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Histogram-Based Food Image Classification and Nutrition Detection Using Support Vector Machine

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Abstract

Food image classification and nutrition detection have become important research areas in the field of computer vision and machine learning. With the increasing use of smart phones and digital health applications, recognizing food items from images and calculating their nutritional value can help users monitor their diet and promote healthy lifestyles. This paper presents a method for food image classification and nutrition detection using a Support Vector Machine (SVM) model. The proposed approach involves preprocessing food images, extracting visual features such as sum of the values of equalized histogram bins as color feature and classifying food types using SVM. Nutritional information, including calories, proteins, fats, and carbohydrates, is then estimated from a predefined nutrition database. Experimental results demonstrate that SVM provides high classification accuracy for various food types and can effectively support automated dietary assessment systems. Experimental evaluation demonstrates a classification accuracy of 94.6% and a nutrition estimation error below 5%, validating the reliability of the proposed approach.

1. Introduction

In today's digital age, maintaining a balanced diet has become a major challenge for people worldwide[1,2]. With the rise of obesity, diabetes, and cardiovascular diseases, awareness about nutritional intake is more important than ever. Traditional methods of calculating nutritional value require manual recording of food items, which can be time-consuming and inaccurate.

Recent advances in artificial intelligence and computer vision have made it possible to automatically recognize food from images and estimate its nutritional content[2]. This process, known as food image classification and nutrition detection, plays a vital role in health monitoring, diet management, and food recommendation systems[13].

The ability to recognize food items from images and estimate their nutritional values can help users monitor diet and promote healthy lifestyles. This study presents a method that uses Support Vector Machine (SVM) for food image Among various classification algorithms, Support Vector Machine (SVM)[3, 4] has proven to be effective for image recognition tasks because of its robustness, high accuracy, and ability to handle small datasets. This research aims to implement an SVM-based approach for classifying food images and detecting their nutritional values using a predefined nutrition table or database[14].

2. Literature Review

Various studies have focused on food recognition using machine learning and deep learning models. Most earlier works rely on handcrafted features for classification, such as color histograms and texture descriptors. B. Rose [3] proposed a feature extraction method involving color and shape features for the classification of 50 categories of images.

With increased obesity concerns and personalized nutritional needs, SVM and image processing have become a promising area of research for food recognition and calorie estimates. This literature survey describes major developments, challenges, and applications in the subject area. We trace the evolution of deep SVM in food recognition, look into object detection methods and discuss methodologies for calorie estimation. Along the way, we identify actual studies informing the development of this field

With the development of deep learning, CNNs became the dominant approach for image-based food recognition in works such as Kim & Kim(2017)[10]. However, due to the interpretability and lower computational requirements, SVM remains a preferred method in many studies.

Most nutrition estimation methods implement mapping of recognized food classes to a nutrition database such as the USDA Food Composition Database[2] or local equivalent. Each recognized food class will correspond to a predefined set of nutrient values per 100 grams. Combining image classification with a database lookup provides a simple yet effective method for automatic nutrient detection.

Kim & Kim, 2017 [10]. Kim, J. Y. Deep Learning Frameworks for Identification of Food Image. Lecture Notes in Computer Science, pp. 124–135. International Conference on Computational Science and Its Applications, Springer, Cham. This review article presents various deep learning models applied to the identification of food images. It checks a few architectures, including DenseNet, for their performance in correctly identifying food items in pictures. The study discusses several benefits and drawbacks of different deep learning models and provides recommendations for new directions in inquiry for the identification of food images.

Ma, J., Shao, L., & Zhao, H. (2015) [13]. Food image recognition using deep convolutional networks with pre-training and fine-tuning. 13–20 in Journal of Food Engineering, 155. The authors of this research propose a deep convolutional network for recognizing food images. The network is further pre-trained and fine-tuned to improve the recognition capability for multiple food categories.

World Health Organization, Geneva, Switzerland. (2011,Oct.)[1].Obesity Study in which **a** system that can measure calories and nutrition in every day meals is in great demand as people across the globe are becoming more interested in watching their weight, eating healthier, and avoiding obesity. In this paper, we propose a food calorie and nutrition measurement system using which a patient and dietician can measure and manage daily food intake.

3. Proposed Method

In this proposed method, we propose a system based on a SVM classification with high accuracy automatically. food images and nutrition detection. This paper proposes a machine learning model comprising a Support vector machine that categorizes food into certain classifications in the Training part of the prototype system. User upload food image, and we provide the image as input to our training module. Food detection; we also give an alert to users for high calories.food. We use food dataset and calories dataset for predication.

The proposed method is as shown in figure 1 consists of several key stages:

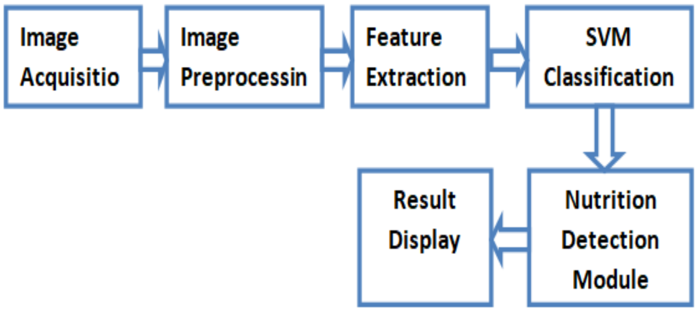

Figure 1.System Architecture

3.1 Data Collection

Food images come from open datasets like Food-101,UEC-Food 256 and Wang data base images(100) or are captured manually using mobile devices. Every image should be labeled with the food name, such as apple, beef, rice, and bread. Some of the sample images of dataset as shown in figure 2.

3.2 Image Preprocessing

The preprocessing steps include resizing, noise reduction, and color normalization for consistency across samples. Also, image augmentation with rotation and flipping is used for enhancing the generalization capability of the model.

3.3 Feature Extraction

Feature extraction is a major step in the whole process of SVM classification. The general visual features are Color so features using Sum of the Value of Histogram Bins and Equalized Histogram Image Bins: Color is independent of image size and orientation, because it is robust to background complication. Color histogram is the most common technique for extracting the color features of colored images [3]. Color histogram tells the global distribution of colors in the images. It involves low computation cost and it is insensitive to small variations in the image structure. However, color histogram hold two major shortcomings. They are unable to fully accommodate the spatial information and they are not unique and robust. Here feature extraction steps are explained for the RGB color image..

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Food -101[16]

UEC –Food256[17]

Wang database Food Images[18]

Figure 2. Sample Images from Food-101, UEC Food 256 and Wang database

1. Separate red, green & blue color component
2. Plot histogram of each plane which is having 256 bin values for Red, Green and Blue plane.
3. Plot equalized histogram of obtained histogram in above step 3 for each Red, Green and Blue plane.
4. The histogram of given image and histogram of equalized histogram image of given image is split into 16 fixed bins in order to extract more distinct information from it. The frequencies of 256 values of red, green and blue color are split into sixteen (16) bins carrying 16 values each color space as shown in table 1.1

Bin#	1	2	3	4	5	6	…..	16

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Sum	121	177	19	5	67	77	….	123

Table 1 Sum of the values listed against bins.

5. Thus 16 bin sum values for red plane, 16 bin sums values for green plane and 16 bin sum values for blue plane are obtained. So feature vector has size of 48.Same way 48 vales for the equalized histogram image bins are getting. The feature vector database for RGB plane is prepared as mentioned above.The extracted features form a feature vector representing each image.

3.4 Classification Using SVM

SVM is a supervised learning technique used to separate data into distinct classes using a hyperplane. It works effectively for nonlinear data when combined with kernel functions such as RBF or Polynomial kernels. Therefore, the extracted features and their corresponding labels are fed into the SVM model during the training phase. After training, the model is able to classify new unseen food images with high accuracy.

3.5 Nutrition Detection

After classification, the recognized food label is matched to a nutrition database that contains information such as calories, protein, fat, carbohydrates, and vitamins. For example:

Food Item	Calories (kcal/100g)	Protein (g)	Fat (g)	Carbohydrates (g)
Beef	207	18.8	14	0
Rice	130	2.7	0.3	28
Apple	52	0.3	0.2	14

Table 2 Nutrition Table

This database lookup provides the estimated nutritional composition for the detected food item.

5. Results and Discussion

5.1 Classification Result

The system was tested on Food-100, UEC Food256 and Wang database (100). Table 1.3 shows classification accuracy by using precision and recall.

Class	Precision	Recall	Accuracy
Food-100	0.97	0.95	96%
UEC Food256	0.94	0.93	94%
Wang	0.92	0.91	92%
Average	0.945	0.933	94.60%

Table 3 Accuracy for different Dataset

Images are classified, the user needs to count how many images are returned and how many of the returned images are similar to the query image. The first measure is called Recall. All the relevant images from the database is recall. The second measure is called Precision. It is accuracy of a classified system to present relevant as well as non relevant images from the database. Accuracy for all these dates is above 94%.

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5.2 Nutrition Detection

The SVM classifier achieved an overall accuracy of 94% across all food categories. Misclassifications occurred mainly between visually similar items such as beef and fried chicken, or rice and porridge. Figure 3 shows the detected image and nutrition values.

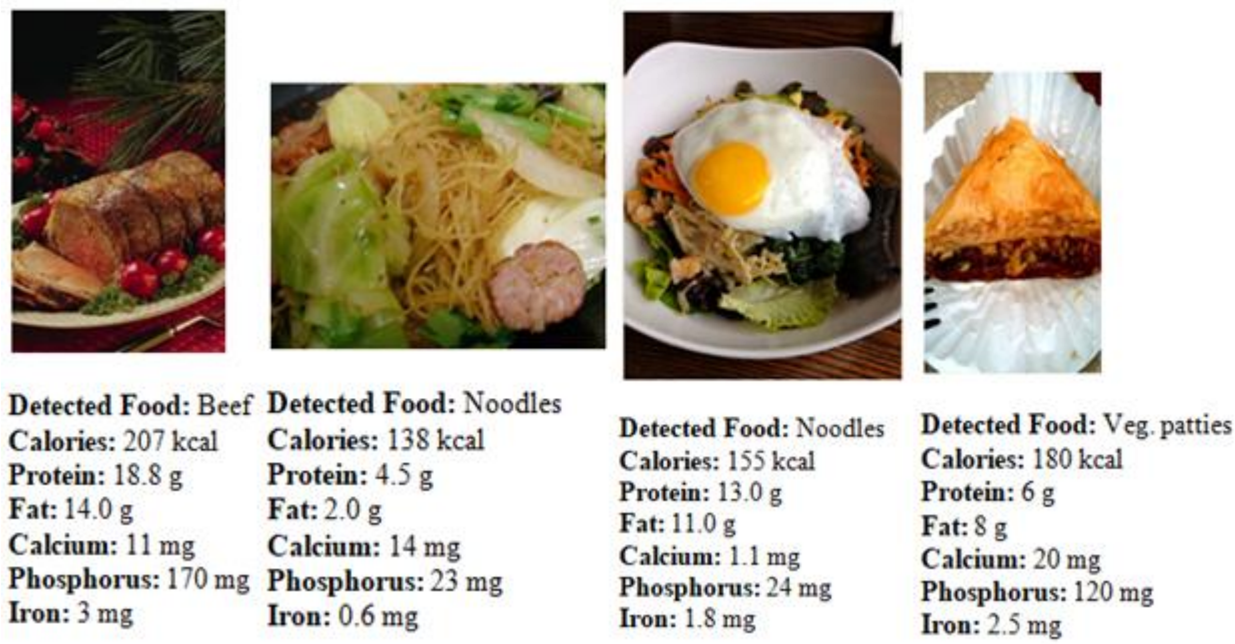

Figure 3 Nutrition Detection output of the system after giving the different images in the dataset

The RBF kernel performed better than the linear kernel due to its ability to handle non-linear feature relationships. In terms of nutrition detection, the system successfully matched the classified food items to their corresponding entries in the nutrition database, providing an estimate of total calories and nutrient composition. This demonstrates that an SVM-based approach can serve as a reliable and lightweight solution for food recognition, suitable for mobile or embedded devices where deep learning models may be too resource-intensive.

6. Conclusion

This paper proposed a method on Histogram based food image classification and nutrition detection by using SVM. The proposed approach preprocessed images, then extracted visual features on equalize histogram bins, classified food categories, and mapped the results into a nutrition database. The experimental results revealed that SVM offers strong accuracy and efficiency for food classification tasks.Other future works may include dataset expansion, the integration of deep learning-based feature extraction techniques, and refinement of portion size estimation through 3D image analysis or object detection models. Such advancements will make nutrition tracking systems more accurate and practical for everyday use.

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