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PERFORMANCE ANALYSIS OF NUTRITIONAL CONTENTS IN FOOD IMAGES USING SARAN

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ABSTRACT

In the present day scenario, analysis of nutrition and calories in daily food intake has become indispensable. The increasing obesity problems have made a significant effect on the people to be concerned about the calories they consume. In this paper, we propose a food calorie measurement system that can help them to measure and manage daily food intake. This method is employed to identify if the food image is good or rotten. If it is found to be good then it is taken for calorie measurement analysis and classified based on standard calorific tables using Self- Adaptive Resource Allocation Network [SARAN]. Then, based on the BMI of a person, the result alarms about whether the food under analysis is suitable to the person or not. The results show that the accuracy of the system is acceptable and it will greatly improve and facilitate current manual calorie measurement techniques.

Keywords: food image processing, calorie measurement, obesity management, dietary assessment.

1. INTRODUCTION

Nowadays, the increasing rate of overweight children and adults is a worldwide health issue. Obesity is a major problem which is increasing day by day. This frames the basic cause for all the health issues like hypertension, heart attack, type II diabetes, high cholesterol, breast and colon cancers, and breathing disorders. People get easily tempted towards the taste of the food and forget to analyze how much they eat. According to a study published in the noted journal Lancet, India is just behind US and China in this global hazard list of top 10 countries with highest number of obese people. The US topped the list with 13 per cent of the obese people worldwide in 2013, while China and India together accounted for 15 per cent of the world's obese population, with 46 million and 30 million obese people, respectively [1]. According to the study, number of overweight and obese people globally increased from 857 million in 1980 to 2.1 billion in 2013. This is one-third of the world's population. In 2008, more than one in ten of the world's adult populations were obese [2], but in 2012 this figure has risen to one in six adults [3], an alarming growth rate.

The weight reduction treatments have also been increased on the other hand. Various dietary modifications, behavior modifications, doing regular exercises, self-assessments are followed but people lack in the awareness of how much calories they can consume for a day.

Calories are a must for the body, as they are generate energy. But as it is said that an excess of anything is bad and the same applies to the intake of calories too. If there is an excess of calories in our body, it gets stored in the form of fats, thus making us overweight. Adult calorie requirements differ from that of a child and in the same way, the daily calorie requirement of an athlete would differ from that of a person who does not have a very active routine. Thus, the calorie intake requirement differs from person to person, depending upon several factors like age and body composition [4]. In Table-1, the daily calorie needs of male and female are sorted accordingly to their age groups.

Table-1. Daily calorie needs

AGE GROUPS	DAILY CALORIE NEEDS MALE	DAILY CALORIE NEEDS FEMALE
19 - 59	2550	1940
60 - 74	2350	1900
75 & ABOVE	2100	1810

During food intake, it is unknown that how much calories we take and hence here a method which can show off the level of calories in each food item we consume is proposed. Based on the Body Mass Index [BMI] of a person, the system alarms about the calories in the food is appropriate to the person through digital food image processing techniques.

2. RELATED WORK

The assessment of food intake in adolescents has been previously performed using a number of methods like food record (FR), the 24 – hour dietary recall, and a Food Frequency Questionnaire (FFQ) with external validation by doubly labeled water (DLW) and urinary nitrogen. These methods are mostly based on manual recording of the intake nutrients. For instance, the approach used in the 24-hour Dietary Recall is the listing of the daily food intake by using a special format for a period of 24 hour while a brief history may be incorporated into the view to facilitate probing for foods and beverages consumed. The main disadvantage of the 24HR is the delay and inaccuracy of reporting the eaten food comes from several factors, such as age, gender, education, credibility and obesity [5].

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With the introduction of modern technologies, the use of image processing systems in food calorie analysis has been addressed. The idea is taking a picture of the food before and after eating and to send the picture to a research centre to be analyzed. This will obviously come up with a shortcoming of offline data processing. If people start sending all the images of the food they consume ten huge database management and analysis tools have to be employed in the research centre which reduces the performance results to a greater extent.

Chang *et al.* [6] proposed a dining table equipped with different sensors located within the table and RFID tags, the RFID identifies the food, and the sensors weight the amount of the portion. But this requires the user to eat only at that table, such environments are therefore impractical, if we intend to apply this kind of measurement in common situations such as food courts or restaurants.

Some other techniques require the person to take a picture of the food before eating it, so that the picture can be processed offline, either manually or automatically, to measure the amount of calorie. For example, the work in proposes a method that uses a calibration card as a reference; this card should be placed next to the food when capturing the image, so that the dimensions of the food are known. However, this card must always be present in the photo when the user wants to use the system. The drawback is that the system will not work without this card, which means that in the case of misplacement or absence of the card, the system will not work. Another method uses the photo of the food and feeds that to a neural network developed by researchers in. But the user must capture the photo in a special tray (for calibration purposes), which might not be always possible and so the method might be difficult to follow for the average user [7].

In our proposed system, we aim at overcoming these disadvantages by using a system which discriminates between a good and rotten food intake and only when a good food is given as input, a calorie measurement analysis is carried out further for the calculation the calories based on the size and shape of the food. Also, the Body Mass Index of the person is considered and accordingly the system alerts about the lack or need of the calories.

3. BACKGROUND

a) Measurement unit: Calorie definition and nutritional tables

Calories refer to the amount of energy that the foods we consume contain. In order to maintain an ideal weight it is important to consume the recommended amount of calories every day. It is defined as the amount of heat energy needed to raise the temperature of one gram of water by 1° [8]. This unit is commonly used to measure the overall amount of energy in any food portion that consists of the main food components of carbohydrate, protein, and fat. The amount of calories that a person needs is directly proportional to the amount of physical activity carried out. In general, children and teenagers need more calories as they are active and their bodies are still in the process of development. Senior citizens will need lesser calories as they do not have much of strenuous physical activity.

Table-2. Calorific table.

FOOD NAME	WEIGHT IN GRAMS	CALORIES
APPLE WITH SKIN	140	80
ORANGE	110	62
TOMATOES	123	30
BREAD	100	17
CARROT	100	22

b) Body Mass Index (BMI)

Body Mass Index (BMI) is a number calculated from a person's weight and height. BMI is a fairly reliable indicator of body fatness for most people. BMI is used as a screening tool to identify possible weight problems for adults. However, BMI is not a diagnostic tool. For example, a person may have a high BMI. However, to determine if excess weight is a health risk, a healthcare provider would need to perform further assessments. These assessments might include skin fold thickness measurements, evaluations of diet, physical activity, family history, and other appropriate health screenings. The general formula to calculate the BMI of a person using height in meters and weight I kilograms is

$$\text{BMI} = \frac{\text{WEIGHT IN KILOGRAMS}}{[\,(\text{HEIGHT IN METERS})\,]^{2}}$$

Table-3. BMI range.

BMI CLASSIFICATION	
UNDER WEIGHT	< 18.5
NORMAL RANGE	18.5 - 24.9
OVER WEIGHT	> = 25.0
PRE OBESE	25.0 - 29.9
OBESE	> =30.0
OBESE CLASS I	30.0 - 34.9
OBESE CLASS II	35.0 - 39.9
OBESE CLASS III	> =40.0

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Using the standard BMI formula the Body Mass Index of the person is calculated and based on the results he/she can be sorted as obese, normal range and underweight [9]. The classified ranges of BMI are shown in the Table-3

4. PROPOSED METHOD

The overall design and blocks of our proposed system is shown in Figure-1 As the figure shows, at the early stage the food image is taken by the user with the thumb. This is followed by the preprocessing step. This includes the use of color space conversion from RGB to HSV.

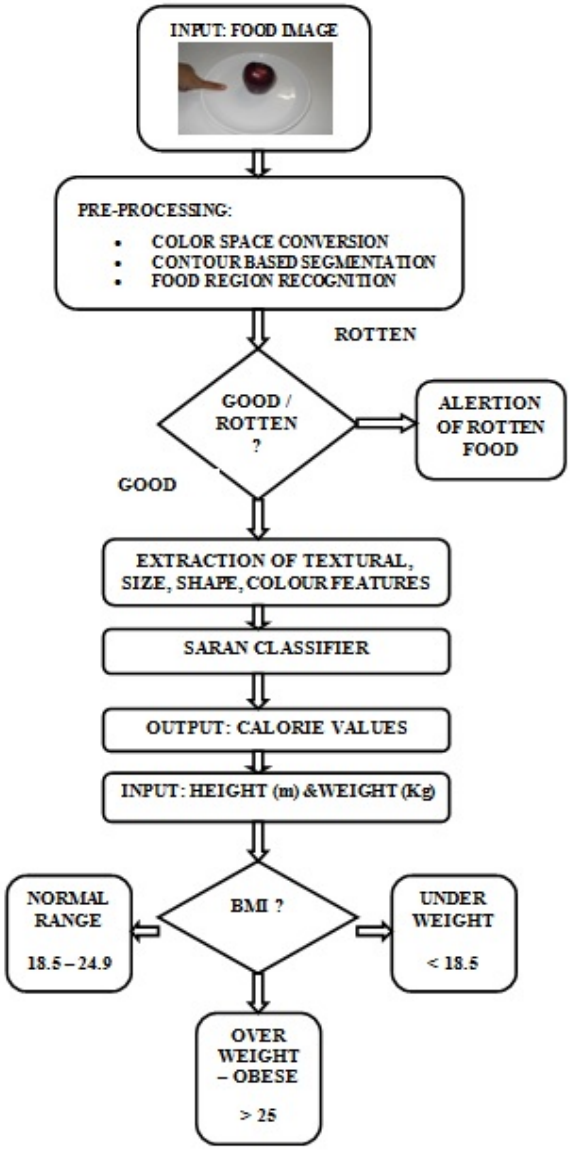

Figure-1. Overall system design.

The converted RGB image is then put into Contour Based segmentation where the boundary of the image is actually separated and the foreground food image is clearly segmented from the background image. The segmented foreground food image is then taken and food region is recognized based on the R, G, B intensity values and L, A, B – Luminance and two color channels 'a' and 'b' valves extracted from the food image.

Later, a database is created and based on the above calculated values the food images are discriminated as good food and rotten food. Only those images which are good are taken for further analysis and the rotten food images are alerted to the user.

In order to calculate the calories from the good food image the textural features are extracted from the image. These features include GLCM (Grey Level Co-occurrence Matrix) features such as contrast, correlation, energy, homogeneity, autocorrelation, cluster prominence, dissimilarity, entropy, maximum probability, sum average, sum variance, sum entropy, difference entropy, information measure of correlation I, information measure of correlation II, inverse difference normalized and inverse difference moment normalized.

This is then followed by the extraction of shape, size and color features from the food image. The area and volume is measured with reference to the thumb to avoid miscalculation of the actual size and volume of the food image. The features extracted are finally given to the Self Adaptive Resource Allocation Network (SARAN) classifier [10] and calorie values are calculated using the formula given below.

$$\text{CALORIES IN THE FOOD IMAGE} = \frac{\text{CALORIE FROM THE TABLE} * \text{MASS IN THE PHOTO}}{\text{MASS IN THE TABLE}}$$

This classifier gives more accurate results than the commercially used classifiers.

At the end, the calorific value of the good food image is shown off. The person is now intimated to enter his/her body height in meters and weight in kilograms. Based on this input, the Body Mass Index of the person is calculated using the above mentioned formula and sorted as underweight, normal range and obese. If he within underweight range, it alerts them as he needs more calories to make him reach the balanced level. If he is within range, it alerts them as he has a balanced BMI ratio and he is healthy. If he is within the overweight or obese range, then it alerts them as the calories obtained from the food under analysis is too much and he need to reduce the amount of calorie intake.

5. PERFORMANCE ANALYSIS

During the analysis of the images, the system showed the results for the good as well as rotten food images. Also, the calorific values have been obtained for the good food and according to the BMI level of the person the appropriate alert is given to the person. The various results obtained are showed in the Figure-2 (a),(b), (c) and (d).

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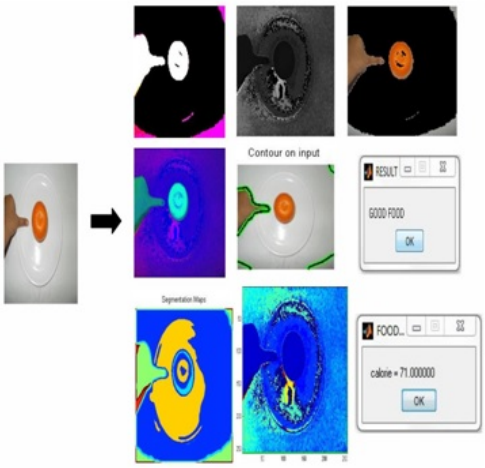

Figure-2(a). Results for good food.

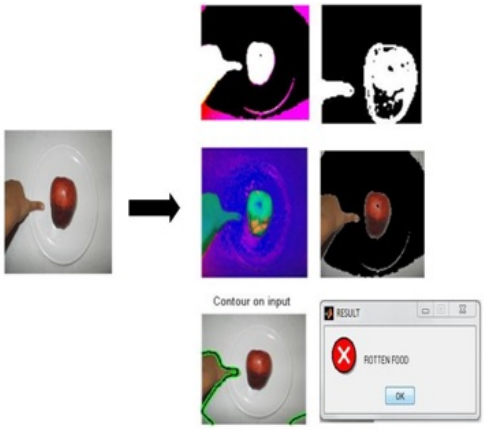

Figure-2(b). Results for rotten food.

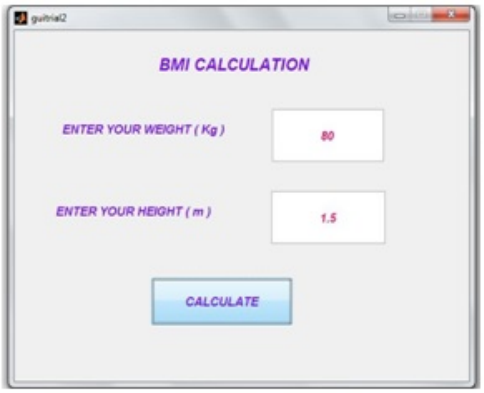

Figure-2(c) and **(d)** Results of BMI calculation.

6. FUTURE SCOPE

The proposed model can be further improved with an idea of integrating Personal Digital Assistants or Smartphone for taking an input from the user. Also, various sensing equipments can be employed through the mobile phones to detect the height and weight of the person rather than entering it manually. Algorithms can be adopted to improve the performance results that can be expandable to mixed foods.

7. CONCLUSIONS

The methodological approach of finding the quality of the food and later on the calories in it proved to be an ample evidence for the efficiency of the system being used. The result obtained based on the BMI results provided significant realization about how much calories we consume. This model can be deemed to be used in various professional fitness training areas to facilitate the dietitians for the measurement of calories consumed by the trainees. It is important to continue the lines of further research so that the self assessment of calorie management of every person can be strengthened.

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