"Food Calorie Estimation Using Deep Learning".

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Abstract - *In today's world, the most important thing that matters is health. People have become more health-conscious and are careful about the food they eat. Maintaining a healthy diet is crucial for various reasons, as it plays a significant role in promoting overall well-being and preventing a range of health issues. Many diseases are affecting people due to diets, high in processed foods, sugars, and unhealthy fats, leading to nutrient imbalance and potential health issues. One of the main reasons for this situation is that people are not aware of what and how much food they are consuming. Existing techniques, particularly sensor-based ones, can nevertheless determine a food's nutritional content, but they are not very practical for daily use. In this paper, we are employing a convolutional neural network technique to construct and design an effective web-based system for food detection and calorie calculation. We propose a system that estimates calories in food through image processing. An image of food serves as the model's input. The food calorie value is calculated using the proposed CNN algorithm. The system also consists of image acquisition, object detection, weight estimation, and calorie calculation as its process.*

Key Words*: *Calorie Estimation, Convolutional Neural Network, Food Detection, Image Processing, Deep Learning.

1.INTRODUCTION

Food is the key to the human body. Nowadays more and more people care about dietary intake since an unhealthy diet leads to numerous diseases. Modern lifestyle is often fast-paced, and people may opt for convenient, processed, or fast foods due to time constraints. These choices are sometimes high in calories, also contain unhealthy fats and sugars, leading to nutrient-poor diets. A diet plan always needs to take into consideration the total number of calories to be consumed to maintain a fit and healthy life. Yet, this interaction can be troublesome and tiring. Since individuals will in general dodge troublesome and tiring things, they regularly don't follow the amount they eat, and this may prompt stoutness.[1]

Consuming a balanced diet ensures a safe supply of energy for daily activities. The food industry's standard procedure involves labeling every ingredient calorie count that goes into making a dish. However, this method is costly, time-consuming, error-prone, and most importantly it has no effect on an individual's ability to control their calorie intake. Measuring approximate calories directly from the food can be a great abetment in this regard. However, to the best of our knowledge, there is no medical technology that can calculate in real time the number of calories contained in any food.[2]

Creating and developing a real-time food calorie calculation system based on image recognition is a far more practical approach to solving this issue. This device would provide a quick, low-cost method of measuring calories with exceptional precision.[3] In this regard, computer vision-based techniques—like Convolution Neural Networks, or CNN—have been shown to be successful in providing a quick and easy way to classify images in real-time while assessing the caloric content of food photos. Utilizing the R-CNN technique, which offers superior accuracy compared to other Deep Learning models. Our initiatives seek to create an automated calorie estimation system that uses neural networks, specifically R-CNN, to compute calories from given food photos and present the results on the website.

Using the Deep Learning algorithms like Convolutional Neural Networks we will be able to accurately calculate the food items and food calories from the images uploaded. This paper focuses on the goal to identify the food items and food calories accurately.

2. LITERATURE REVIEW

Much progress has been made in the past few years in identifying food calories from images of food. Some of the most popular techniques for determining food intake are shown here, along with the outcomes. Our goal is to illustrate the uniqueness of our suggested system by outlining the benefits and drawbacks of these approaches.

A method utilizing the GrabCut algorithm and Mask R-CNN for image-based calorie estimation was presented by Subaran et al. in 2022[4] They were able to obtain acceptable outcomes for every food category in the dataset. They offered a novel method of computing calories by utilizing the density phenomenon, bounding box, calibration index, etc.

The emphasis of Liang and Li et al. [5] is on the ECUSTFD, a distinct food image data set that contains mass and volume records for the foods. They use a deep learning method (Faster R-CNN) to identify foods and use a calibration object to estimate calories in detail. The contour of each meal is obtained using the GrabCut algorithm. There are 2978 images in their data set. Nevertheless, the method for estimating calories disregards real-time features.

In 2019, Razib Khan et al. noted the rapid rise in obesity and other lifestyle-related diseases around the world.[6] suggested a technique based on the parameter-optimized Convolution Neural Network (CNN) for utilizing a handheld camera to identify food photos from typical meals. To determine the food items and the amount of calories. Even so, they guarantee to offer a more accurate and straightforward way to transform the current manual system into an automated one that runs in real-time. Their system was only able to provide about 85% accuracy in the end, and more precise work needed to be done.

According to Shaikh Mohd. Wasif et al. [4], leading a healthy lifestyle may be essential for every person in the modern world, and what they eat is crucial to achieving an equivalent. This paper focuses on developing software that shows users the number of calories in the food they plan to eat. The software will use two user-provided images—the highest view and, consequently, the view—to achieve this. There will be a search object in the picture as well, possibly a coin with a known volume. The Faster R-CNN algorithm will be used to help detect the food item in the image.

Following the calculation of volume, the mass of the food item is calculated using formulas, and the calories of the food item are calculated using the mass-calorie relationship. Yanchao Liang and Co. [6] proposed a method for deep learning. Food volume and mass records are included in the dataset. It uses the top and side views of the food to estimate calories.

Every image has a calibration object that will be used to determine the image's scale factor. Food(s) and calibration objects are detected using the Faster R-CNN object detection method, and each food counter is obtained using the Grab Cut algorithm. They then calculated the volume and calories of each food. Pallavi Kuhad et al. [7] proposed a method that considers the Category of tools and uses image processing to recognize single and multiple mixed food objects, namely deep learning and SVM. Calorie estimation is done using finger-based calorie measurement and distance measurement methods. A block resize method has also been proposed, which estimates calories based on measured distance values and the recognized food object name. The obtained accuracy is 97%.

S. Dhanalakshmi et al. in their paper, proposed that automatic recognition of food images can help people consume quantified food daily. There are currently no applications that can automatically recognize food and estimate its calories. Not only does their proposed system detect various fruits and vegetables, but it also provides per-serving calories for each food detected in a single image. To accomplish this, we will use the user's input of the food image. The CNN algorithm is used to detect this food item. The following step is image segmentation using OpenCV's morphological functions. The volume of the food is calculated after segmentation.

Following that, the calories of the food are calculated using formulas. Mrs. Srilatha Puli and Co. [9] The proposed model uses a deep learning algorithm to provide a unique solution for measuring calories. The calculation of food calories is critical in the medical field. Because this food calorie is beneficial to one's health. This measurement is taken from the image of food in various objects, such as fruits and vegetables. This measurement is performed with the assistance of a neural network. Tensorflow is one of the most effective methods for classifying machine learning methods. The Convolutional Neural Network is used in this method to calculate the calorie

content of food. An image of food is used as the input to this calculated model. The proposed CNN model calculates the food calorie value with the help of food object detection. Volume error estimation is used as the primary parameter in the result, and calorie error estimation is used as the secondary parameter. The volume estimation error is gradually reduced by 20%. This indicates that the proposed CNN model outperforms the existing model in terms of accuracy.

According to V. Balaji Kasyap et al. [18], the existing model for calorie estimation is manual. So, they provided a unique solution for measuring calories by using a deep learning algorithm. The proposed method is to create food recognition and detection while using several algorithms. Those algorithms are CNN, Random Forest, and SVM to get better accuracy and we obtained it. We have used a food image dataset which is publicly available. CNN was used for image recognition. Also, we trained the models using information from the dataset. Also, accuracy has further improved through optimization, hyperparameter tuning. We have written a function that determines calories based on the fruit detected by taking into consideration the average calorie value of that fruit.

3. PROPOSED SYSTEM

In this paper, we propose a novel deep learning-based approach with a website interface to solve the problem of food image recognition. On the website, we can upload images of food. This food calorie estimation system then goes through deep learning phases and works to find out the approximate calories present in the food. We specifically propose CNN-based algorithms with a few major optimizations, such as an optimized model and an optimized convolution technique.

3.1 DEEP LEARNING

Deep learning is a new approach to machine learning that has recently been proposed to move machine learning systems toward the discovery of multiple levels of representation. A multilayer deep neural network model is used in deep learning. The deep features of the sample data are created by processing the sample features in successive layers of the model, in accordance with the connection law of neurons in the human brain. Artificial neural networks are hierarchical structures, just like deep neural networks. The input, hidden, and output layers make up the multilayer perceptron that makes up the model. In contrast to deep neural networks, artificial neural network models only have two to three layers of forward neural networks, and each layer has a modest number of neurons. As a result, they are not as capable of processing massive datasets. The deep neural network model has a powerful learning function in addition to being able to realize the abstract expression of data since it has several layers, each of which has many synapses.[22]

3.2 FASTER REGION CONVOLUTIONAL NEURAL NETWORK (R-CNN)

Another cutting-edge CNN-based deep learning object detection technique is the faster region convolutional neural network. In this architecture, the network uses the given input image to create a convolutional network that produces a convolutional feature map. Rather than identifying the region proposals made in earlier iterations, a different network is used to learn and predict these regions. The predicted region proposals are then reshaped using a region of interest (ROI) pooling layer, which is then used to classify the image within the proposed region and predict the offset values for the bounding boxes.[19]

We demonstrate that deep learning can be a powerful tool for improving the accuracy of food classification and recognition.[12] Using the increasing technology we will be able to provide a unique platform that will help in eliminating the worry about food intake from people's lives.

Our proposed system is divided into two sections:

1) A web portal with user registration and login for displaying food calorie information.

2) A faster R-CNN algorithm to detect food and estimate calorie counts from input images.

The Proposed flow diagram is depicted below:

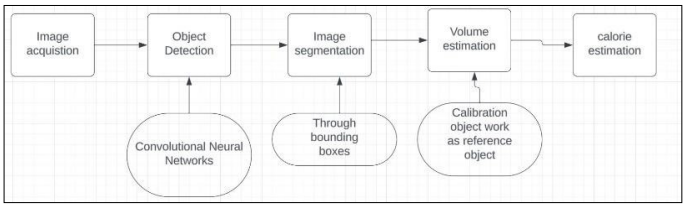

Fig-1: Flow diagram.

The proposed methodology allows for automatic food detection and calorie estimation.

The system consists of five stages:

1. Image acquisition and Preprocessing
2. Object Detection
3. Image Segmentation
4. Weight and Volume Estimation
5. Calorie Estimation

1. Image Acquisition and Preprocessing:

Image acquisition refers to the process of capturing or obtaining an image and converting it into a digital format that can be processed and analyzed by a computer. For our project, we have taken the dataset available at Kaggle named food_360 and a food dataset. The user is asked to upload a picture of their food and use them as input to test the model. The images are then converted to 4D tensors and fed into the Convolutional Neural Network for learning.

2. Object Detection:

For this system, we used Convolutional Neural Network (CNN) algorithm for object detection. CNN, also known as ConvNet, is a deep neural network class based on shared-weights architecture and translation invariance. A CNN is made up of an input layer and an output layer, with multiple hidden layers in between. CNN is widely used in object detection tasks due to their ability to automatically learn hierarchical features from input data, making them well-suited for image processing tasks.

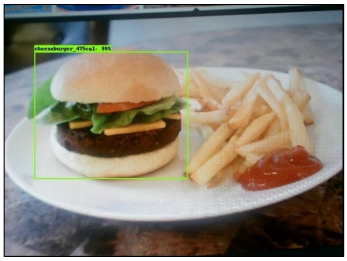

Fig-2: Object Detection

3. Image Segmentation:

Segmentation is the process of dividing a digital image into multiple segments in order to simplify or change the image's representation into something more meaningful and easier to analyze. Image segmentation results in a partitioning of the image into distinct, non-overlapping regions. It eliminates noise from the image. Each segment is often referred to as a “segment”, “region”, or “superpixel”.

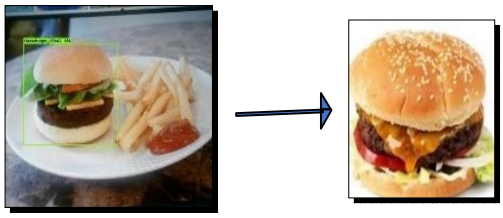

Fig-3: Image Segmentation

4. Volume and Weight Estimation:

To estimate the volume, we calculate the scale factors based on calibration objects. We use a coin to show the specific process of calculating the volume. The diameter of the coin is 2.5 cm. This calibration object works as a reference object.

The side view scale factor is calculated as:

$$S = \frac{2.5}{(Ws+Hs)/2}$$

Where,

Ws = Width of a Side view of the bounding box

Hs = Height of Side view of the bounding box

The top view scale factor is calculated as:

$$T = \frac{2.5}{(Wt+Ht)/2}$$

Where,

Wt = Width of Top view of the bounding box

Ht = Height of Top view of the bounding box

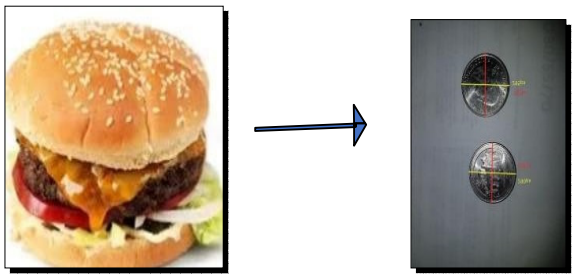

Fig-4: Weight Estimation

5. Calorie Estimation:

After estimating the volume, the next step is to estimate each food's mass. It can be calculated as:

$$\mathbf{m = p * v}$$

Where,

m = mass

v = volume (cm^3)

p = density (g/cm^3)

Then the calorie of the food can be obtained with

$$\mathbf{C = c * m}$$

Where,

C = estimated calories

m = mass

c = Kcal/g

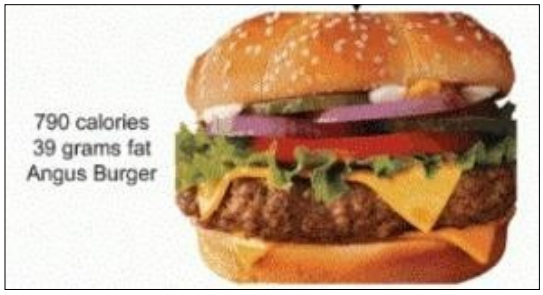

Fig-5: Calorie Estimation

4. CONCLUSION

The main goal of this study is to identify the calories of a food from a given image, which will help people overcome diseases caused by obesity, such as diabetes, heart disease, kidney failure, and so on. We believe that educating people about food calories will enable them to live a healthier lifestyle by keeping track of how many calories they consume. So, in this paper, we have mentioned Convolutional Neural Network (CNN) algorithm for object detection, and we will trained the system using food image dataset after training, we can use the model to detect the food items on the plate and estimate the number of calories per gram using the formula. Our finding provides new information about how calories are estimated from food images.

5. FUTURE WORK

In the coming stages, we intend to overcome the issues and develop a web application that not only identifies food items with high accuracy from an image captured on a smartphone but also reviews the user's medical records to suggest whether the amount of calories should be taken or not. Furthermore, we intend to work with a larger dataset shortly. Following that, our project intends to create a diet chart recommendation system based on the user's calorie count and health chart. This project will benefit many people all over the world who are concerned about their food intake and choices.

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