CALORIE AND NUTRITION MEASURMENT FROM FOOD IMAGE BY USING SVM & KNN

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Abstract— Measuring daily food consumption for obese patients is one of the challenges in obesity management. In this project, a computer vision based system to estimate energy intake based on food pictures taken. I propose a Food Recognition System (FRS) for calories and nutrient values assumption. The system then processes and classifies the images to detect the type of food and portion size, then uses the information to estimate the number of calories in the food. Emerging food classification methods play an important role in nowadays food recognition applications. For this purpose, a new recognition algorithm for food is presented, considering its shape, colour, size, and texture characteristics. Using various combinations of these features, a better classification will be achieved. Food calorie and nutrition measurement system that can help dietitians to measure and manage daily food intake. Here the food image is segmented into multiple segments by using the K-Means clustering. After that the texture, shape, and size features are extracted from the food image by using the Gabor filter. The performance improvement of food classification will be obtained by the combination of Support Vector Machine and K-Nearest Neighbor method. The better classification will be obtained by these combined method. The volume of the food is measured. After the mass calculation the calorie and nutrition of each food can be derived using nutritional tables.

I. INTRODUCTION

The prevalence of obesity is getting increased dramatically. Obesity is one of the most leading factors for numerous diseases, such as heart disease, hyper-tension and diabetes. There is a strong correlation between obesity and positive energy balance, which is the difference ingested energy from expended energy. Energy Intake (EI) is being taken into account as one of the primary reasons for gaining weight. Energy intake can be defined as the calorie equivalent of the consumed amount.

The idea presented in this project is driven by the growing apprehensions regarding health problems related to obesity and being overweight. Obesity in adults has become a serious problem. A person is considered obese when the BMI is higher than or equal to 30 (kg/m2). In 2008, more than one in ten of the world's adult population were obese, but in 2012 this figure has risen to one in six adults, an alarming growth rate. Recent studies have shown that obese people are more likely to have serious health conditions such as hypertension, heart attack, type II diabetes, high cholesterol, breast and colon cancers, and breathing disorders. The main cause of obesity is the imbalance between the amount of food intake and energy consumed by the individuals. Therefore, to lose weight in a healthy way, as well as to maintain a healthy weight for normal people, the daily food intake must be measured.

The main cause of obesity is the imbalance between the amount of food intake and energy consumed by the individuals. Therefore, to lose weight in a healthy way, as well as to maintain a healthy weight for normal people, the daily food intake must be measured. In fact, all existing obesity treatment techniques require the patient to record all food intakes per day to compare the food intake with consumed energy. However, in most of the cases, unfortunately patients face difficulties in estimating and measuring the amount of food intake due to the self-denial of the problem, lack of nutritional information the manual process of writing down this information, and other reasons. As such, a semiautomatic monitoring system to record and measure the amount of calories consumed in a meal would be of great help not only to patients and dieticians in the treatment of obesity, but also to the average calorie-conscious person Indeed, a number of food intake measuring methods have been developed in the last few years. However, most of these systems have drawbacks such as usage difficulties or large calculation errors. Furthermore, many of these methods are for experimental practices and not for real life usage. In this paper, I propose a personal software instrument to measure calorie and nutrient intake using a smartphone or any other mobile device equipped with a camera. This system uses image processing and segmentation to identify food portions i.e., isolating portions such as chicken, rice, vegetables, and so on, from the overall food image, measures the volume of each food portion, and calculates nutritional facts of each portion by calculating the mass of each portion from its measured volume and matching it against existing nutritional fact tables.

II. RELATED WORK

A Novel Method for Measuring Nutrition Intake Based on

Food Image - RanaAlmaghrabi, Gregorio Villalobos, ParisaPouladzadeh

A food nutrition and energy intake recognition system for medical purposes is proposed. This system is built based on food image processing and shape recognition in addition to nutritional fact tables. In this method, a measurement method that estimates the amount of calories from a food's image by extracting the volume of the food inside the image by using the thumb as a reference. The application is designed to aid dieticians for the treatment of obese or overweight people, although normal people can also control more closely their daily eating without worrying about overeating and weight gain. The initial effort has focused on identifying food items in an image by using shape recognition and image processing and classification by using SVM, and as a result we reach a reasonable measurement error for this method. In this measurement system, the goal is to develop and implement an instrument that measures daily food intake using mobile devices with a built-in camera to capture a photo of the food intake before and after eating, in order to estimate the amount of consumed calories. The proposed system depends on a new technique: the usage of the thumb as a calibration reference to estimate the amount of food from the captured photo. The Food Recognition System (FRS) captures a photo of the food and uses the patient's thumb as a measurement reference to calculate the amount of calories and nutrients from nutrition fact tables. A support vector machine (SVM) is a computer algorithm that learns by example to assign labels to objects. The SVM is successfully used for pattern recognition in various fields. The method is a very useful classifier since it determines a hyperplane that separates classes with the largest margin between the vectors of the two classes . The problem here is how obtain a linear separation. The disadvantage of this paper is the thumb size is varied. This experiments covered simple type of food and we are working on escalating it by testing more food types. This measurement method estimates the amount of calories from a food's image by extracting the volume of the food inside the image by using the thumb as a reference. this method achieves a reasonable error equal to 4.22%

A multiscale representation including opponent color features for texture recognition - Amit Jain and Glenn Healey

In this paper a representation for color texture using unichrome and opponent features computed from Gabor filter outputs. The unichrome features are computed from the spectral bands independently while the opponent features combine information across different spectral bands at different scales. Opponent features are motivated by color opponent mechanisms in human vision. A method for efficiently implementing these filters, which is of particular interest for processing the additional information present in colorimages. Gabor representations are used for color texture. The representation uses unichrome features computed from each spectral band independently, as well as opponent features that capture the spatial correlation between spectral bands. The opponent features are motivated by opponent processes in the human visual system. Using a data base of 2560 image regions. Gabor filters have been used extensively for the analysis of texture in grayscale images. These filters achieve optimal joint localization in space and spatial frequency and can be used to decompose images into components corresponding to different scales and orientations. The representations are limited by the large computational expense associated with the random field model.

Unsupervised texture segmentation using Gabor filters - Ani1 K. Jain,FarshidFarrokhnia

In which a texture segmentation algorithm inspired by the multi-channel filtering theory for visual information processing in the early stages of human visual system. The channels are characterized by a bank of Gabor filters that nearly uniformly covers the spatial- frequency domain. This paper propose a systematic filter selection scheme which is based on reconstruction of the input image from the filtered images. Texture features are obtained by subjecting each (selected)filtered image to a nonlinear transformation and computing a measure of "energy" in a window around each pixel. An unsupervised square-emr clustering algorithm is then used to integrate the feature images and produce a segmentation. The limitations of this texture segmentation algorithm is the lack of a criterion for choosing the value of a in the nonlinear transformation. Also, the algorithm assumes that different channels are independent from each other.

III.BACKGROUND WORK

An initial phase of this project involved studying different image recognition techniques being used to classify different foods. It is also appropriate to mention that the student took Surgery for Engineers, a Robotics Special Topics Course offered by Carnegie Mellon University, as an attempt to understand the relationships between the computing and medical disciplines. Since the student does not have any image recognition related prior work or course background, a simple simulation of trained data and feature vectors was created by the student to better understand the concepts involved in image recognition, and a preliminary model using Support Vector Machines using Cornell University's freely available SVM Lite package was studied to classify the generated vectors.

A. STEPS BEFORE FEATURE EXTRACTION

After scaling the input image to the desired size, minor lighting problems are resolved by adjusting the intensity of the gray scale version of the input image. Then perform adaptive equalization of the color histogram for different sub parts over the entire image, and finally pass it through a linearly averaging kernel to remove some level of noise and blur. Minor lighting problems are resolved, but extreme lighting such as bright camera flashes are not resolved well, so we assume the image is taken with the flash turned off. Pixel values with minimum intensity are first removed, and the entire image is then normalized by dividing by pixel values of the maximum intensity. This accounts for variance in color, lighting, texture and other intensities over different sections of the image. Using this method, a binary segmentation mask is generated. This method works best for plain backgrounds in cases where the background is lighter than foreground non-touching objects. Miscalculated background and foreground connected components are corrected based on area. The binary mask is then dilated and eroded to remove other unwanted noise before performing feature extraction on the detected objects (connected components). Figure 2.6 gives us a visual overview of the steps involved in our algorithm before feature extraction.

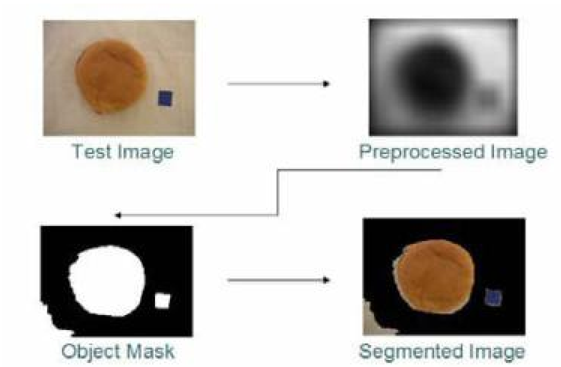


Figure 2.6: Steps before Feature Extraction

B.REFERENCE OBJECT

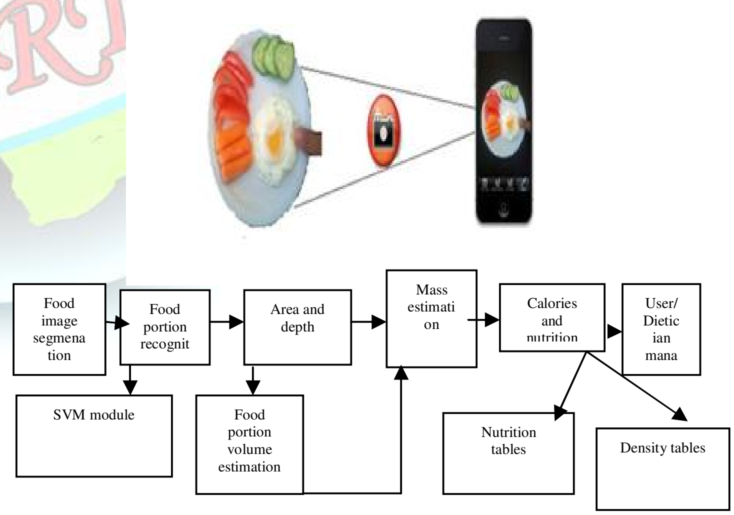
A special known predetermined static reference object that will be the same across all images is used to have some basis for extracting features such as size and color. The special reference object based feature extraction methods allows for the correction of errors by features based on trained models of food objects with respect to the same reference object. Without the reference object, it becomes difficult, to understand the size of an item or its color, since these might vary based on the distance the food item is from the camera or lighting and other conditions that affect the entire image. This special reference object based feature extraction algorithm is run on the labeled connected components derived from the segmentation and labeling stage.

IV. EXISTING SYSTEM

The overall design of the existing system and its blocks are shown in Fig. 1.1. As the figure shows, at the early stage, images are taken by the user with a mobile device followed by a preprocessing step. Then, at the segmentation step, each image will be analyzed to extract various segments of the food portion. It is known that without having a good image segmentation mechanism, it is not possible to process the image appropriately. That is jointly used color and texture segmentation tools. This will show how these steps lead to an accurate food separation scheme. For each detected food portion, a feature extraction process has to be performed. In this step, various food features including size, shape, color, and texture will be extracted. The extracted features will be sent to the classification step where, using the support vector machine (SVM) scheme, the food portion will be identified. Finally, by estimating the area of the food portion and using some nutritional tables, the calorie value of the food will be extracted. There is a one-time calibration process for the thumb, which is used as a size reference to measure the real-life size of food portions in the picture.

Fig. 1.2 shows the overall sequence of steps in existing system. The user captures two photos of the food: one from above and one from the side; the side photo is needed to measure depth, to have a more accurate volume measurement. The system uses image segmentation on the photo taken from the top and uses contours to isolate various food portions. The detailed design, implementation, and evaluation of this image processing and segmentation component are described.

From all of the above, it is clear that, for obese individuals to lose weight healthfully and for normal people to maintain a healthful weight, the daily food consumption must be measured . Thus, obesity treatment requires the patient to have healthy food and decrease daily food intake. But in most obesity cases, it is not easy for the patients to measure or control their daily eating due to the lack of nutrition education, self-control and denial of the negative effects of obesity. Therefore, using a monitoring food system will assist the patient as an effective option for obesity treatment.



.Figure 1.1: Diagram of the Food Recognition System

Nowadays, new technologies like computers and smartphones are involved in the medical treatment of different types of diseases and obesity is considered one of these common diseases. Much evidence shows that behavioral treatment and changing lifestyle habits is very effective in managing weight loss. In this research, a developed system is used that measures and detects the daily food intake for an individual who is overweight or obese or even wants to monitor the food he or she consumes daily. To reach this goal, a Food Recognition System (FRS) to measure calorie and nutrient intake values by using a smartphone or any other mobile device with a built-in camera. In detail the importance of the system and it is different from other dietary intake applications. This paper describe in detail how the results of the image are transitioned to the nutritional tables of food with the least possible error, which is the main goal. The user must take a picture of the selected food with his or her smartphone before and after eating to compare the sizes of the portions before and after the food intake, in case the user does not finish the meal. The system will then process the food images to detect different types of food and their particular portion sizes.

In other words, this system introduces a new food intake measuring system called the FRS. The idea behind these semi-automatic dietary intake assessments is to help and improve the treatment and management of obesity and overweight and take advantage of new technologies in the field of public health. By uploading the FRS application on their mobile phones, obese and overweight patients will have the opportunity to monitor their daily food intake without making any misreporting errors. Moreover, people with healthy weights can also use this system to watch their daily intake, which will assist them in avoiding obesity and becoming overweight. In addition, dietitians also can use this device to treat obese patients. A high-level block diagram illustrating the steps and the general architecture of the FRS is shown in Figure 1.2

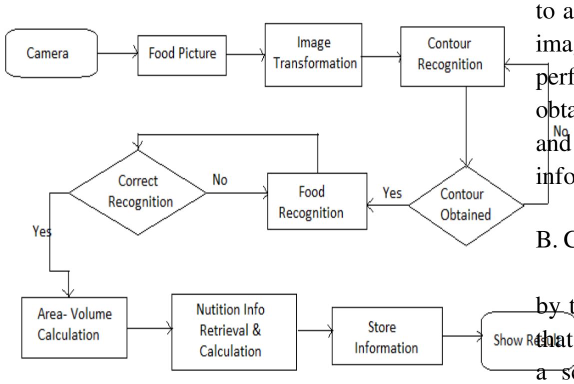


Figure1.2: The general architecture of the food recognition system (FRS)

The first step of the FRS is capturing an image of any food in a special way. Using image segmentation methods, the food portion area and all dimensions will be extracted from the photo. After that, the Support Vector Machine (SVM) technique will classify and identify the type of food. This will allow the system to extract the food volume from the image in an exclusive approach that will give the system the ability to calculate the mass of the food. Finally, the system will obtain all the nutrition facts by the adoption and the usage of food and density nutrient fact tables.

V.PROPOSED SYSTEM

In this proposed system, consists of all the methodologies used in the construction of the FRS. This system define a method to estimate the number of calories from an image by taking the advantages of some concepts. First, it will go through the references that is applied to this system to extract the measurements in an easy, unique way. This will explain the correct techniques to use this method to get the best results. Then the system will explain how it used the result from the first analysis stage to estimate volume so this method can continue the calculation correctly. A full block diagram of the general proposed method is shown in Figure.

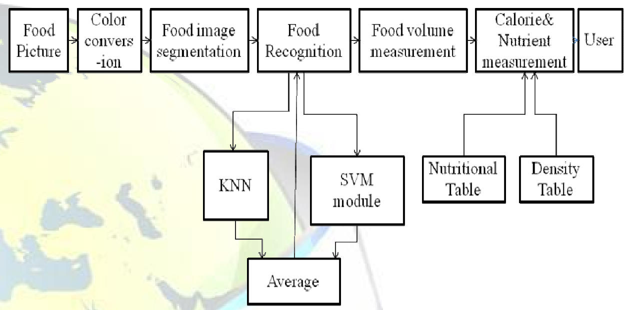


Figure2.1:Block diagram of calorie measurement

A.IMAGE PROCESSING

Image processing is a form of signal processing in which an image, picture or frame from a video is processed to produce another image or a set of information, parameters or specific data obtained from the characteristics of the initial image to be analysed. In this case, image processing is used to analyse the two-dimensional signals inside the data of the image to define the contours of the food in the image, perform a segmentation and a measurement of the objects to obtain an approximation of the real-life size of the portions, and finally allow the nutritional facts calculations with the information obtained from the image processing procedure.

B. COLOR CONVERSION

The use of color in image processing is motivated by two principal factors; First color is a powerful descriptor that often simplifies object identification and extraction from a scene. Second, human can discern thousands of color shades and intensities, compared to about only two dozen shades of gray. In RGB model, each color appears in its primary spectral components of red, green and blue. This model is based on Cartesian coordinate system. Images represented in RGB color model consist of three component images. One for each primary, when fed into an RGB monitor, these three images combines on the phosphor screen to produce a composite color image. The number of bits used to represent each pixel in RGB space is called the pixel depth. Consider an RGB image in which each of the red, green and blue images is an 8-bit image. Under the second itions each RGB color pixel is said to have a depth of 24bit. MATLAB 7.0 2007b was used for the implementation of all results.

C.RGB IMAGE TO GRAYSCALE IMAGE CONVERSION:

Any color image comprises of three basic colors: Red (R), Green (G) and Blue (B). Various large numbers of colors are formed due to the combination of these basic colors. Human eye notice these colors due to the variations in intensity of the RGB colors. Thus it is very crucial task to convert any RGB color image to other color space maintaining the intensity information. The color image is converted in to gray scale image. A gray-scale image is composed of different shades of grey color. A true color image can be converted to a gray scale image by preserving the luminance(brightness) of the image. Here the RGB image is a combination of RED, BLUE AND GREEN colors. The RGB image is 3 dimensional. Choosing a color space to focus on the subject is a critical task. When working with image intensity, it is important to preserve the intensity information while converting RGB image to Grayscale image. Thus, itneed to consider both luminance and chrominance factor, also decrease the calculation overhead in the above mentioned algorithm.

Color image will be converted into gray scale image. Average method is used for this conversion. Color pixel is described by R,G,B.

Average value=(R+G+B)/3

Color image= A[1:w, 1:h, 1:3]

Gray scale =A[1:w, 1:h]

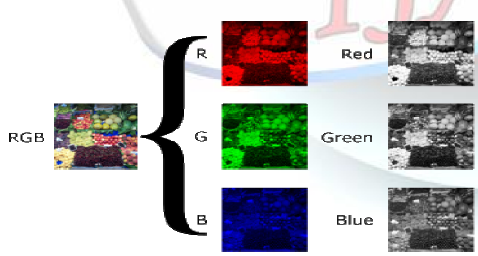


Figure2.2:Diagram for RGB to Gray scale conversion

D.BACKGROUND REMOVAL:

Pixel values with minimum intensity are first removed, and the entire image is then normalized by dividing by pixel values of the maximum intensity. For correction of miscalculated masked and unmasked pixels, improper regions are flipped using an adaptive thresholding method. This correction technique is applied due to the variance in color, lighting and other intensities over different sections of the image. Sub-image matrices are extracted and an average threshold is calculated for each matrix. Corresponding pixels in the sub-image above the local threshold are marked as background or foreground depending on their color intensity values.

This method mainly works for cases where the background is lighter than the foreground objects. In cases where touching objects are lighter or darker, the adaptive algorithm masks out a portion of the lighter object. This can still be ignored if the lighter intensity object is not too small. However, if very narrow, it will lead to a false positive region in the detected background mask. To overcome these limitations, only considering images that have lighter backgrounds with non-touching objects.

CLUSTERING ALGORITHMS:

K-means

K-medoids

Hierarchical Clustering

There are many other algorithms used for clustering.K-means algorithm was used in the project and the distances were calculated using Mahalanobis and Euclidean distances.

K-Means Clustering Overview:

K-Means clustering generates a specific number of disjoint, flat (non-hierarchical) clusters. It is well suited to generating globular clusters. The K-Means method is numerical, unsupervised, non-deterministic and iterative.

K-Means Algorithm Properties:

There are always K clusters.There is always at least one item in each cluster.The clusters are non-hierarchical and they do not overlap.

Every member of a cluster is closer to its cluster than any other cluster because closeness does not always involve the center of clusters.

The K-Means Algorithm Process

The dataset is partitioned into K clusters and the data points are randomly assigned to the clusters resulting in clusters that have roughly the same number of data points.

E.MAHALANOBIS DISTANCE:

Mahalanobis Distance is a very useful way of determining the ”similarity” of a set of values from an ”unknown”: sample to a set of values measured from a collection of ”known” samples

Superior to Euclidean distance because it takes distribution of the points (correlations) into account.Traditionally to classify observations into different groups. It takes into account not only the average value but also its variance and the covariance of the variables measured. It compensates for interactions (covariance) between variables. It is dimensionless.

The formula used to calculate Mahalanobis distance is given below.

$$Dt(x) = (x - Ci) * Inverse(S) * (x - Ci)`$$

Here X is a data point in the 3-D RGB space,

Ci is the center of a cluster. S is the covariance matrix of the data points in the 3-D RGB space. Inverse(S) is the inverse of covariance matrix S.

Euclidean Distance:

The Euclidean distance is the straight-line distance between two pixels

$$\text{Euclidean distance} = \sqrt{((x1 - x2)^2 + (y1 - y2)^2)}$$

where (x1,y1) & (x2,y2) are two pixel points or two data points.

E. SOFTWARE OVERVIEW

This research has been completely developed with MATLAB. This high performance language for technical computer, integrates computation, visualization, and programming in an easy-to-use environment. One of the reasons of selecting MATLAB in this research is because it fits perfectly in the necessities of an image processing research due to its inherent characteristics. MATLAB's basic data element is an array that does not require dimensioning. This is especially helpful to solve problems with matrix and vector formulations. And an image is nothing but a matrix or set of matrices which define the pixels value of the image, such a grey scale value in black and white images, and Red, Green and Blue or Hue, Saturation and Intensity values in colour images. In addition, MATLAB includes an Image Processing Toolbox which supports a wide range of image processing operations, such as

Geometric operations

Neighbourhood and block operations

Linear filtering and filter design

Transforms

Image analysis and enhancement

Binary image operations

VI.RESULT AND DISCUSSION

Testing the images with particular distance to estimate the shape, texture and the size of the food. Several approaches have been adapted in this system to recognise the features of the food image. In addition, we combined two approaches, the k-mean colour clustering method and the mean-shift segmentation method, to get more accurate results in the colour segmentation. Then we applied counter-detection to extract the food portions and identify each part of the food by its colour. To get more accurate results, we used Gabor filters to measure texture segmentation. The Food recognition system with multiple feature using k-mean colour clustering system results are shown by various figure below.

A.COLOR CONVERSION OF INPUT IMAGE

Initially the color food image was taken as the input image. Afterthat the color conversion will be done on the food image. The gray scale image will be obtained by using the average method

Figure 3.1: Color conversion of input image

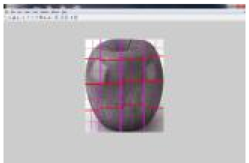
B.SEGMENTED IMAGE

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Here the food image will be segmentation was obtained by using the kmeans algorithm.

Figure 3.2: Segmented Image

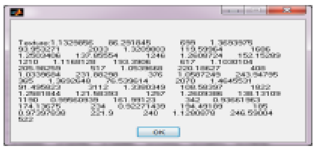
C.FEATURE EXTRACTION

Apple image is loaded as an input image and all its features including shape, texture, size, feature results of images are shown.



D.TEXTURE FEATURE

The texture features of each pixel in an image is extracted by using the gabor filter.

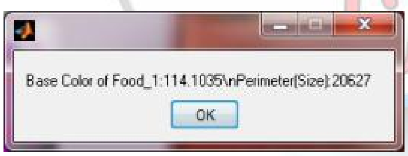


SHAPE FEATURE

The shape feature of the segmented food image is given below.

SIZE FEATURE

The size feature of the food image is given below.



VII. CONCLUSION

I conclude that it is possible to achieve nearly automatic recognition and feature extraction of food image.The framework is to have a system for food image recognition completely on the basis of shape, texture, size. Several food recognition techniques are developed based upon colour and shape attributes. Hence, using colour features and shape features analysis methods are still not robust and effective enough to identify and distinguish food images. A new food quality determination system has been proposed, which combines four features analysis methods: texture-based, shape-based and size-based in order to increase accuracy of recognition in a faster way.The proposed method can also classifies and recognizes food images based on obtained feature values by using this method.

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