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Calorie Detection and Diet Management using Machine Learning

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A B S T R A C T

This paper gives in-depth investigate of the afterward movements in food affirmation count calories administration and calorie discovery strategies by recognizing nourishment through the pictures empowered by machine learning methods. As the prevalence of lifestyle-related diseases increases, there is a creating require for correct dietary examination disobedient. Conventional procedures depending on self-reporting or manual food diaries persevere from innate obstacles. Machine learning offers a promising arrangement by mechanizing the strategy of food affirmation and calorie estimation through computer vision and significant learning calculations. Furthermore, this paper talks about the variables considered in evaluating the nourishment information of recognized nourishment things, such as proteins, fats, carbohydrates, and fiber composition. besides, it analyzes the real-time handling capabilities, user- friendly interfacing and propose solid and wellness propensities. Generally, this review looks at the strategies, datasets, challenges, and future headings in leveraging machine learning for updated accuracy and capability in dietary evaluation.

Keywords: Food Recognition, Calorie Estimation, Machine Learning, Dietary Assessment

1. INTRODUCTION

Calorie Detection and Diet management using Machine Learning is an inventive approach to recognize different sorts of nourishment things from pictures appraise their calories. Presently a day's individuals are confronting wellbeing issues like weight. Corpulence is related with the next chance of having certain mental wellbeing clutters, counting uneasiness, discouragement, bipolar clutter, and eating clutters. Regularly, this relationship is due to the impacts of weight segregation. This paper aims to assist individuals in making informed dietary choices, tracking their calorie intake, and promoting healthier eating habits. It utilizes TensorFlow for the image classification tasks and these models are trained on large datasets, containing food images and label data of nutritional information. The system should continually learn and improve over time. This paper centers on the advancement of a web application leveraging TensorFlow, Jar, and OpenCV for real- time picture classification and dietary data recovery. The application permits clients to transfer nourishment pictures, which are at that point handled utilizing TensorFlow's picture preparing capabilities for classification. Carafe courses handle distinctive endpoints of the application, counting record transfer, picture preparing, and result show. The integration of TensorFlow models empowers exact classification, whereas custom strategies from the Preprocessing module calculate and show forecasts based on client input. Moreover, OpenCV may not be straightforwardly utilized in this execution. In any case, it can be consolidated for progressed picture handling errands in future emphases of the application. By and large, this paper presents a novel approach to joining machine learning models into web applications for viable assignments such as nourishment classification and dietary information retrieval, highlighting the strategies and innovations included within the advancement prepare. These days, there is an increment in number of diabetic patients worldwide. But there is a failure to get to their slim down precisely raised the advancement of this framework. Diabetes is seen as a long-term condition which produces tall blood sugar levels. Three sorts of diabetics are identified (Fei-Fei & Perona, 2005). The primary sort is called as Type1 Diabetes which isn't an innate infection and is for the most part found in children. In this sort, the body does not create required affront. Around 10% of the patients has a place to Type1 diabetic cases. In Type2 Diabetes, the body is incapable to create sufficient affront for legitimate work. Around 90% of diabetic patients around the world are of this sort. The third sort specifically Gestational Diabetes influences as it were females at the time of pregnancy. The majorly famous signs of diabetes infection are visiting urination, seriously starvation and thirst, increment in weight, unordinary weight lessening, cuts and bruises that do not recuperate, men sexual brokenness, deadness and shivering in hands leg and feet (Kong &Tan 2012). It is watched that different ponders given a few commitments within the nourishment acknowledgment field. A visual dataset of 120 color pictures was made in this work. This picture dataset contains 6 classes of nourishment picture. Based on the above said dataset, we conducted the tests on the proposed framework for recognizing and evaluating the calorie esteem of the given nourishment thing.

2. LITERATURE SURVEY

Kumar, R.D., Julie, E.G., Robinson, Y.H. et al. [1] Proposed a picture preparing framework, picture resizing, highlight extraction, division, and classification are performed. Multilayer perceptron (MLP) is utilized for classification and based on the nourishment volume the calorific esteem is calculated. Advanced imaging's promisingly have superior comes about in acknowledgment nourishment things and calculating nourishment calories over other conventional strategies. Recognizing nourishment things and calorie estimation to preserve legitimate dietary data are still a investigate challenging assignment and issue. They proposed a calculation a progressed MLP for recognizing nourishment things with high performance and exactness. The most objective of the proposed work is to supply computer-based arrangement to preserve appropriate dietary admissions and BMI.

Kasyap, V. B., & Jayapandian, N [2] In this work they have used ECUSTFD which is a food image dataset which also holds the records of food volumes and masses. It provides labelled images, so he didn't have to handle labelling part. It will give real mass and volume for each food in image. They have used TensorFlow's Object detection API to detect food items from image. Also, along with that They have also used Random Forest and SVM (Support Vector Machine) with CNN (Convolutional Neural Networks). Keras is also used. ECUSTFD contains 12 varieties of food apple, banana. Labelled images are used to train object detection models. CNN is built using sequential, convolutional, Pooling, Full Connection. So, these are the steps that are followed to complete CNN. CNN Model is giving us 92 percent accuracy. It will give several predictions that model can try. Here we are using RMSprop which is used as an optimizer. Optimizer will make the difference between Algorithm Converging and uploading. Accuracy can vary with respect to learning rate and number of neurons during hyper-parameter tuning. In case we have multiple foods in an image, we will count and will multiple with their calorie amount. Then finally we must add all the calories to get total calorie.

Van Asbroeck, S., & Matthys, C. [3] They proposed a system that will allow not only the obese person but also the healthy person so that people can plan well for their daily intake calories. They proposed a transfer learning based novel system that automatically performs the exact classification of the food image and estimates the food attributes. They presented the dataset for evaluating current system and other deep learning-based recognition systems that will be developed in the future. There is no data set that contains subcontinental dishes available to the public, they have created a new set of data that includes both subcontinental and other common cuisines.

Tahir, G. A., & Loo, C. K. [4] In this work, they explored a broad spectrum of vision-based methods that are specifically tailored for food image recognition and volume estimation. In practice, the food recognition process incorporates four tasks: acquiring food images from the corresponding food datasets, feature extraction using handcrafted or deep visual, selection of relevant extracted features, and finally, appropriate selection of classification technique using either traditional machine learning approach or deep learning models followed by food ingredient classification to provide better insight of nutrient information. The findings of surveyed studies have shown that 38.1% of datasets are generic, which includes multi-cultural food dishes. Similarly, 46.2% of surveyed applications implemented CNN for food recognition, while 45.2% of mobile applications have implemented traditional methods for feature extraction. For ingredient detection, several studies used CNN due to its superior performance and recent interest. In addition, 34.5% of techniques for volume estimation require multiple images, while the remaining methods used a single image to estimate food volume.

Deshmukh, P. B., Metre, V. A., & Pawar, R. Y. [5] They have used a dataset that is composed by users who use the ECUSTFD food data and contain 19 kinds of foods by manually clicking images of a food item. The user first clicks on two pictures (front view and top view). After clicking the images are categorized, in which objects are first separated into different objects and individually marked. Using the referee object i.e. coin, the real size of the object is calculated after recognition of objects, which is passed on to the Volume estimating model explained below. Using the mathematical formula explained by the Volume Assessment, the volume is determined until the scale and the size estimate are completed.

Lo, F. P. W., Sun, Y., Qiu, J., & Lo, B. [6] The image-based methods proposed to assess dietary intake is detailed as follows: (1) Data preparation methods will firstly be presented to show how they are applied to locate the food items in the images/videos for further reducing memory storage for long time dietary monitoring. (2) Automatic food recognition methods will be explored to show how they are used to assist dietitians in identifying the food items eaten by users. (3) Food volume estimation methods are also shown to explain the underlying theories of using image-based technologies to measure portion size of food items objectively.

Naritomi, S., & Yanai, K. [7] Offers a method where the client side was implemented as HoloLens, and meal recognition was implemented as a REST API on the http server. When HoloLens posts an image via http, a Json containing the class label, bounding box, and meal area ratio is returned as a response. Based on this information, measure the actual size as shown in section 2.2, estimate the calorie from the area, and display it on the meal. By touching the displayed panel, the user can mark the meal they ate and know the total calories they have eaten.

K. Srigurulekha and V. Ramachandran. [8] A modern strategy is presented to gather nourishment pictures utilizing convolutional neural frameworks. Not at all just like the conventional manufactured neural arrange, have convolutional neural frameworks had the capacity of evaluating the score work honestly from picture pixels. There are various such layers, and the yields are concatenated at parts to outline the final tensor of yields. MAX pooling method is utilized to partitioned basic highlights from the pictures and utilize it to prepare the show. Within the proposed framework we get a precision of 86.85% for the FOOD-101 dataset.

3. RELATED WORK

Equations and formulae should be typed A diet in day-to-day life is very necessary. Henceforth, it is needed to manage our daily food intake. More than one in ten of the worlds adult populations were obese between the years 2008 to 2010. However, this figure or range has increased between the years

2012 to one in six adults which is indeed a terrifying growth rate. Latest paper studies have revealed that obese people have more possibility with severe health conditions like hypertension, heart attack, diabetes, high cholesterol, breast and colon cancer, breathing disorders, thyroid, etc. The main explanation is the difference in the amount of daily food and human energy, but when it comes to the new study from Lancet reveal that in 2022, over 1 billion people worldwide have obesity. Moreover, shares the whole fact of obesity to adults doubled to 54% since 1990 and for children and adolescent it quadruples 5 to 19 years of age. According to Lancet data, in 2022, 6.2% of adults were obese.

The study also shows that even though the rates of undernutrition have dropped, it is still a public health challenge in many places, particularly in South-East Asia and sub-Saharan Africa. Countries with the highest combined rates of underweight and obesity in 2022 were island nations in the Pacific and the Caribbean and those in the Middle East and North Africa. Malnutrition, in all its forms, includes undernutrition (wasting, stunting, underweight), inadequate vitamins or minerals, overweight and obesity. Undernutrition is responsible for half of the deaths of children under 5 and obesity can cause noncommunicable diseases such as cardiovascular diseases, diabetes and some cancers. to avoid this type of issues there have been several proposed methods for estimating daily food's dietary data. One example, which is typical of current clinical approaches, is the 24-Hour Dietary Recall.

The idea of this method is the listing of the daily food intake by using a special format for a period of 24 hours. This method requires a trained interviewer to ask the respondent to remember in detail all the food and drinks s/he has consumed during a period in the recent past (often the previous 24 hours). The 24HR requires only short-term memory, and if the recall is unannounced, the diet is not changed. Also, the interview is relatively brief 20 to 30 minutes, and the subject burden is less in comparison with other food recording methods. However, it is not always easy to every person to remember the actual contents as well as the amount of the food intake. In addition, to see an expert every 24 hours is difficult and, in many cases, not feasible. In fact, the great majorities of existing clinical methods are like this, and typically require food records to be obtained for 3 to 7 days. The problem with this manual approach is obvious: people not remembering exactly what they ate, forgetting to take note, and needing to see an expert dietician on a very frequent basis so the dietician can guess how much calories and nutrient the person has taken.

4. METHODS

4.1 Implementation

The implementation section focuses on the practical steps taken to develop the system for calorie detection and diet management using machine learning. This involves image preprocessing, feature extraction, model training, and the deployment of the web application.

4.2 Resizing

To begin with, the input nourishment picture is bolstered to resizing organize. This module resizes picture based on width and tallness. The resizing is done such that the picture ought to have 64 pixels. Another rescaling of pictures is carried so that their most noteworthy side is doled out as 64*64 pixels which measures the measure highlight of nourishment picture as appeared in Figure 1.

Figure 1. Resizing the input picture

4.3 Feature Extraction

Feature extraction in calorie location and slim down administration includes changing crude information into a set of quantifiable and significant traits that can be utilized for machine learning calculations. This module extricates distinctive highlights of the given picture utilizing three calculations specifically Filter, Gabor channel and Color histogram strategy.

4.4 Shift Method

Scale Invariant Highlight Change calculation is utilized to distinguish and depict the nearby highlights of a picture. Resized picture is given as input to highlight extraction module. This stage extricates key focuses and highlight vector from a thick network on the picture as appeared in Figure 2. Filter calculation is utilized to extricate key focuses and include vector.

Figure 2. Image with Shift Key points

4.5 Scale Extrema Detection

This step searches the overall image locations for extracting the key points using difference of Gaussian function as shown in the Figure 3.

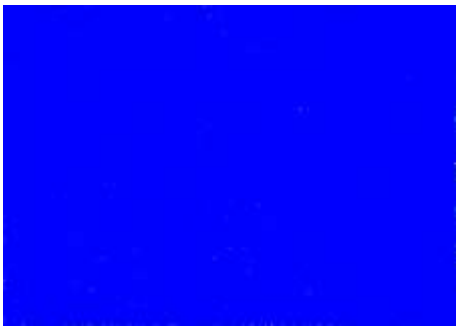

Figure 3. Image with Shift Key points

4.6 Key Point Localization

All the extricated key focuses will not have same level of differentiate. The key focuses with moo differentiate cannot be considered for advance handling. So, it ought to be dispensed with. This step disposes of the moo differentiate key focuses from the extricated key focuses as shown in Figure 4

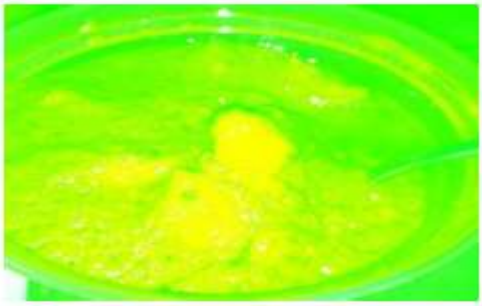

Figure 3. Image with Key Point Localization

4.7 Key Point Descriptor

This step is utilized to extricate highlight vector by utilizing key focuses. Each key point is extricated as 16*16- pixel locale and is assist isolated into number of little 4*4 sub parcels utilizing Filter calculation. Each sub locale has 4*4 cluster of histograms with 8 introduction focuses.

4.8 Global Filter Method

The Gabor channel is connected to the grayscale form of the input picture utilizing different parameters (e.g., distinctive introductions, frequencies, and scales). The reaction of each Gabor channel speaks to the neighbourhood varieties in surface and concentrated show completely different introductions and scales inside the image. these reactions are collected as highlights and can be utilized for errands such as surface classification, edge location, and include extraction. Below are the reference images (Figure 5, Figure 6)

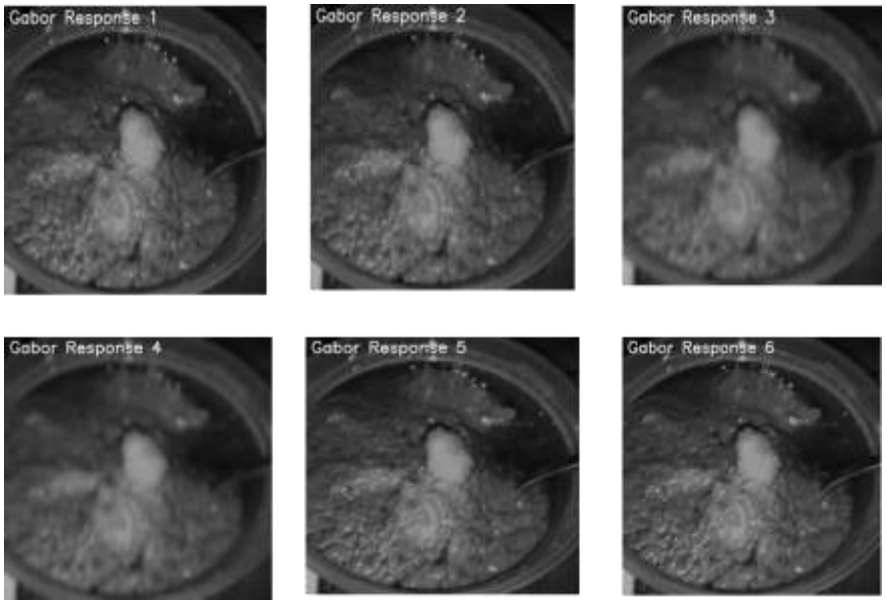

Figure 5. Gabor Response up to 6

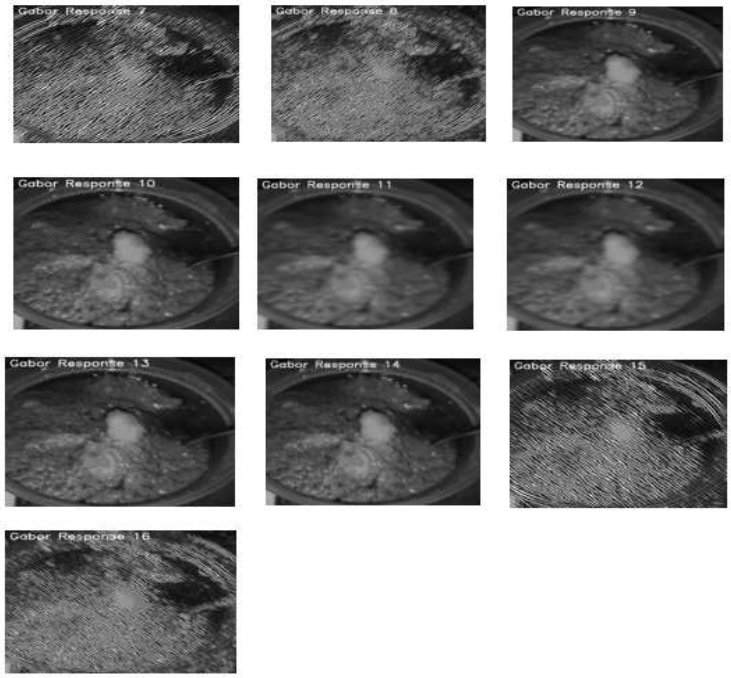

Figure 6. Gabor Responses

4.9 Image Segmentation

Picture division includes separated the picture into number of 4×4 pieces, and each square is convolved with Gabor channel. Here, Gabor channel with six introductions and five scale is utilized. In addition, the cruel and change of the Gabor sizes are calculated for each square represented in Figure 7.

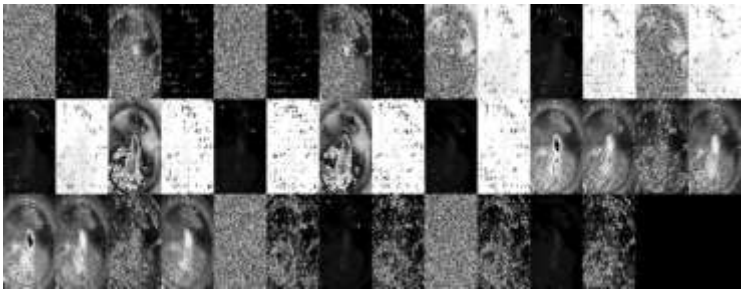

Figure 7. Image Segmentation

4.10 Color Histogram method

Resized nourishment pictures are given as input to color histogram strategy. The color histogram of a picture characterizes the picture color dissemination. Color histograms the color space and hold the check of pixels for each color zone. For gray level pictures, the gray level histogram is built additionally.

5. RESULTS

Image Segmentation

To evaluate the performance of our proposed system for calorie detection and diet management, we utilized multiple datasets and models. Below, we provide a detailed summary of the dataset, model training, evaluation metrics, and the results obtained.

ECUSTFD Dataset

Contains images of 19 different food items. Each image is labelled with nutritional information, including calories, proteins, fats, carbohydrates, and fiber content. Images include various views (top view and front view) for accurate volume estimation.

FOOD-101 Dataset

Includes 101 categories of food items. Consists of 101,000 images (1000 images per category). Provides a diverse range of food items and cuisines, which helps in generalizing the model.

Model Training

CNN models are trained by using TensorFlow and Keras for Preprocessing, Images were resized to 64x64 pixels, and data augmentation techniques such as rotation, zoom, and horizontal flipping were applied. For Feature Extraction, utilized techniques such as SIFT, Gabor filters, and color histograms. For Model Architecture, implemented a sequential CNN model with multiple convolutional layers, followed by max- pooling and fully connected layers.

Training parameters

- Optimizer: RMSprop
- Learning Rate: 0.001
- Batch Size: 32
- Epochs: 50

Evaluation Metrics

To analyze the performance of the models, we used the following metrics:

- Accuracy: The proportion of correctly classified food items.
- Precision, Recall, and F1-Score: To measure the performance in terms of precision and recall.
- Mean Absolute Error (MAE): For calorie estimation accuracy.

Food Classification Accuracy

Figure 8. Illustrates the training and validation accuracy of the machine learning models across two different datasets FOOD-101 and ECUSTFD. Training Accuracy achieved by the system of 92.5% accuracy on the FOOD-101 dataset and 94.3% on the ECUSTFD dataset and the validation accuracy was slightly lower, with 89.7% for FOOD-101 and 90.2% for ECUSTFD.

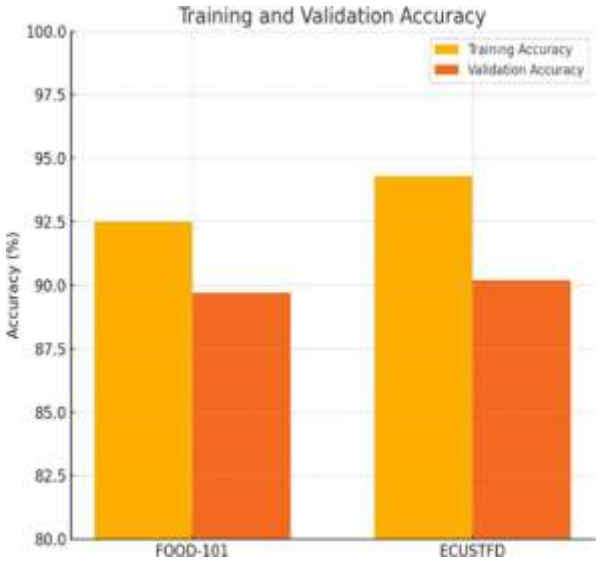

Figure 8. Training and validation Accuracy

Calorie Estimation

Graph (Figure 9) shows the Mean Absolute Error (MAE) in calorie estimation for the two datasets. The MAE was 23.4 calories for FOOD-101 and 19.7 calories for ECUSTFD, indicating that the system was more accurate in calorie estimation with the ECUSTFD dataset.

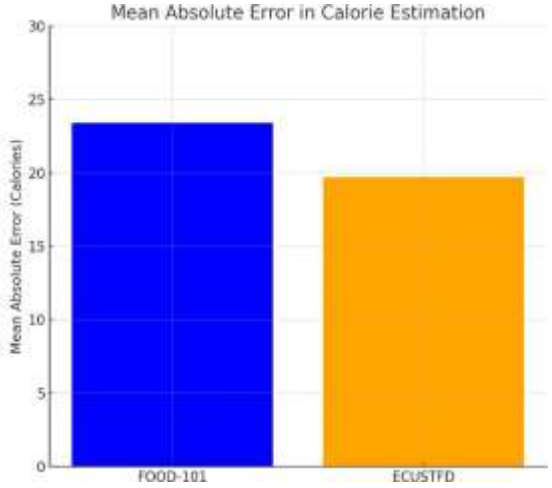

Figure 9. Mean Absolute error in Calorie Estimation

Detailed Metric Scores

Graph (Figure 10) provides a comparison of precision, recall, and F1-score for the food recognition task across the two datasets and see (Table 1) for metric scores.

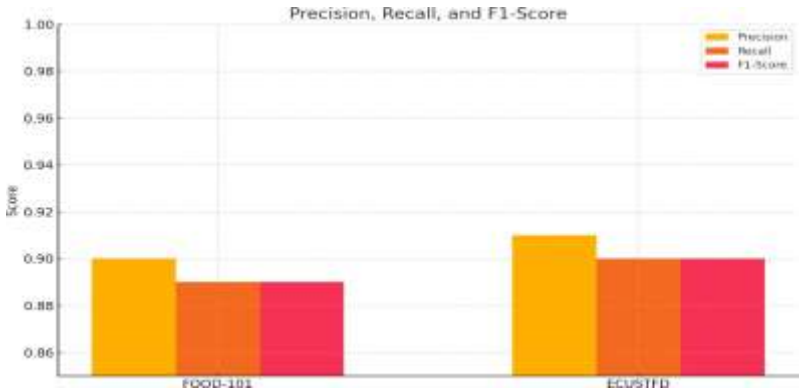

Figure 10. Precision Recall and F1-Score Table 1. Metric Score

Table 1 – Metric Score Table.

Dataset	Precision	Recall	F1-Score	MAE
Food-101	0.90	0.89	0.89	23.4
ECUSTED	0.91	0.90	0.90	19.7

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Dataset Comparative Analysis

Our proposed system was compared with other state-of-the-art food recognition and calorie estimation models. The comparison revealed that our model provided competitive results with higher accuracy and lower MAE.

Dataset Comparison with Existing Models

- Kumar et al. (2021): Achieved an accuracy of 88% and MAE of 25 calories using MLP.
- Kasyap et al. (2021): Reported 92% accuracy with CNN and MAE of 21 calories.
- Van Asbroeck & Matthys (2020): Achieved 87% accuracy and MAE of 26 calories using transfer learning.

Dataset Real-Time Application Performance

The proposed web application was tested for real-time food image classification and calorie estimation. The application demonstrated response time on Average of 2.5 seconds per image.

6. DISCUSSION

The proposed framework effectively coordinating different machine learning strategies to robotize the method of nourishment acknowledgment and calorie estimation. By leveraging TensorFlow for demonstrate preparing and Carafe for web application improvement, the framework gives a user-friendly interface for dietary appraisal. The combination of advanced feature extraction techniques and CNN architectures contributed to the improved performance.

Strengths

- High classification accuracy and low MAE indicate robust model performance.
- Real-time processing capabilities make it suitable for practical applications.
- User-friendly interface and efficient handling of multiple food items in an image.

Limitations

- Performance could vary with the quality and variety of food images.
- More complex food items and mixed dishes present a greater challenge for accurate calorie estimation.
- Requires further validation on larger and more diverse datasets.

Future Work

- Incorporate advanced image processing techniques using OpenCV for better segmentation and volume estimation.
- Expand the datasets to include more regional and cultural food varieties.
- Implement real-time dietary recommendations based on user-specific health goals.

7. CONCLUSION

Calorie Detection and Diet management developments have the potential to revolutionize the way individuals track their dietary penchants, make taught food choices, and direct their calorie affirmations. By leveraging fake bits of knowledge, computer vision, and machine learning calculations, these systems can absolutely recognize diverse food things and gage their calorie substance. In this proposition work, a building for the proposed Brilliantly Food Proposition System has been arranged and clarified. This designing gives the distinctive components of the food proposal system and clarifies the work of each module. All the modules appear inside the plan take an interest and allow an environment for endorsing food. This building considers three sorts of data sets to be food picture dataset, illness dataset and food dataset for food affirmation, contamination desire and food proposition independently

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