FOOD RECOGNITION AND NUTRIENTS IDENTIFICATION FOR MAKING HEALTHY FOOD CHOICES

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ABSTRACT

Food Recognition System(FRS) plays an important role in today's modern day life. To lead a healthy life system to measure the amount of nutrients contained in food consumed by humans is important to reduce obesity. High calorie intake in the human body has proved harmful leading to several diseases. To identify food items accurately in such systems, image processing is used. Image processing techniques like image segmentation, feature extraction and classification are used for food recognition and nutrients identification. In the proposed work, image segmentation is done using color and shape segmentation which segments the food portion from the background. In the next step, the key features are extracted from segmented portion using Scale-invariant Feature Transform(SIFT). SIFT is used for texture feature extraction. For classification, Artificial Neural Network(ANN) is used which recognizes the food. After recognition, the nutrient fact table is prepared and based on the amount of fat contained in the food identification whether the food is healthy or not is done. Proposed system gives better accuracy in classification using ANN.

Keywords: *Image segmentation, Feature extraction, Object recognition and Artificial Neural Network.*

1. INTRODUCTION

Nowadays, people have very busy schedules due to changes in their lifestyle and work commitments. Obesity is becoming a common problem in today's modern day life. The main cause of obesity is the combination of consumption of excessive unhealthy food and lack of physical activities[3]. Research shows that obese people are more likely to have serious health conditions such as hypertension, heart attack, diabetes, high cholesterol, cancers, and blood pressure[1]. Lot of nutritional information is available on internet but such information has not helped people to incorporate a healthy diet in their daily routine. We need a system which can make changes to the food choices of people and give them effective results. A system which can inform the user about the nutritional information of a food item and also classify it as healthy or non-healthy will be useful.

To identify the food in the system, image segmentation, feature extraction and classification is done and prepare the nutrient tables to find the amount of individual nutrients like protein, carbohydrates, energy, fat and sugar contained in the food for identification of healthy food.

To identify the food in our system there are various steps like pre-processing, image segmentation, feature extraction and classification. Then using the nutritional fact table the information about nutrients contained in the food recognized is provided to user. Ideal fat for each food class is obtained and the decision whether the food is healthy or not is made available to users of the system.

2. RELATED WORK

2.1 IMAGE SEGMENTATION

In Segmentation, the image is partitioned into segments. After segmentation, the boundary detection of food **portions are obtained. The methods for segmentation are color, shape, size and texture segmentation.**

A. **HISTOGRAM :** Histogram is the graph showing the number of pixels in an image at each different intensity value. Color histogram is the distribution of colors in an image. Either individual histogram of each color channel can be obtained or 3-D histogram containing combined result of all 3 channels can be prepared.

B. COLOR AUTOCORRELOGRAM : It is used for checking randomness in an image. It is a new feature for image indexing. The value should be near zero for randomness. It shows how spatial correlation of pair of colors change with distance. It is the probability of finding identical colors at certain distance. A graph is created which shows the number of pixels having the same intensity color within a particular distance surrounding the pixel in an image.

C. **COLOR MOMENTS :** Color moments are features that can be used to differentiate images based on their features of colors. They provide measurement of color similarity between images. Moments are mean, standard deviation and skewness.

2.2 FEATURE EXTRACTION

Feature Extraction is a crucial stage of FRS on which the performance of recognition depends. It extracts the meaningful set of information which is called feature vector. Feature Vector represents characteristics of food portion in images.

A. SCALE-INVARIANT FEATURE TRANSFORM(SIFT) : SIFT is used for detecting local features points in an image. For every feature point, it provides a set of features which describe a small region around that point. The features identified are invariant to rotation and scale. The feature points extracted from the image during training phase can be used to recognize food portions in the testing phase. The food is recognized in the input image by individually comparing each feature from the input image to the features extracted and finding candidate matching features based on Euclidean distance of the feature vectors.

2.3 CLASSIFICATION

In Classification step, the features extracted are given as input. In classification the food in image is recognized and is assigned a class label based on its features.

A. ARTIFICIAL NEURAL NETWORK : ANN plays an important role in object recognition and they carry out recognition task faster and with more reliability. They are capable of modeling and processing nonlinear relationships between inputs and outputs in parallel. It is a multi-layer approach where each layer has neurons as input. The neurons in every layer are connected with neurons of all other layers in the network. ANN contains the weights of all the previous layers which are connected. The cost function is used to find the optimal solution to the problem which is being solved. The best output can be obtained by optimization techniques such as gradient descent or stochastic gradient descent.

There are two phases in ANN : training phase and testing phase. In training phase, a training dataset is loaded into the system to train them and feature set is prepared. During the testing phase, the key features extracted from input image are matched with the feature set of training phase and then classification is done. The input image is assigned to the class in the classification process with which the feature points match.

3. COMPARISONS OF IMPLEMENTED TECHNIQUES

Table 1: Comparison of Implemented Techniques

No.	Paper	Researchers	Method Used	Advantages	Disadvantages
1.	Using Graph Cut Segmentation for Food Calorie Measurement	Parisa Pouladzadeh , Shervin Shirmohammadi , Abdulsalam Yassine	Graph cut segmentation, SVM classification	Efficient , robust and finds best contour of objects.	As the area of food is not uniform there are some problem in extracting exact portion of food.
2.	Using Distance Estimation and Deep Learning to Simplify Calibration in Food Calorie Measurement	Kuhad Pallavi, Abdulsalam Yassine, Shervin Shimohammadi	Deep learning method with Distance estimation method	High accuracy than SVM. Calibration is done internally.	System is not able to find the real dimension of food object.
3.	Food Calorie Measurement Using Deep Learning Neural Network	Pouladzadeh Parisa, Pallavi Kuhad, Sri Vijay Bharat Peddi, Abdulsalam Yassine, and Shervin Shirmohammadi	Deep Learning Neural Network	Deep learning does not affect central layers and works on top layers.	The system is trained twice during the training phase becomes time- consuming.
4.	Food Image Recognition with Convolutional Neural Networks	Zhang, Weishan, Dehai Zhao, Wenjuan Gong, Zhongwei Li, Qinghua Lu, and Su Yang	Convolutional Neural Network	All the processes like pre-processing and feature extraction are done internally by the system.	Does not work well for small database.
5.	Measuring Calorie and Nutrition From Food Image	Pouladzadeh Parisa, Shervin Shirmohammadi, Rana Al-Maghrabi	Color and texture segmentation and SVM	Calculating the area of the food portion with thumb is more flexible, controllable and reliable.	Every time user has to capture two photos and store them which increases the overhead on the database.

4. PROPOSED SYSTEM

The flowchart of the proposed system is as shown in fig-2. First a database of the food images is prepared. The database is then loaded into the system for further processing. An image from database is chosen and taken as input image for the system.

In pre-processing, resize operation is performed which changes the dimension of the input image. The pre-processing step is followed by segmentation which divides the food portion into segments. Segmentation is done using color and shape segmentation. In color segmentation operations like histogram, color auto correlogram and color moment is performed. In shape segmentation, canny edge detection to extract the geometrical shape of the food is done. For each detected food portion, a feature extraction process is performed using SIFT. In this step, the food features are extracted which are sent to classification step. The classification is performed using artificial neural network(ANN), where the food is recognized. Based on the database created a nutrition fact table is prepared. Ideal fat content for each food in the database is obtained and comparison with the actual fat is done to get information whether the food is healthy or not.

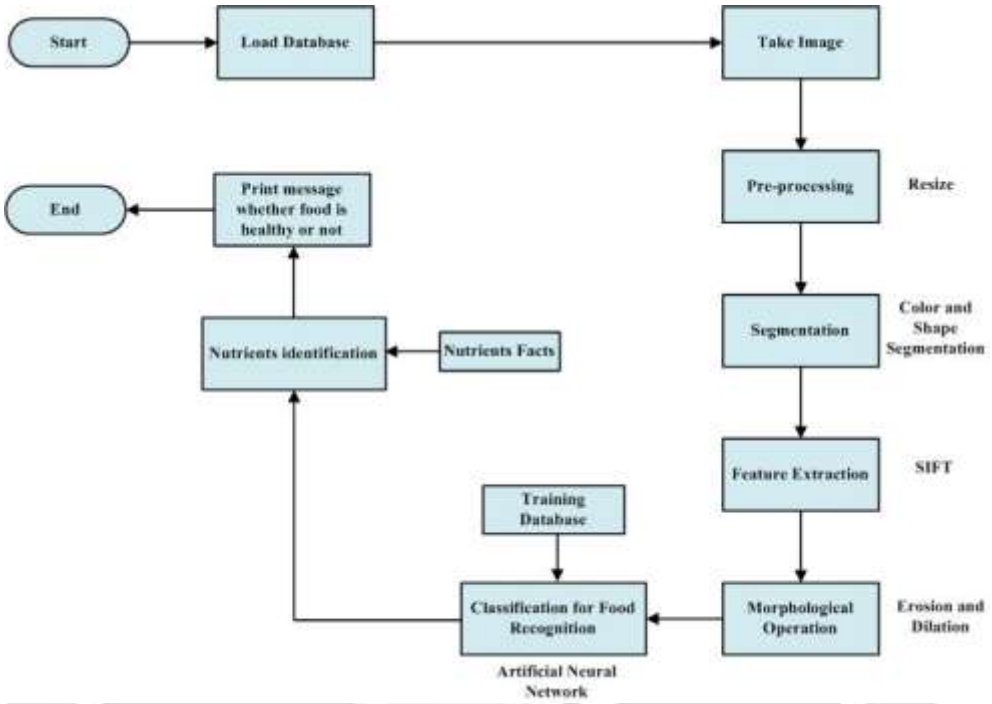
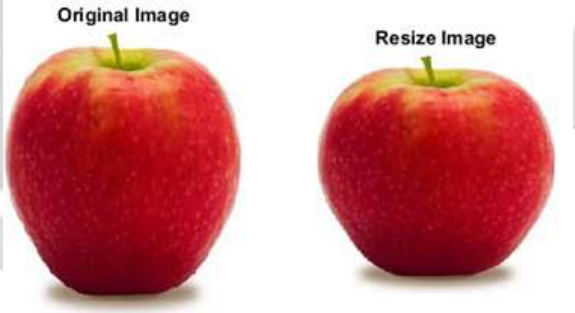


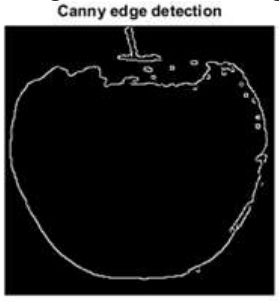
Fig- 2 Proposed system flowchart

5. RESULT ANALYSIS

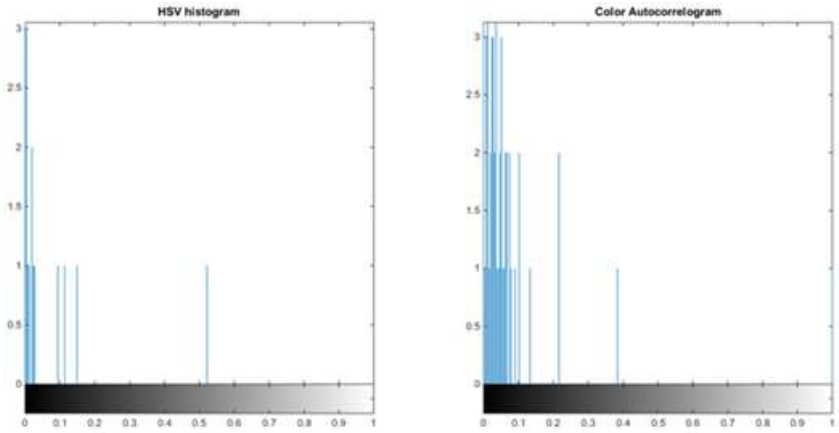
Implementation results of the proposed system is done using MATLAB R2014b. The operations were carried out on desktop computer having Intel i5processor with 8GB RAM having Windows 8.1(64 bit) Operating system. The parameter selected for result analysis of proposed system is Accuracy. Based on the parameter decided the recognition of food in the plate using ANN classification method will be calculated. In the system accuracy of recognition rate of every class using ANN classification is calculated. The screen shots of the intermediate results to generate the final output are shown below.



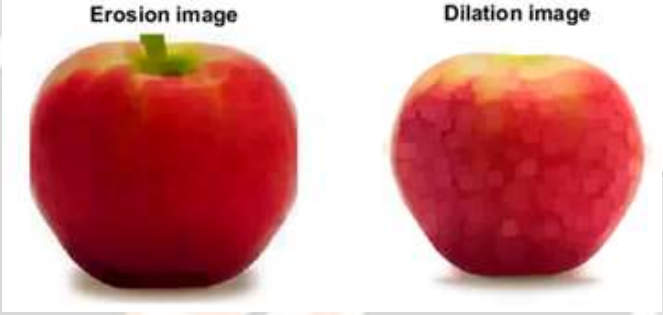
(a) Original and Resize image



(b) Canny edge detection



(c) Histogram image and Color auto correlogram image



(d) Morphological Operations

(e) Output screen

Fig-3 Intermediate results

Table-1 Result Analysis table for ANN

Food type	**Accuracy**
Apple	90%
Orange	80%
Banana	100%
Pineapple	100%
Mix fruit	100%
Dhokla	100%
Manchurian	100%
Noodles	100%
Average	**96.25%**

6. CONCLUSION

In the proposed system, a system for food recognition and identification of different nutrients contained in the recognized food object is carried out. The system helps people by helping them make healthy food choices and maintaining a healthy life. The system focuses on feature extraction and classification for accurate food recognition. For feature extraction, SIFT is used which identifies texture features from segmented portions. The classification is done using ANN, which is a learning approach. ANN has two phases, during training phase the system learns from the training dataset and creates a model file which is given as input during the testing phase and classification is done. The nutritional fact table is given as input to the system which provides nutritional information about food and based on the amount of fat contained the food is identified as healthy or non-healthy. Accuracy of the classification is improved using ANN as compared to SVM. The accuracy of the proposed system is 96.25%. The system works well for single foods, in future the accuracy of mixed foods can be improved significantly.

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