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Assessing Food Volume and Nutritious Values from Food Images using Decision Tree Approach

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Abstract – *Obesity and being overweight have become growing concerns due to their association with many diseases, such as type II diabetes, several types of cancer and heart disease. Thus, obesity treatments have been the focus of a large number of recent studies. Because of these studies, researchers have found that the treatment of obesity and being overweight requires constant monitoring of the patient's diet. One of the important steps in the success of healthy diet is measuring food intake each day. One of the challenges in obesity management studies is measuring daily food consumption for obese patients. Countless recent studies have suggested that using technology like smart phones may enhance the under-reporting issue in dietary intake consumption. In this thesis, we propose a Food Recognition System (FRS) for calories and nutrient values assumption. The user employs the built-in camera of the smart phone to take a picture of any food before and after eating. The system then processes and classifies the photographs to discover the kind of food, portion size and then uses the knowledge to estimate the quantity of calories within the food using decision tree. An essential step in the system as it is used to estimate and calculate the food volume and amount of calories in the image.*

Keyword: *Image Processing, Food Obesity, Monitoring and decision tree*

1. INTRODUCTION

High calorie intake has proved harmful worldwide, as it has led to many diseases. However, dieticians have mistaken that a standard intake of number of calories is essential to maintain the right balance of calorie content in human body. There has been an unprecedented rise worldwide in over weightiness and obesity, as well as in diseases they cause. Thus, monitoring daily eating routines in order to avoid excess calorie intake has become an important issue in maintaining a good quality of life. Studies have shown that several diseases are linked to excessive calorie intake in humans. Pan found that breast, colon, and prostate cancers are caused by high calorie intake. High calorie intake was found to be only second to tobacco in directly causing cancer. Moreover, a previous study found that a proper diet involving lower calorie intake helped the residents of Okinawa to increase their life expectancy and lower the risk of age-associated diseases. High calorie values in food that is nutritionally poor led to systemic inflammation and reduced insulin sensitivity, as well as a cluster of metabolic abnormalities, including obesity, hypertension, and glucose intolerance. a review of the literature showed that reducing the calorie intake lessened the risk of cancer in humans. To assist people in tracking their calorie intake, efficient and convenient mobile applications have been developed that alert users to the number of calories they consume. Such mobile applications are becoming increasingly popular. Mobile applications have the capacity to provide the easy collection of personal health-related data and timely behavioral cues. Additionally, research has focused on the benefits of mobile and 2 Internet technologies in reaching diverse populations, such as rural communities, in order to reduce health disparities and promote health interventions. Obesity treatment needs the patient to note the amount of the daily food intake, but in most cases, it is not simple for the patients to measure or control their daily intake due to the lack of nutrition or self-control. Therefore, by using an automatic food intake monitoring system, we can assist the patient and provide an effective tool for the obesity treatment. Nowadays, new technologies such as computers and smart phones are involved in the medical treatment of different types of diseases, and obesity is considered as one of the common disease. From the last Calorie intake must rely mostly on the weight of the individual, his or her daily activity, age and gender. Each person should daily consume a certain amount of calories. If the amount of calories expenditure is increased, it will lead to weight gain and, therefore, the risk of obesity. Other facts for any food categories or any food item thus, all nutrient facts tables should include the number of calories plus. In our system, we will use the nutrient fact tables and the amount of calories for each type of food as a basic criterion, and this will allow us to find the amount of calories in a food image. In fact, the FRS relies on the already established nutrient fact tables as a reference to estimate the number of calories from any selected food photo. These data are stored in the system database in tables. 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 analyzed. In our case, we used image processing to analyses 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. An image or a set of images is used as input of the FRS (re-image) plus the objects present inside each photo (the thumb). These images are analyzed by signal processing, and the outcome of the

image processing is another image, images, or a set of features extracted from the original images. The pre-processing action comprises color, texture features and, size and shape. Many tests and trials should be done to achieve the desired result image processing requires. In this paper an automatic dietary monitoring of canteen customers that is based on histograms feature techniques for automatic food recognition and leftover estimation in a canteen scenario. Although the canteen scenario includes some apparent simplification such as controlled image acquisition conditions, known weekly menu etc., the problem of food recognition and leftover estimation. Nowadays, the major problem faced by people in food sector is due to the enormous variations in the tray and plate composition. The visual appearance of the same dish may greatly change depending on how it is placed on the plate. The system is able to identify and recognize the food category and estimate the amount of food and carbohydrates. Moreover, we can classify by decision tree and identify different calories of food.

2. LITERATURE REVIEW

S. Saha and D. Nandi [6], twenty well known data mining classification methods are applied on ten UCI machine learning medical datasets, and the performance of various classification methods are empirically compared while varying the number categorical and numeric attributes. The types of attributes and the number of instances in datasets. Out of this twenty classification methods Bayes Net., Naïve Bayes, Classification via Regression, Logistic Regression and Random Forest Classification methods are the best.NB-Tree, Classification via Regression and Bayes Net methods are the best for categorical attribute datasets. Out of these above five rule based classification methods PART and Decision Tree methods are the best.

Kiran Ambhore [7], Obesity is the major cause of overweight this leads to the type II diabetes, heart disease and cancer. A food is said to be healthy after measuring its calories and its nutrition and it is a challenging task. Smartphone plays a vital role in today's technological world using this technique will enhance the issue in intake of dietary consumption. A food image recognition system was being devolped for measuring the nutrition and calorie values. After taking the food image the colour, shape, size and texture features are extracted and it is given to the K-nearest neighbour (KNN) for recognizing the food and then the nutrition table helps to measure the calorie values.

I. M. N. A. Yasa, [8], C5.0 algorithm is used to create a decision tree based on the experts, while fuzzy logic used to categorize the type of hypertensive disease that suffered by the patient and increase the level of accuracy of the diagnosing system. The accuracy of the combination between c5.0 algorithm and fuzzy logic is about 97.19% treats an evaluation of the analyzed results of classification algorithms selected for better prediction based on the characteristics of data from the data set with liver disease, by Naïve Bayes, Decision Tree, Multilayer Perceptron and k-NN used in a previous study, which developed our data set, and Those algorithms were compared in several kinds of evaluating criteria like precision, recall, sensitivity, specificity, and so on. Through the experiments, we could know that in view of precision, in the performance of prediction test, Naïve Bayes is comparatively preferable than others, but in other criteria such as Recall and Sensitivity, Logistic and Random Forest took precedence over other algorithms as considering the algorithmic characteristics to liver patient data set.

Daniele Lima da Cruz1 Márcia Nacif [9] New nutritional guidance tools have been used by various health professionals. Among these are health-oriented cell phone applications with several resources that can help the user maintain a healthy diet. In this context, this study had as main objective to build a nutritional assessment application for mobile phones with Android system. An app called Diet Help was developed, with seven screens: "User Profile", "Food Record", "Summary of the day", "Diet history", "Food calories", "Healthy Eating" and "Delete User". The main programming languages used were Android Java, Javascript and SQlite for database. Diet Help allows calculation of body mass index, nutritional status according to age and sex, informs recommended daily energy intake, the amount of calories and nutrients consumed in each meal and if consumption (intake) is in accordance with the recommended levels for the user age and sex. It also allows users to find the amount of calories and nutrients per 100g of any food and provides information on healthy eating based on the food guide

3. PROPOSED SYSTEM

Food is one of the most important requirements of every living being on earth. The human beings require their food to be fresh, pure and of standard quality. The standards imposed and automation carried out in food processing industry takes care of food quality. Now a day, people across the universe are becoming more sensitive to their diet. Unbalanced diet may cause many problems like weight gain, obesity, diabetes, etc. Hence, different systems were developed so as to analyze food images to calculate calorie and nutrition level. This system proposes an effective way to measure and manage daily food intake of patients and dietitians. The system will take the images of food and using image processing, segmentation and classification it calculates the nutrition and calorie content in the food. The proposed system will certainly improve and facilitate the current calorie measurement techniques. In this paper, food portion recognition system uses for measuring the calorie and nutrition values. The user will just take a picture of the food image then recognize the image to detect the type of food portion and classify the image using decision tree. To classify the image perform segmentation, food portion recognition using skull striping and classification using support vector machine to calculate the calorie along with the type of energy in accurate way.

3.1 Pre-Processing

Once the picture of the food is captured by the user, the image is transformed and prepared for the next step, which we will explain in the following subsection. In the beginning, a simple conversion must be performed on the image to change the image size into a standard format for precise results for system segmentation. Thus, the size of each image will be compared with standard size categories. We have defined one size category as a standard, which are 970 × 720 pixels for simplicity. Larger images will be reduced to this size before accomplishment of any image-processing technique.

3.2. Segmentation

Segmentation is a process of extracting and representing information from an image is to group pixels together into regions of similarity Segmentation subdivides an image into its constituent regions. According to a set of predefined criteria similar features are being segmented. Clustering pixels into salient image region is the main aim of image segmentation. Segmentation could be used for object recognition, occlusion boundary estimation within motion or stereo systems, image compression, image editing, or image database look-up. The segmentation phase starts immediately after analyzing the pre-processing step. This part will operate with four different features: color, texture, shape and size, on which we are mainly concentrating in this project. These parts also include the calculation in pixels of the thumb and its size in pixels. The extracted size will be used in transforming the pixel size of food portions to actual, real-life size. In addition, the color feature will be extracted by using the color histogram, while the size feature will be extracted by including the pixels in the Region of Interest (ROI) for each food portion. Moreover, this will give us the shape feature which will be used in our calculating method. Standardized datasets are needed for the assessment of segmentation algorithms. The segmentation is often the key step in interpreting the image, if an image has been preprocessed appropriately to remove noise and artifacts. The process in which regions or features sharing similar characteristics are identified together is called image segmentation. Statistical classification, thresholding, edge detection, region detection, or any combination of these techniques may be used in image segmentation. The most segmentation techniques are either region-based or edge based; the output of the segmentation step is usually a set of classified elements. In image processing, Segmentation is the process of partitioning a digital image into several segments. The goal of segmentation is to simplify an image into something that is more meaningful and easier to analyze.

3.3 Texture feature extraction and Food Portion Volume Measurement

It is extremely appropriate to estimate the mean and also the variance of the energy of the filtered image. To calculate the surface area for a food portion, we propose to superimpose a grid of squares onto the image segment so that each square contains an equal number of pixels and, therefore, equal area. First comparison with other methods, the grid will easily match with irregular shapes, which is important for food images because most of the food portions will be irregular. Naturally, there will be some estimation error, but this error can be reduced by making the grid finer. Second, depending on the processing capabilities of the user's mobile device and the expected system response time from the user's perspective, we can adjust the granularity of the grid to balance between the two factors.

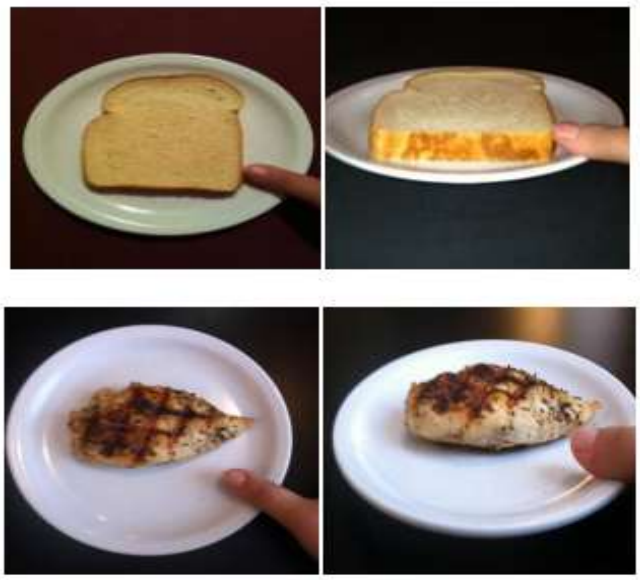

Fig -1: A captured food images to find calorie

3.4. Classification using decision tree

The processing of finding a set of model that distinguish data class for the purposes of being able to use the model to predict the class of objects whose class label is unknown is called classification. Classification is the process to construct a model based on the training set and uses it to classify new data or test set. It is a supervised learning as observations; measurements are accompanied by known class labels in a large amount of training set and new data is classified based on training set. Classification is one of main activities in the distillation of knowledge by learning supervised approach. High calorie intake has proved harmful worldwide, as it has led to many diseases. However, dieticians have mistaken that a standard intake of number of calories is essential to maintain the right balance of calorie content in human body. In this thesis, we consider the category of tools that use image processing to recognize single and multiple mixed food objects, namely decision tree. We propose a method for the fully automatic and user-friendly calibration of the sizes of food portions. This calibration is required to estimate the total number of calories in food portions. In this work, to compute the number of calories in the food object, we go beyond the finger-based calorie calibration method that has been used in the past, measuring the distance between the user and food object has been done automatically.

A decision tree is a predictive modeling technique from the fields of machine learning and statistics that builds a simple tree-like structure to classify the data according their categories. A decision tree is like a tree structure, in which each internal node denotes a test on an attribute. Decision tree model worked as step by step then food addiction is used as data source. Data Training is used to determine entropy an information gain. Then, select max value gain. Choice node by gain maximum. Target is Class. Decision Tree based on Decision Tree Induction.

Step 1: Tree is constructed in a top-down recursive divide-and-conquer manner.

Step 2: At start, all the training examples are at the root.

Step 3: Attributes is categorical (if continuous-value, they are discretized in advance).

Step 4: examples are partitioned recursively based on selected attributes.

Step 5: test attributes are selected on the basis of a heuristic or statistical measure.

Conditions for stopping partitioning when all samples or a given node belong to the same class. There are no remaining attributes for further partitioning-majority voting is employed for classifying the leaf, and there are no samples left. Entropy is a measure of uncertainty associated with a random variable.

4. EXPERIMENTAL RESULT

The estimation of food volume through an image is a major challenge in dietary intake assessment applications. In this section, we will examine the methodology of obtaining the volume of any food image by utilizing the area size that has been extracted from the photo after the image analysis and the shape recognition process. As soon as the photos of the selected food are captured, the application starts to analyse the pixels of both thumb and meal from the first photo (top view).

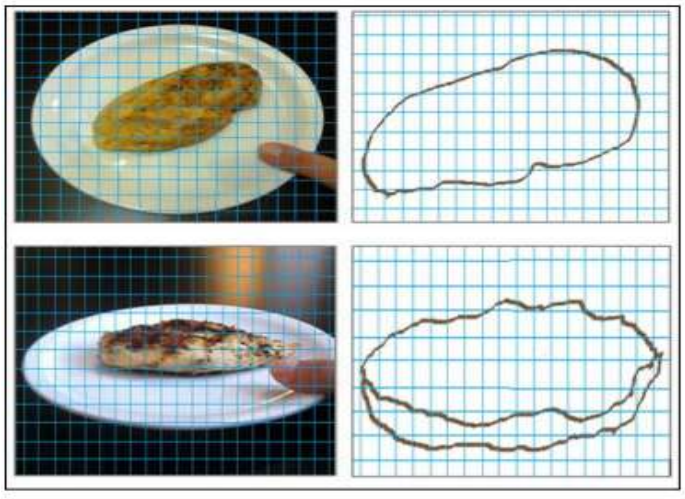

Fig 2 -Pre-Processing image

The main resulting value from this calculation is the area size (height and length) in pixels, which will be used with the other dimensions of the food item from the second side of photo (photo) to generate the width (volume). Finding the volume of the photo leads us to easily calculate the amount of the calories in the calories selected food via a special algorithm that depends on the nutritional tables stored inside our application. In the next subsections, we will elucidate in detail how we calculate volume in irregular and regular shapes.

The main objective of the FRS is to estimate the amount of nutrition values and calories for any food type from an image. Thus, caloric estimation is the main, final stage for our system. In fact, the importance of using the already stored nutrient fact tables will also appear in this stage. In general, the system starts to calculate

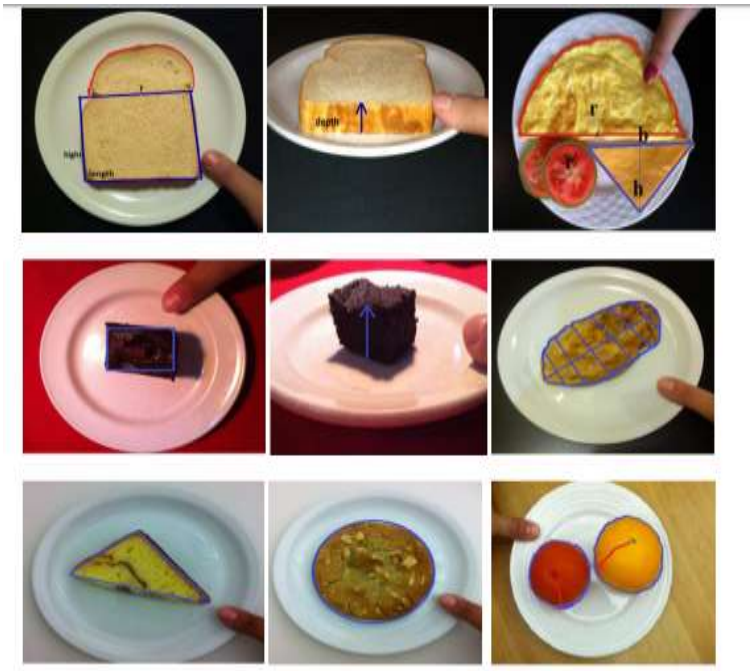

Fig 3 - Calculating calories

the calories by comparing the inputs from the image (mass) with the inputs from the nutrient tables (mass measured by gram and calorie amount, which is measured by calories), which are already stored in the application's database. We propose a novel method to measure and estimate the amount of calories in any image.

After calculating the size, we started applying the proposed method to compute the mass of the food inside the image. Thus, we used the known variables, which are volume and food density, to calculate the mass. We also measured and weighed all the selected food manually to ensure the validity of the proposed method at the same time. Thus, finding the mass of the selected food allowed us to calculate the amount of the calories and this is simply by applying our proposed equation that allowed us to compare the amount of calories and mass in the standard tables with the estimated results.

Table - 1: Volume of different types of simple food

No.	Food item	Volume	No.	Food item	Volume
1	Bread	42.9	16	Fish (filet)	23.2
2	Apple	44.6	17	Chicken breast	18.6
3	Orange	85.6	18	Cheese (slice)	81.1
4	Steak	12	19	Sauce	20.6
5	Bread/toast	8	20	Pasta	50.2
6	Brown bread	7.3	21	Red Beans	22
7	Cake	4.6	22	Corn	14.31
8	Spaghetti	55	23	Green Pepper	34.7
9	Cookies	14	24	Chocolate Cookies	10.5
10	Omelet	18	25	Marble cake	8.24
11	Carrot	2.2	26	Rice	18.7
12	Cucumber	2.1	27	Cabbage	202.4
13	Potato	13	28	Lettuce	8.3
14	Banana	6.9	29	Fish (filet)	16.9
15	Tomato	34	30	Chicken breast	304.2

5. CONCLUSION

Now-a-days, people are getting more health conscious and tend to keep a check on nutritional gain from the packed food products they consume. Main problem in human nutrition is the assessment of usual food intake. The recent proposal of e-Health personalized intervention has been given. Performing dietary assessment using digital photos of food became popular. 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 using decision tree. Our system provides better result.

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