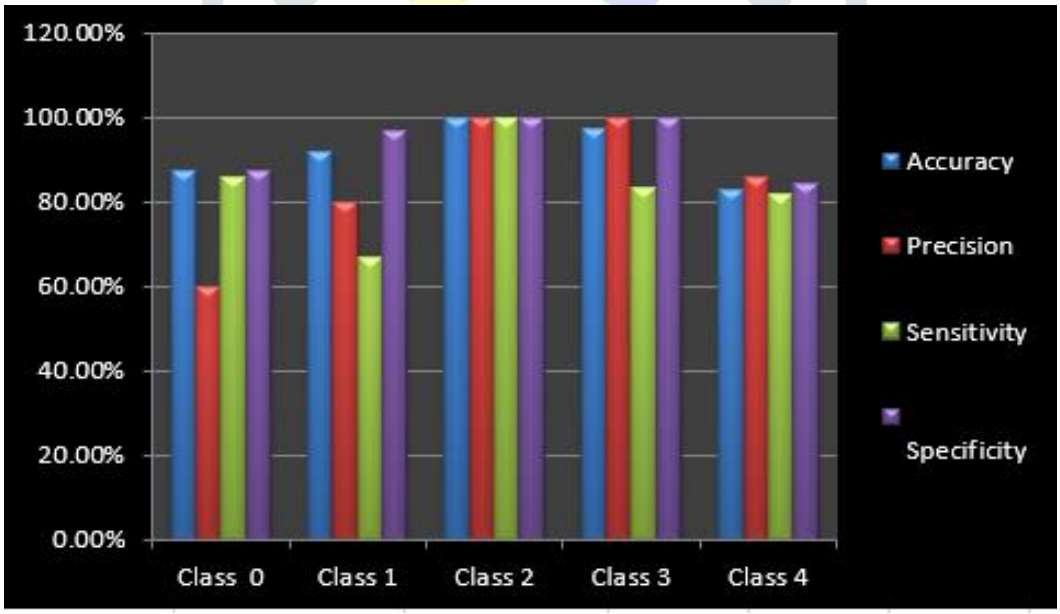

Figure 4: System performance

The classwise accuracy of the above mentiondd 5 classes are shown in figure

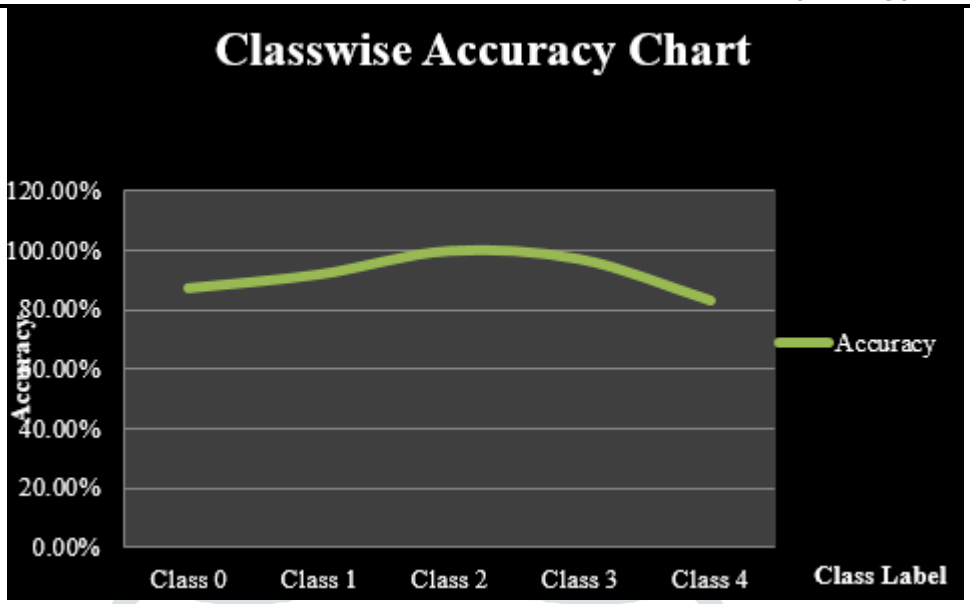

Figure 5 : Class wise accuracy

Thus the use of CNN provides an average accuracy of 91. 82% in detecting calories in the food images.

VI. Conclusion

The suggested model calculated calories from food images, such as idli , Dosa, Medu vada, Samosa and poha, , or, using a convolution neural network. The technology allows the user to quickly determine how many calories are in a food item by taking a picture of it. CNN has demonstrated 91.82% accuracy in calculating the calorie content of food images. Additionally, the use of CEDD and FCTH features to food photos provides a dependable and effective way to record colour, texture, and edge information that aids in precisely determining the food image's calorie count. Due to the tight correlation between obesity and several ailments such as diabetes, hypertension, and cancer, the system serves to increase people's knowledge about the kinds of foods they should eat and the appropriate amount of calories they should be consuming. Consequently, this would lead to a general decline in the proportion of the population that is fat.

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