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Performance Analysis of SVM to Measure Calorie and Nutrition from Food Images

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Abstract: Now a day's obesity is a major problem in human life. So the people are very eager to measuring their weight, healthy eating and also avoiding obesity, so they were need a system to measure the calorie and nutrition from the daily in taking food. A new System is proposed to measure the calorie and nutrition from the food image and it helps patients and dieticians for managing their daily in taking food. In this generation the usage of Personal mobile technology such as smart phones or tablets usage has been increased and also the users can carry with them periodically all the time, so by using a built-in camera of mobile the snapshot of food is taken to measure the consumption of calorie and nutrient components. The results have acceptable accuracy in calorie measurement technique can be done by using MATLAB.
Index terms: Calorie and Nutrition measurement, obesity management

I. INTRODUCTION

Obesity in adults has become a serious problem. BMI for men and women are obtained from the calorie needs. Calorie requirement is used to determine energy needs. The energy needs are determined by the needs of Protein, Carbohydrate, Fat, Vitamin and Mineral. In recent studies shows that more than one in ten of the people were affected in obese. Due to this obesity 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 reason for the obesity is the imbalance between the daily food intake and the energy consumed by a person (i.e.) if the food intake amount is more than the energy consumption. Therefore, to reduce the weight and also to maintain the healthy weight for normal people, the measurement of the daily food intake is necessary. In previous obesity treatment technique require to record all food intakes, which are compared to the consumption of energy by a person in a day. Due to the lack of nutritional information, self-denial of the problem, and the manual process of writing down the information (which is tiresome and can be forgotten), the patients faces more difficulties in estimating the amount of food intake. As such, a semiautomatic monitoring system to record and measure the amount of calories consumed in a meal, which provide more help not only to patients and dieticians in the treatment of obesity, but also to the average calorie-conscious person. In last few years a number of food intake measuring methods have been developed but these methods have some drawbacks such as usage difficulties or large calculation errors.

Now a day's new technologies such as computers and Smartphone are involved in the medical treatment of different types of diseases and obesity is considered one of these common diseases. So in this paper I use the Smartphone or any other device equipped with camera. This system uses the process of segmentation, feature extraction, and classification to find the food portions from the captured images and then measure the volume, mass of each food portion and then calculate the calorie value from the nutrition table.

There have been a number of proposed methods for measuring daily food's dietary information. One example, which is typical of current clinical approaches, the doubly labeled water (DLW) method was developed in the early 1950s by Lifson and McClintock in 1966. DLW method used to estimate the energy expenditure.DLW is considered the gold standard method for measuring total energy expenditure. In this method a dose of heavy Oxygen O18 and Hydrogen H such as deuterium in a certain quantity have given to a human or animal, and then collect samples of urine or saliva in consecutive periods (i.e., several days or weeks) and measure the concentration of some of the elements.

This method is one of the most expensive measuring intake methods because it requires costly

equipment to estimate the concentrations of the isotopes that need to be measured.

To improve these clinical methods, the researchers have been trying to improve some techniques. In this technique the person to capture 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, J. D. Fernstrom, *et al.*, proposes a method the system uses a calibration card as a reference. When taking a picture of the food items this card should be placed next to the food. So the dimensions of the food are known. However, the user wants to use the system then this card must always be placed near the food. The drawback is that without this card (i.e.,) 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 this method the user capture the photo of the food in a special tray for the calibration purpose. A personal digital assistive (PDA) system has also been proposed for the measurement of calorie from food images. In this the patients use the PDA to record their daily food intake information on a mobile phone. But this result shows the estimation of food portion has significant error and also it takes a longer time to record the information. Yet another approach is the neural network based method. In this to take the picture of the food with a smartphone , these picture is compared to the predefined foods with known nutritional values, these values are stored in a database, by using these values to estimate the calorie value. The drawback of this method is, it does not consider the size of the food. Compared with the above all methods, this proposed system has fewer advantages. This system takes a snapshot of the food image using the built-in camera of a smart phone and also uses the patient's thumb for calibration which solves the problem of using calibration cards or special trays. In this method especially to capture the patient's thumb and also store this image with its measurement.

By using the patient thumb placed near the dish, easy to measure the real life size of the portions. Then using segmentation, feature extraction, and classification to measure the volume, mass of each food portion and then calculate the calorie value from the nutrition table. The Nutrition table is available in Health Canada website.

II. PROPOSED METHODOLOGY

The proposed methodology consists of four phase, namely segmentation, feature extraction, classification, and calorie calculation. The block diagram of the proposed methodology is shown in Fig 1.

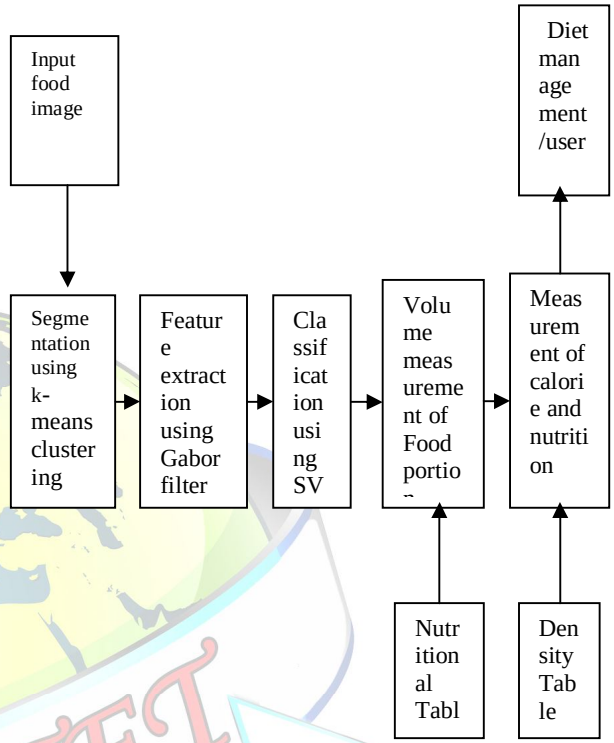

Fig 1. Proposed Method

A. Image Segmentation

Image segmentation is the process of partitioning a digital image into multiple segments. Here, using the K-means clustering for image segmentation as shown in Fig.2.It is a partitioning method. It uses an iterative algorithm that minimizes the sum of distances from each object to its cluster centroid, over all clusters. For example, the distance between two pixels are determine by the Euclidean distance is given by,

$$\text{Euclidean distance} = \sqrt{((x_1 - y_1)^2 + (x_2 - y_2)^2)} \qquad (1)$$

Algorithm.

The K-means algorithm will do the three steps below until convergence

1. Determine the centroid coordinate
2. Determine the distance of each object to the cendroids
3. Group the pixel based on minimum distance

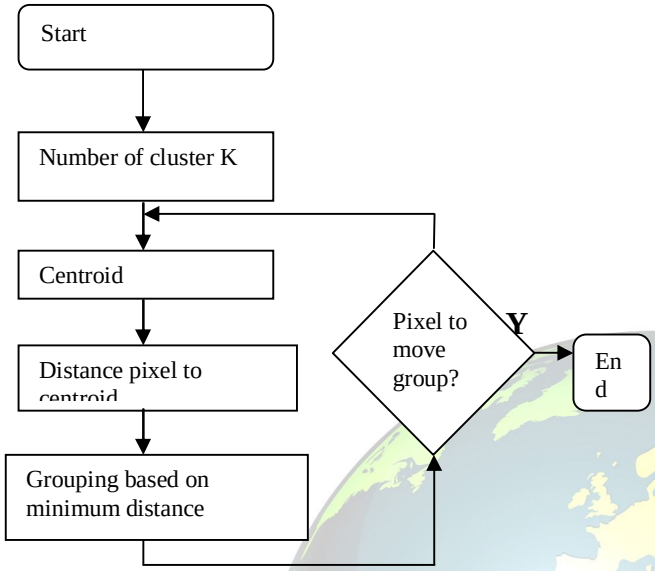

Fig 2. Flow Chart Of K-Means Clustering

B. Feature Extraction

Feature extraction is defined as the transformation of input data to set of features is called feature extraction. Here using the Gabor filter to extract the feature from the food image. The Gabor filter produce more accurate result in feature extraction. There are four features like size, shape, color, and texture are extracted here. It is an edge detection linear filter . Frequency and orientation representations of Gabor filters are equal to the human visual system, and it is used to detect the texture of the images. It is one of the Gaussian kernel based method. The input image is decomposed into the number of filters images by using the set of frequency orientation. Here using the 2-D Gabor filter, which is provide more accurate resolution in both frequency and spatial domain.

Here we using five scales (S = 5) and six orientations (K = 6) so using 30 digital filters which have 48 features.

C. SVM Classification

SVM is used as a computer algorithm which assigns the labels to any object based on its threshold values. SVM is used as a classification device which is based on the machine learning theory. The SVM under the category of supervised learning method. It will provide more accurate results to stored data into the best group.

Steps involved in SVM, first we have to choose the kernel function which is suitable for classification. Then we choose the value of C. where, C is the regularized parameter which is based on the margin value. After that, we solve the optimization problem for matching. And then construct the classification function.

A Support Vector Machine which is used to find the best straightening out hyper planes in a high dimensional feature space.

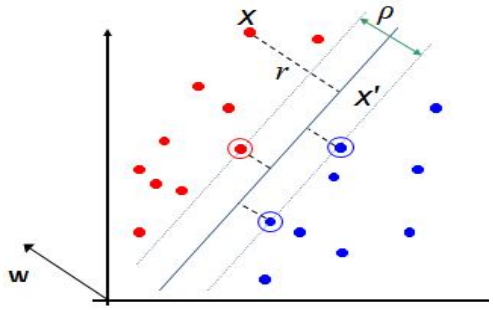

Fig 3: Support Vector Machine Representation

The distance of the separator can be determine by

$$r = y\frac{w^T X + b}{||w||} \quad \ldots(5)$$

From the Fig 3 shows that the representation of SVM. And Fig 4 shows that the SVM classifier. Here Margin ρ is the width of separation between support vectors of classes.

$\rho = (x_a - x_b)$ …(6)

In support vector the Hyper plane may be represented by,

$w^T x + b = 0$ …(7)

Here two cases are there,

(1) The value of $w^T x + b$ is positive means the elements will be classified one category. That is,

$w^T x + b = 1$ …(8)

(2) The value of $w^T x + b$ is negative means the elements will be classified one category. That is,

$w^T x + b = -1$ …(9)

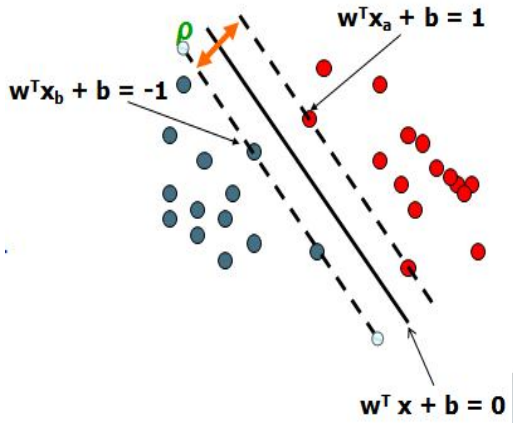

Fig 4. SVM Classifier

The margin value ρ can be determine by finding the difference of the above two equations (8)&(9). We get,

$$w^T(x_a - x_b) = 2 \quad \ldots(10)$$

from (6)

$$\rho = \frac{wT}{2} \quad \ldots(11)$$

III. Volume And Calorie Estimation

In volume estimation method, the users thumb can be used as a reference. In this there are two photos are taken one from the top view and another from the side view as shown in Fig 5.

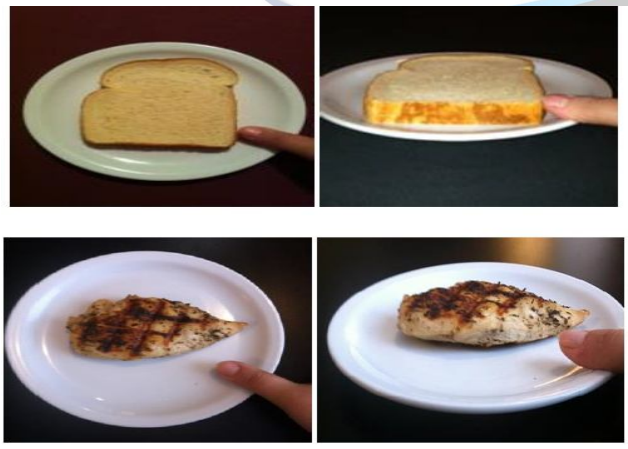

Fig 5: A Captured Food Images With The Correct Position Of The Thumb

By using the top view we have to calculate the total area (TA) of the food portion. The total area is calculated as the sub areas (T_i) for each square (i) in the grid. The sub areas are calculated in the segmentation process.

The total area is given by,

$$TA = \sum_{i=1}^{n} T_i \quad \ldots(12)$$

By using the side view we have to measure the depth (d) of the captured food image.

The Fig 6 shows that the measurement of total area and depth from the food images.

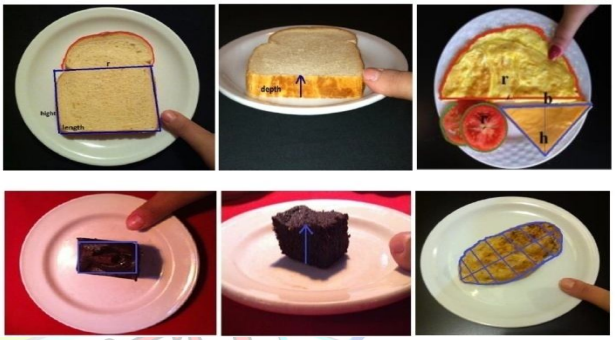

Fig 6: Calculating Area And Volume Of The Food Images

The volume can be calculated by

$$V = TA * d \quad \ldots(13)$$

After that the mass of the food image can be measured by

$$M = \rho V \quad \ldots(14)$$

Where M is the mass of the food portion, ρ is the food density, and V is the food volume extracted before from the image, plus the user's thumb inside the photo.

Each of the food has different density. Food density tables can be found online or in the Health Canada food guide. There are many types of density are there, here the Bulk density is considered the suitable one.

Then we have to estimate the calorie from the food image by using the following formula

$$\text{Calorie in the photo} = \frac{\text{calorie from nutrient table} * \text{mass in the photo}}{\text{mass from nutrient table}}$$

IV. Results And Discussion

From the table 1 shows that the results of the food recognition system. In this there are four features are there. It will produce the accurate result in its texture only compared to all the other features.

Table 1: RESULTS OF FOOD RECOGNITION SYSTEM

Table 2. ACCURACY OF PROPOSED METHOD IN COMPARISION WITH REAL VALUES

Food Portions	Weight(Grams)	Calculated Calorie	Real Calorie	Absolute Accuracy (%)
Cake	100	275	250	90
Egg	150	15	17	88
Apple	200	100	114	87
Tomato	150	23	30	76
Cucumber	100	27.5	30	91
Average Accuracy				86.4

No	Food items	Recognition rate (%)					
		Using color features	Using texture feature	Using size features	Using shape features	Using all features	Using all features(10 fold cross-validation)
1	Apple	60.33	85.25	31.22	22.55	97.64	91.41
2	Orange	65.38	79.24	41.04	71.33	95.59	90.19
3.	Corn	52.00	81.93	71.33	34.61	94.85	97.00
4	Tomato	71.29	69.81	48.09	45.01	89.56	79.82
5.	Carrot	74.61	79.67	69.30	65.19	99.79	92.34
6	Chicken	69.81	71.45	28.02	34.27	86.55	84.52
	Total Average	65.57	77.89	48.17	45.49	93.997	92.348

As the table 2 shows, the accuracy of the proposed method in non mixed food is approximately around 86%.

V. CONCLUSION

In this work, a measurement method that estimates the amount of calories from a food's image by measuring the volume of the food portions and using nutritional facts tables to measure the amount of calorie and nutrition in the food. This system is designed to aid dieticians for the treatment of obese or overweight people, although normal people can also benefit from this system by controlling more closely their daily eating without worrying about overeating and weight gain. This paper focussed on identifying food items in an image using image segmentation and classification and measures volume and calorie based on food portion mass and nutritional tables. Results of this paper indicate the reasonable accuracy in area measurement, and subsequently volume and calorie measurement.

VI. FUTURE ENHANCEMENT

Following plans can be used to improve the measurement of the mass of the food to achieve higher accuracy.

a) Better estimation of the area of each food portion, which can be improved using more accurate segmentation methods

b) Coming up with an approach to measure the depth of the food more accurately, instead of assuming that the depth is uniform throughout the food portion's area, which is what we assume now.

c) All of our simulations are performed on white plates with a smooth texture. We need to expand our work to various plates with different shapes, textures, and colours as well.

d) To increase more accuracy by using the KNN as a classification method.

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